PRTR

ESTABLISHING A POLLUTANT RELEASE AND TRANSFER REGISTER IN CHINA

MANAGING HAZARDOUS CHEMICALS IN ELECTRONICS PRODUCTION

IPE
Institute of Public & Environmental Affairs
公众环境研究中心

IPEN
a toxics-free future

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Institute of Public & Environmental Affairs (IPE)

The Institute of Public & Environmental Affairs (IPE) is a non-profit environmental research organization based in Beijing, China. Since its establishment in May 2006, IPE has developed and operated the Blue Map Database (www.ipe.org.cn) and the Blue Map mobile app. Along with helping the public to access environmental information and protecting individuals' health and welfare, IPE devotes itself to serving green supply chain development, green finance and public environmental supervision in order to promote positive interaction between government, companies and the public and to push for improvement in environmental quality and green development.

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IPEN (www.ipen.org) is a global network of public interest non-governmental organizations working in more than 100 countries to reduce and eliminate the harm to human health and the environment from toxic chemicals.

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Table of Contents

Overview

Approximately 100,000 chemicals are used in the world today.[1] While chemicals can contribute to economic development and improved living standards, they also pose adverse impacts on the environment and human health – especially during manufacturing and production processes. After Rachel Carson published *Silent Spring* in the 1960's, chemical pollution began to draw widespread attention, gradually becoming a priority objective for environmental management.

Pollutant release and transfer register (PRTR) systems are environmental databases or inventories of potentially hazardous chemical substances and/or pollutants released to air, water and soil and transferred off-site for treatment or disposal. Around the world, PRTR systems play a crucial role in environmental governance by requiring polluters to be transparent and accountable toward end-of-pipe pollution discharge, safeguarding the public's environmental right to know, and enabling media and civil society to supervise and push for discharge reductions, thus becoming key measures for controlling toxic and hazardous chemicals.

Since the establishment of the U.S.'s Toxics Release Inventory (TRI) system in 1986, PRTR systems have been launched in over 50 countries worldwide.[2] Many other countries have expressed interest or are exploring the possibility of requiring PRTR disclosure. As environmental information disclosure systems have spread between nations, best practices sharing has prompted global improvement in environmental governance and pollution control. Meanwhile, international agreements such as the PRTR Protocol to the Aarhus Convention and the Strategic Approach to International Chemicals Management (SAICM) have also helped emphasize the importance of PRTR systems for managing the environmental and health impacts of hazardous chemicals.

Since China's Measures on Environmental Information Disclosure went into effect in 2008, vast improvements in environmental information transparency in China have helped to address the country's environmental enforcement gap. Subsequent requirements in 2014 for around 14,000 of China's key state-monitored enterprises to disclose real-time data for their air emissions and wastewater discharge were the first of their kind worldwide, reflecting the Chinese government's innovation in environmental information transparency.

Nevertheless, China's efforts to leverage information disclosure as a means of pollution control have focused more on disclosure of conventional pollution parameters, and have yet to extend to persistent and accumulative pollutants such as hazardous chemicals and toxic heavy metals that threaten environmental quality and public health alike.

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[1] See video: http://www.saicm.org/EmergingPolicyIssues/Hazardousnbsp;Electricals/tabid/5474/language/en-US/Default.aspx

[2] https://www.epa.gov/toxics-release-inventory-tri-program/tri-around-world

China continues to serve as the "workshop of the world," playing host to capital-intensive manufacturing processes that use copious amounts of energy and are highly polluting. Among such industries, electronics production poses an inordinate burden on China's environment. The manufacturing processes required to produce electronics components such as printed circuit boards (PCBs), semiconductors, LCD screens, batteries and power supply units are chemical-intensive and could be highly polluting. For instance, production of PCBs may require large amounts of heavy metals, such as copper, nickel and lead. Due to significant wastewater discharge, many of these pollutants accumulate in the environment, causing a threat to the environment and human health.[3]

Among all of the sources of hazardous chemical pollution, the electronics industry is also more challenging to manage since it involves a comparatively higher number of factories and therefore emissions are more dispersed, as evidenced by such severe pollution in electronics manufacturing clusters in the Yangtze River Delta and Pearl River Delta. Of course, if one goes further upstream, one may also touch upon more concentrated sources of pollution.

For example, inspection teams dispatched by China's central government as part of an enforcement drive beginning in 2016 found 18 centralized wastewater treatment plants in the Shanghai area to have issues with heavy metals in wastewater exceeding legal standards.[4] Facing severe consequences, the wastewater treatment facilities declared that the "culprit" is actually upstream enterprises that discharge effluent into pipes without permits or whose effluent exceeds pre-treatment standards, including many electronics manufacturers.

China's management of hazardous chemicals began in 2002. However, during the period between China's 11th and 12th five-year plans, control efforts focused more on massive emissions of sulfur dioxide (SO_2) and nitrogen oxide (NO_X), as well as chemical oxygen demand (COD), ammoniacal nitrogen and other conventional pollutants, rather than hazardous chemicals. Only with the 2013 implementation of the Measures on the Environmental Management and Registration of Hazardous Chemicals (Trial) did China begin to make information disclosure requirements for enterprises' transfer and release of hazardous chemicals. It could be said that this departmental regulation was the only normative document in China with that included a semblance of a PRTR system.

Although China's 13th Five-Year Plan for Eco-Environmental Protection began to "strengthen risk control in heavy metals, hazardous waste, and toxic and hazardous chemicals" as one of four key tasks, the Measures on the Environmental Management and Registration of Hazardous Chemicals (Trial) were never seriously implemented, and this regulation was ultimately annulled in 2016.

In addition to the Measures on the Environmental Management and Registration of Hazardous Chemicals (Trial), China's new Environmental Protection Law and its accompanying Measures

[3] BSR, "Electronics Supply Networks and Water Pollution in China": https://www.bsr.org/reports/BSR_Electronics_Supply_Networks_Water_Pollution_in_China.pdf

[4] http://www.chinanews.com/gn/2017/04-12/8197384.shtml

on Environmental Information Disclosure for Enterprises and Public Institutions, which were implemented in 2015, require that the environmental information from key pollution-discharging entities be made public. The latter requires the public disclosure of "the names of key pollutants and characteristic pollutants, discharge mode, number and distribution of emissions outlets, emissions concentration and total volume, situations of emissions exceeding standards, as well as implemented pollutant emissions standards and approved emissions totals." China's new Water Pollution Prevention and Control Law, which went into effect in 2018, also explicitly requires that "enterprises, public institutions and other producers and operators that discharge toxic and hazardous water pollutants on the aforementioned list shall carry out monitoring, environmental risk assessment, and inspection of hidden environmental and safety risks at discharge points and their surrounding environments, as well as disclose information about toxic and hazardous water pollutants and adopt effective measures to protect against environmental hazards." According to IPE's statistics, some key entities for wastewater monitoring have publicly disclosed their characteristic pollutants and hazardous waste discharge. However, data on the release and transfer of toxic and hazardous substances has not yet been publicly disclosed in a comprehensive and complete manner, and has not yet become the norm.

To address this gap, in recent years, some regions and organizations have launched pilot work in certain areas to establish PRTR disclosure systems. For instance, in the Tianjin Economic Development Area (TEDA), the EU-China Environmental Governance Programme supported an effort to implement PRTR disclosure to train corporations on disclosing their annual data. The Institute of Public & Environmental Affairs (IPE) served as a partner in this project and helped to develop a series of PRTR requirements based on the experience of OECD countries that are also suitable for China's domestic situation. Greenpeace has also promoted disclosure of hazardous chemicals releases by clothing companies and governments through its Detox campaign.[5]

At the same time, since the launch of the Green Choice Initiative in 2007, IPE has advocated for companies to manage the environmental impacts of their supply chains in China by requiring their high environmental impact suppliers to disclose annual PRTR data on IPE's database. PRTR disclosure has been integrated into the Corporate Information Transparency Index (CITI) standards,[6] which were jointly developed by IPE and the Natural Resources Defense Council (NRDC), and has thus garnered a positive response from a number of international and domestic companies. Within the IT industry, brands such as Apple and Dell have integrated disclosure into their supply chain management mechanisms.

Yet, so long as disclosure remains voluntary, rather than mandatory, the results of efforts by TEDA and organizations such as IPE to promote PRTR disclosure systems in China will remain

[5] https://www.greenpeace.org/archive-international/en/campaigns/detox/water/detox/intro/

[6] The CITI was jointly developed by IPE and the Natural Resources Defense Council (NRDC) in 2014 as the first quantitative evaluation system to assess brands' environmental management of their supply chains in China. More information can be found here: http://wwwen.ipe.org.cn/GreenSupplyChain/Main.aspx

severely limited. First, without mandatory requirements from regulations, companies and NGOs can only exert pressure on polluters to require voluntary disclosure based on corporate social responsibility, and therefore hold limited bargaining power. Second, the majority of corporations to exert influence have published conventional pollutants from routine monitoring, but have a lack of motivation to monitor and disclose hazardous pollutants. As a result, voluntary disclosure mechanisms are limited in their ability to use rankings and other means to pressure high polluters to reduce emissions, since rankings can only be based on information voluntarily disclosed by enterprises. Finally, lack of mandatory PRTR requirements discourages innovation and pollution prevention efforts of leading companies.

In recent years, a series of cases of hazardous waste discharge through hidden pipes, illegal burying, and cross-boundary dumping have emerged, of which several have resulted in pollution incidents that have drawn public concern and instability. New amendments to China's Water Pollution and Prevention Law, which went into effect on January 1, 2018, require the publication of a list of toxic and hazardous water pollutants and disclosure of relevant information by users of such pollutants for the first time, reflecting greater attention toward control of hazardous chemicals.

China's experience again shows that effective control and management of toxic and hazardous materials requires the establishment of a PRTR system, and establishing a PRTR system requires a strong legal foundation. Government should play a significant role in legislation and implementation, including drafting and implementing specific and standardized policies. On another level, different subsets of the public need to strengthen their recognition toward the importance of corporate disclosure of toxic and hazardous substances, and work together to promote the establishment of the system. At present, legislative work has not yet been fully launched, but pollution from hazardous substances will not wait. All parties must act, especially major international and domestic companies and large financial institutions. They should begin by implementing green procurement and green finance, and promote disclosure of discharge data as a requirement for supply chain and credit, as well as for enterprises receiving investments.

Controlling toxic and hazardous substances is crucial for preserving the environment and the health of future generations. Establishing and implementing a PRTR system will help us move one step closer to restoring China's blue skies and clear waters.

1. Introduction: Examining Uses and Releases of Hazardous Chemicals in Electronics Production

Approximately 100,000 chemicals are used in the world today.[7] While chemicals can contribute to economic development and improved living standards, chemicals also pose adverse impacts on the environment and human health – especially during manufacturing and production processes. This is true not just for the production of these chemicals themselves, but also for those industries that require the use of chemicals to create products that are purchased by consumers on the market or are components in other final goods.

The electronics industry is a major downstream user of chemicals that discharges significant amounts of chemicals as byproducts from manufacturing. Production of certain electronics products, such as computers and mobile phones, may use as many as over 1,000 different chemicals, primarily heavy metals, rare earth metals, solvents, and polymers and flame retardants.[8] Specific chemicals commonly found in electronics products include lead, mercury, cadmium, zinc, yttrium, chromium, beryllium, nickel, antimony trioxide, halogenated flame retardants, tin, PVC, and phthalates.[9] Moreover, as consumers demand smaller and lighter products, electronics manufacturers are increasingly turning to rare materials and metals.

These chemicals pose detrimental impacts throughout the entire life cycle, from harming factories workers' health and environmental damage during production to causing pollution and health risks through disposal of electronics waste ("e-waste"), much of which is shipped to developing countries where supervision of final processing is lax to nonexistent. For instance, China handled around 70% of the world's e-waste in 2012, but inefficient legislation caused much of this waste to be processed via a "grey market" for recycling worth about $15 billion USD.[10]

Pollution from electronics is a huge area for concern because its high concentration of heavy metals, halogenated compounds, and harmful chemicals threatens human health and the environment alike.[11] For example, production processes for electronics components, such as printed circuit boards (PCBs) and hard drives, require ample use of heavy metals. Researchers have linked e-waste pollution to be a precursor to cardiovascular disease, DNA damage, and

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[7] See video: http://www.saicm.org/EmergingPolicyIssues/Hazardousnbsp;Electricals/tabid/5474/language/en-US/Default.aspx

[8] Global Chemicals Outlook: Toward Sound Management of Chemicals. UNEP, 2013: p. 14.

[9] Global Chemicals Outlook, p. 36.

[10] http://www.nature.com/news/take-responsibility-for-electronic-waste-disposal-1.20345

[11] Hazardous Substances in e-Waste: http://ewasteguide.info/hazardous-substances

even cancer.[12] Electronics wastewater, when improperly treated, can disrupt ecological balance in aquatic environments, causing such phenomena as massive fish die-offs.

Meanwhile, consumer demand for electronics products continues to drive growth in the market for electronic chemicals and materials. According to estimates, revenues from the global consumer electronics market are expected to grow annually at over 15% during the period from 2016 to 2020.[13] Because of this growing demand, the aforementioned issues associated with chemicals pollution from electronics will only become more relevant.

China as a Hotspot for Hazardous Chemicals Pollution from Electronics Production

China is often referred to as the "workshop of the world," and for good reason: its share of global manufacturing output by value has risen from less than 3% in 1990 to nearly a quarter in 2015.[14] In particular, China is the world's hotbed for electronics manufacturing. In 2011, over 90% of all personal computers and over 70% of all mobile phones produced globally came from China.[15]

Although this staggering growth has spurred the development of China's economy, it has also fomented a vast range of environmental challenges. The sheer concentration of electronics manufacturing concentrated in China means that China bears the brunt of impacts from hazardous chemical usage. In 2010, China accounted for 14% of the global total of chemicals used for production of integrated circuits and printed circuit boards, as measured by dollar value.[16] The share of global trade in intermediate inputs produced in the Asian region has also risen dramatically, from 14% in 2000 to 50% in 2012.[17] In many cases, these components are the segments of global supply chains that require the most energy-, water- and chemically-intensive processes, so they exert the greatest impact on the environment.

In China, electronics manufacturing poses especially dire impacts on the environment because similar manufacturing processes are distributed across many different factories, yet clustered in specific regions, such as the Taihu Lake Basin and Pearl River Delta. A 2013 investigation by Chinese environmental organizations including IPE and Suzhou-based Lvse Jiangnan revealed levels of nickel pollution sediment from the Huangcangjing River in Jiangsu Province exceeded limit values by nearly 40 times. Prior investigations at the Louxia River revealed concentrations of copper and nickel that exceeded the NOAA Sediment Quality ERM value by 80 and 15 times,

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[12] 'E-waste pollution' threat to human health: http://www.iop.org/news/11/may/page_51103.html

[13] http://www.persistencemarketresearch.com/market-research/consumer-electronics-market.asp

[14] http://www.economist.com/news/leaders/21646204-asias-dominance-manufacturing-will-endure-will-make-development-harder-others-made

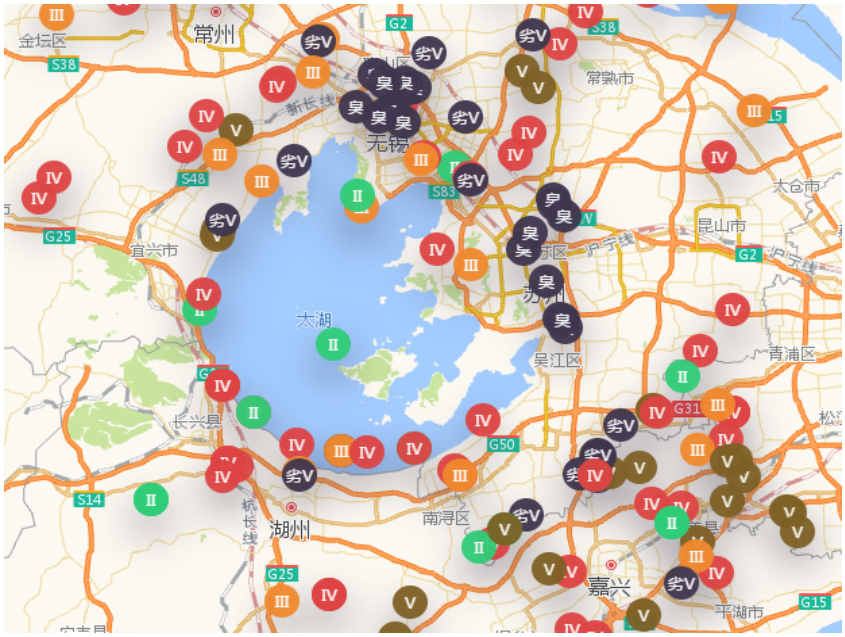
[15] Bank of America Merrill Lynch report, "Not So Trivial Facts," David Ciu.

[16] Global Chemicals Outlook, p. 14.

[17] http://www.economist.com/news/briefing/21646180-rising-chinese-wages-will-only-strengthen-asias-hold-manufacturing-tightening-grip

respectively.[18] Even some suppliers that are technically in compliance with the law continue to pollute the environment by diluting contaminated wastewater until the pollutant concentration meets national standards -- yet the total volume of contaminants remains the same as before dilution.

Figure 1. Screenshot from Blue Map Database Displaying Water Quality near Taihu Basin, Jiangsu



Source: IPE's Water Quality Monitoring Map. The red, brown and black circles represent water of such poor quality that it is "unfit for human contact."[19]

Meanwhile, China has been predicted to lead global growth in consumption of electronic chemicals and materials, with an estimated average annual growth rate of 7.7 percent.[20]

Although separate from the use of hazardous chemicals in electronics production, it is also essential to consider the harmful impacts of chemicals manufacturing as an industry in itself, since demand for electronics also supports this industry's profits and growth. China is the world's largest chemical manufacturer and user, and chemical production is predicted to grow 66% from 2012 to 2020, as compared to much lower growth rates of 25% in North America and 24% in Western Europe.[21]

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[18] Who is Polluting the Taihu Basin? Green Choice Alliance IT Industry Supply Chain Investigative Report, Phase VII, August 2013. http://wwwoa.ipe.org.cn//Upload/20131112123538SWY.pdf

[19] Roman numerals indicate the classification of water quality based on China's national government statistics, which measure quality on a six-category system ranging from Class I as the best to "劣 V" indicating quality is even worse than Class V. Black "臭" symbols indicate waters to be rectified as part of the Chinese government's "Black & Smelly" rivers initiative. Read more here: https://www.theguardian.com/world/2016/jun/22/black-smelly-citizens-clean-chinas-polluted-rivers.

[20] Global Chemicals Outlook, p. 14.

[21] "Mid-Year 2011 Situation & Outlook." T.K. Swift, M. Gilchrist Moore, and S. Bhatia, et. Al. American Chemistry Council, 2011.

A 2017 investigation by Greenpeace[22] revealed severe pollution outside the Lianyungang Chemical Industrial Park in Jiangsu Province, with much of the pollution in the form of compounds that are highly persistent upon reaching the environment. This pollution is likely typical of many industrial chemical parks in China, and policies restricting chemicals production to specific localities have effectively produced pollution hotspots in dire need of improved management and transparency.

Moreover, in April 2017, the discovery of industrial wastewater ponds in Hebei, Tianjin, and other places drew widespread public attention.[23] The difficulty of determining which companies or even how many companies dumped industrial waste at those locations exposed the current lack of effective regulation of toxic and hazardous substances. In countries with PRTR systems, the government requires companies to record and disclose their use, discharge, and transfer of pollutants, with particular attention to heavy metals, volatile organic compounds, and dangerous chemicals. These systems are powerful tools to track and reduce the release of pollutants. But in China, companies' handling of toxic and hazardous substances remains opaque. Of 120 cities evaluated on the 2016-2017 Pollution Information Transparency Index (PITI),[24] only Shenyang was home to industries that disclosed information on dangerous chemicals and emergency contingency plans.

Figure 2. Industrial Wastewater Ponds in Northern China

Source: Chongqing Liangjiang Voluntary Service Center

[22] *Hazardous Chemical Releases at Large: An Investigation at the Lianyungang Chemical Industrial Park*, Jiangsu Province, China. Greenpeace East Asia, May 2017.

[23] http://www.caixinglobal.com/2017-04-21/101081006.html

[24] http://wwwen.ipe.org.cn/reports/Reports.aspx?cid=18336&year=0&key=

Central Environmental Inspections Touch on Electronics Industry Pollution

In 2016, the Chinese government launched a series of central environmental inspections aimed at tackling China's severe air, water and soil pollution. Up through September 2017, the inspections had already covered 31 provinces, autonomous regions and provincial-level municipalities across China. The environmental inspections have not only investigated and accordingly handled tens of thousands of cases of environmental violations, but have also put pressure on local officials, finally helping to begin working through issues of local protectionism toward polluting enterprises.

Compared to limited fines typically levied in the past, punishments issued to violating enterprises over the course of inspections, such as the frequent ceasing of production for improvements and shut down orders, may sharply raise the cost of violations for enterprises. From a long-term perspective, these higher costs will be advantageous toward reversing the previous system of perverse incentives where those who pollute reap benefits, and will force enterprises to internalize the costs of pollution, thus making brands' green procurement become economically rational.

For instance, during the second round of central environmental inspections at the end of 2016, 18 centralized wastewater treatment plants in the Shanghai area were found to have issues with heavy metals in wastewater exceeding legal standards, with six of the plants exhibiting long-term wastewater discharge noncompliance.[25] Facing severe consequences, the wastewater treatment facilities declared that the "culprit" is actually enterprises that discharge effluent into pipes without permits or whose effluent exceeds pre-treatment standards, including many electronics manufacturers.

According to media reports from September 2017,[26] 12 upstream enterprises from industries include electroplating and stainless steel were identified as causing issues at a centralized wastewater treatment plant in the Huaxin area of Shanghai's Qingpu district. Nine of the enterprises had already been slated for elimination, and the remaining three would be required to undergo verification before being allowed to resume production processes.

Electronics factories contributing to heavy metals discharge at the Xujing Wastewater Treatment Plant were also targeted. One circuit boards manufacturer, STATS ChipPAC (Shanghai) Co., Ltd., had already been forced to cease production by the time of media reports; another electronics manufacturer, Shanghai Unitech Electronics Co., Ltd., will cease production by the following year. The shutting of these electronics manufacturers will drastically reduce the amount of copper in wastewater received by the Xujing plant, and sludge will also be able to consistently meet standards for copper content. Several other wastewater

[25] http://sh.qq.com/a/20170910/005222.htm

[26] http://sh.sina.com.cn/news/m/2017-09-07/detail-ifykqmrw1740280-p3.shtml?t=1504747217730

treatment plants in the Shanghai area had already significantly reduced heavy metal content in their sludge from wastewater treatment by July 2017.

Apart from these issues, in 2017, according to media reports, there were repeated incidents of illegal, secret cross-border discharge of hazardous waste via land routes and waterways by enterprises along the Yangtze River. In order to save costs, these enterprises signed low-cost hazardous waste treatment agreements with unofficial environmental contractors. In November 2017, 7,000 tons of solid waste that was being illegally transported via waterway was seized in the Tongling section of the Yangtze River, of which more than 2,000 tons of industrial waste had been directly dumped on riverbanks. The materials that were dumped included pickling sludge, a substance listed in China's National Catalogue of Hazardous Chemicals. According to the Anhui Province Environmental Protection Bureau (EPB), this substance is acidic and contains some heavy metals, and thus may adversely affect aquatic and land ecosystems. [27]

In addition to illegal cross-border dumping, some companies have illegally buried hazardous waste on location. In March 2018, the Ministry of Ecology and Environment (MEE) carried out special inspections of severe environmental pollution at Jiangsu Huifeng Agrochemical Co., Ltd. in the city of Yancheng in Jiangsu province, along with issues with the ineffectiveness of local environmental inspections. The special inspections discovered that no anti-seepage measures had been adopted at the two hazardous waste landfills at the plant site. Furthermore, the hazardous waste was concealed by a layer of concrete, which was in turn covered with construction waste and soil. In some areas, workshops or other buildings had even been constructed on top. The inspection team found the concentration of toluene, ethylbenzene, and xylene at the hazardous waste landfill site to be in severe excess of legal standards. [28]

The string of incidents touching on hidden wastewater discharge, illegal landfills and cross-border dumping of hazardous waste in the past few years once again illustrates the current shortcomings of China's hazardous chemicals management and control. In response to these cases, China's MEE also carried out directed responses and actions. For example, efforts have been made to promote the establishment of treatment capacity, to severely crack down on hazardous waste criminal offenses, and to strengthen supervision of hazardous wastes throughout the entire process. [29] However, in order to completely eradicate these environmental problems, it is necessary to work together to promote effective long-term supervision mechanisms and to mobilize the public to participate in supervision.

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27 http://www.sohu.com/a/221589844_656705

28 https://www.weibo.com/ttarticle/p/show?id=2309404230839897610094#_0

29 https://www.weibo.com/ttarticle/p/show?id=2309404230514176317169#_0

2. The Origins of PRTR Systems

The development of modern industry after the Second World War, especially the chemicals industry, saw artificially synthesized toxic and hazardous substances discharged into the environment en masse as byproducts from manufacturing. Widespread use of chemical fertilizers and pesticides by agriculture also contributed to the release of a large number of such substances. These substances are often invisible, and they cannot be touched or felt. They are thin like fog, light as wind, and their composition is complex. Ordinary people cannot discern their harm. While people are unaware of their danger, these substances enter into the environment and permeate the food chain, affecting the health of living organisms and the human body.

This chapter illustrates the situational background leading to the development of the US Toxics Release Inventory (TRI), the first PRTR system worldwide. For a detailed overview of the US TRI, as well as PRTR systems subsequently developed in other areas of the world, please refer to Appendix II, "Overview of PRTR Systems Worldwide."

Silent Spring

Beginning in the 1960s, some Western scholars began to expose the seriousness of toxic and hazardous substances. One of the most violent shocks to the Western public was Rachel Carson's book, *Silent Spring*. Carson reminded the public that many chemicals used indiscriminately have the power to kill every "good" and "bad" insect. They lay the singing of birds and the vivacity of fish to rest. They universally invade the bodies of fish, birds, reptiles, and livestock and wildlife, and continue to survive and persist in their harm.

In her book, Carson raised the idea of developing a list of toxic and hazardous chemicals so that people could understand them: "But in the plans and hopes of the industry this enormous production is only a beginning. A Who's Who of pesticides is therefore of concern to us all. If we are going to live so intimately with these chemicals— eating and drinking them, taking them into the very marrow of our bones— we had better know something about their nature and their power."[30]

A series of such reports shocked the American public. They used various channels to put pressure on legislatures and government agencies to participate in environmental decision-making and demand environmental information directly relevant to their lives, health, and well-being. Under strong public pressure, the U.S. Congress formulated a series of laws specifically designed to control the discharge of hazardous wastes. A complex control system was established through a network of laws and regulations. A considerable component of this system involves the environmental right-to-know: the Clean Air Act and Clean Water Law stipulate that enterprises must regularly report to the government authorities in charge of the implementation of permits and submit pollutant emissions lists. According to law, the EPA has

[30] *Silent Spring*, Rachel Carson, 1962.

the right to enter factories and to conduct inspections of pollution-discharging equipment, make records and require companies to provide needed information. The public can then obtain any of this environmental information based on the Freedom of Information Act. The Toxic Substances Control Act is actually a means for collection of information regarding the situation of chemical substances. It requires companies to submit all information relating to the production, use, spread and disposal of chemical substances.

In light of this legislation, many problems with the management of hazardous chemicals remained. In 1984, U.S.-owned Union Carbide's pesticide plant in Bhopal, India caused thousands of deaths and shocked the American public. Just as the U.S. chemicals industry was working to convince the public that their factories in the United States would not pose a threat, Union Carbide's factory in West Virginia had a highly toxic chemical spill on August 11, 1986, causing some local residents to be admitted to hospitals for treatment and seriously shaking the public's confidence. Ultimately, the U.S. Congress did not choose to publish new toxic substance control targets. Instead, it issued the Emergency Planning and Community Right-to-Know Act in 1986, requesting the establishment of state emergency committees and local emergency planning committees.

In requiring the government to establish an emergency response system, the Emergency Planning and Community Right-to-Know Act for the first time mandated US companies to report their environmental releases of several hundred chemicals. According to this law, the annual "Toxic Release Inventory" (TRI) should not only be reported or digitally provided to local emergency committees and government environmental protection departments, but these reports should also be accessible to citizen stakeholders and environmental protection organizations.[31]

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[31] The Emergency Planning and Community Right-to-Know Act makes specific provisions concerning the disclosure of relevant environmental information, and stipulates that enterprises are obligated to publicly provide the following information on toxic substances:

A local emergency planning committee, upon request by any person, shall make available a material safety data sheet (MSDS) to the person in accordance with the relevant regulations. If the local emergency planning committee does not have the requested material safety data sheet, the committee shall request the sheet from the facility owner or operator and then make the sheet available to the person in accordance with relevant regulations.

Any person may request a State emergency response commission or local emergency planning committee for tier II information (the chemical name or the common name of the chemical as provided on the material safety data sheet; an estimate of the maximum amount of the hazardous chemical present at the facility at any time during the preceding calendar year; an estimate of the average daily amount of the hazardous chemical present at the facility during the preceding calendar year; a brief description of the manner of storage of the hazardous chemical; the location at the facility of the hazardous chemical, etc.) relating to the preceding calendar year with respect to a facility. Any such request shall be in writing and shall be with respect to a specific facility.

In the case of tier II information which is not in the possession of a State emergency response commission or local

Since the establishment of the TRI, experience sharing has played an important role in spurring the global exchange and spread of PRTR usage. Over 50 countries have fully established PRTR systems or have implemented pilot programs to track and disclose information about chemical releases. Many more countries are in the process of developing PRTR systems, particularly in South and Central America, or have expressed significant interest in developing PRTR. Other multilateral initiatives, including the PRTR Protocol to the Aarhus Convention and the Strategic Approach to International Chemicals Management (SAICM), have also prompted governments to strengthen their capacity for managing harmful chemicals including through PRTR disclosure. For a detailed overview of the US TRI, as well as PRTR systems subsequently developed in other areas of the world, please refer to Appendix II, "Overview of PRTR Systems Worldwide."

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emergency planning committee and which is with respect to a hazardous chemical which a facility has stored in an amount less than 10,000 pounds present at the facility at any time during the preceding calendar year, a request from a person must include the general need for the information. The State emergency response commission or local emergency planning committee may request the facility owner or operator for the tier II information on behalf of the person making the request. Upon receipt of any information requested on behalf of such person, the State emergency response commission or local emergency planning committee shall make the information available in accordance with the relevant regulations. A State emergency response commission or local emergency planning committee shall respond to a request for tier II information under this paragraph no later than 45 days after the date of receipt of the request.

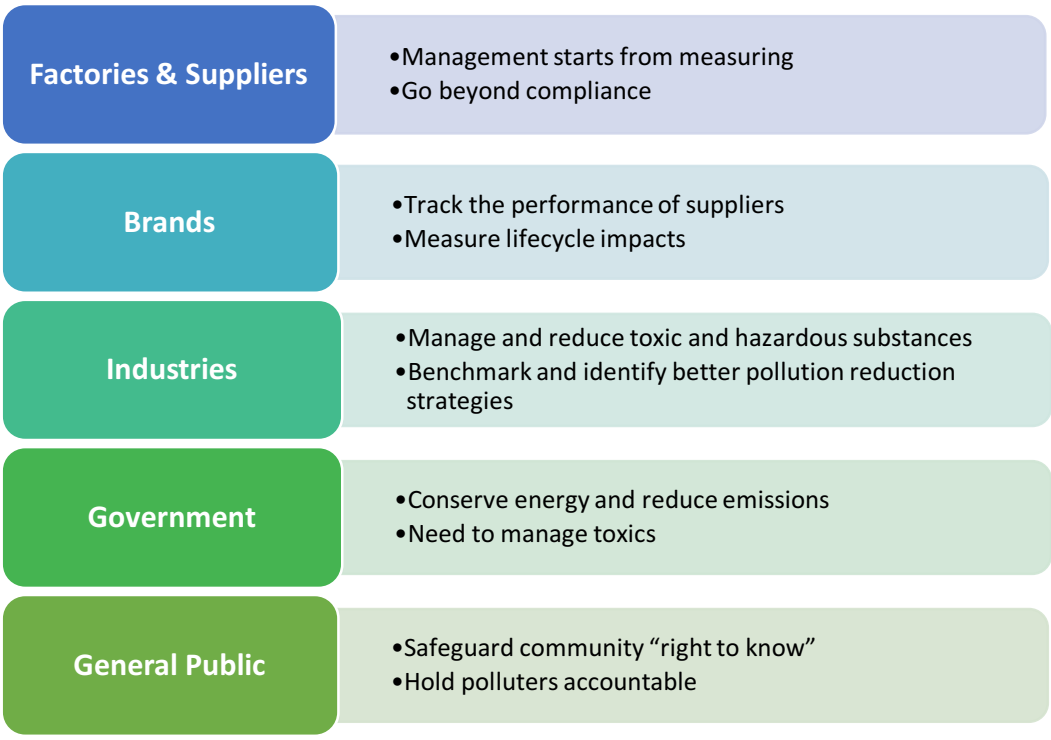
An owner or operator of a facility shall provide the specific chemical identity, if known, of a hazardous chemical, extremely hazardous substance, or a toxic chemical to any health professional who requests such information in writing if the health professional provides a written statement of need stating that the health professional has a reasonable basis to suspect that the information is needed for purposes of diagnosis or treatment of an individual, the individual or individuals being diagnosed or treated have been exposed to the chemical concerned, and knowledge of the specific chemical identity of such chemical will assist in diagnosis or treatment. Following such a written request, the owner or operator to whom such request is made shall promptly provide the requested information to the health professional. An owner or operator of a facility shall provide a copy of a material safety data sheet, an inventory form, or a toxic chemical release form, including the specific chemical identity, if known, of a hazardous chemical, extremely hazardous substance, or a toxic chemical, to any treating physician or nurse who requests such information if such physician or nurse determines that a medical emergency exists, the specific chemical identity of the chemical concerned is necessary for or will assist in emergency or first-aid diagnosis or treatment, and the individual or individuals being diagnosed or treated have been exposed to the chemical concerned.

Each emergency response plan, material safety data sheet, checklist, inventory form, toxic chemical release form, and follow up emergency notice shall be made available to the general public during normal working hours at the location or locations designated by relevant agencies and officials. Each local emergency planning committee shall annually publish a notice in local newspapers that the emergency response plan, material safety data sheets, and inventory forms have been submitted.

3. The Role of Information Disclosure & PRTR Systems

Environmental information disclosure works in a variety of ways. In the best cases, it encourages benchmarking and monitoring of enterprise performance and creates a platform for continuous improvement. It can facilitate self-improvement for willing enterprises and strengthen the ability of government regulators, local communities, and other stakeholders to play a greater role in pollution reduction. Figure 3 below illustrates some of the benefits of disclosure for different stakeholders.

Figure 3. Significance of Disclosure for Different Stakeholders



As part of the so-called "third wave" of environmental governance, information disclosure stands in contrast to other "command and control" approaches to environmental information disclosure. In particular, establishing systems for corporate environmental information disclosure can motivate polluting enterprises to make substantial reductions to their emissions and help to eliminate risks posed by harmful emissions toward citizens' health.

One type of strategy for environmental information disclosure -- rating and disclosure systems -- focuses on amalgamating performance data into ratings that the public can easily understand and digest. The relative simplicity of these programs makes them a feasible solution in countries and regions that lack strong regulatory institutions. However, because disclosed information is often whittled down to a ranking or performance summary, these systems lack usability for other key stakeholders. This is particularly true for businesses

themselves, who may find it difficult to use the information to set targets for practical purposes such as emissions reductions.

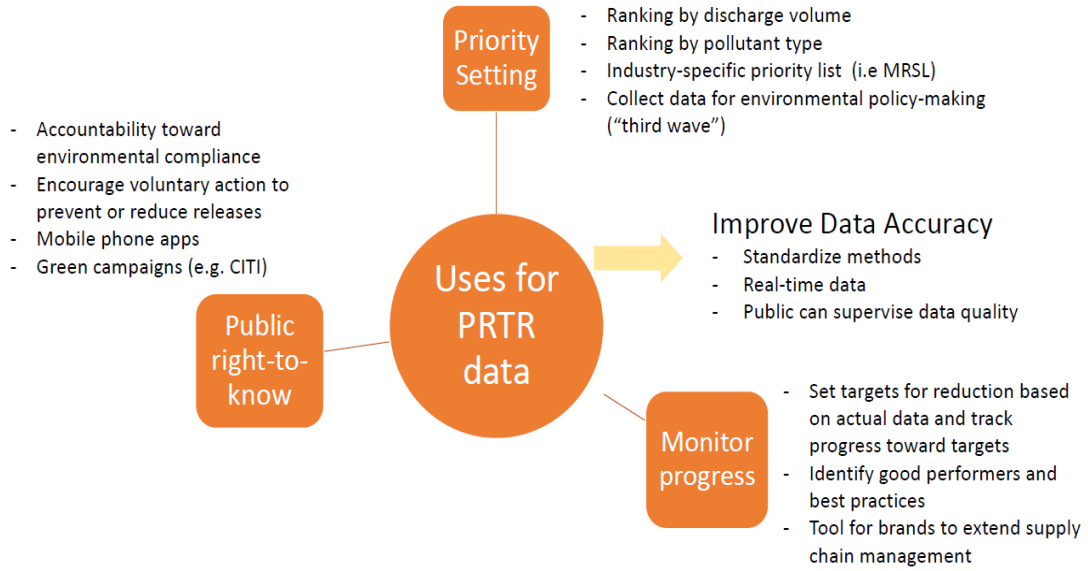
By contrast, pollutant release and transfer registry (PRTR) systems function more or less as a comprehensive pollution accounting system and therefore pose benefits for a wider range of stakeholders. A PRTR system is a national or regional environmental database or inventory of potentially hazardous chemical substances and/or pollutants released to air, water and soil and transferred off-site for treatment or disposal. According to the OECD council, PRTR systems contain the following key components[32]:

- A listing of chemicals, groups of chemicals, and other relevant pollutants that are released to the environment or transferred off-site;
- Integrated multi-media reporting of release and transfers (to air, water and land);
- Self-reporting by covered industry or business categories;
- Periodic reporting (preferably annually); and
- Making data available to the public.

Practical Applications for PRTR Data

PRTR systems worldwide have shown that environmental information disclosure can impel different stakeholders, such as manufacturers, governments and the public, to improve environmental management and governance.

Figure 4. Practical Uses for PRTR Data



[32] https://prtr.unece.org/about-PRTR

Applications for Corporations

The disclosure of hazardous substances information is not something that companies are naturally willing to accept. In the first few years after *Silent Spring* was published, a large number of chemical emitters strongly opposed Rachel Carson's point of view. In fact, just after the Toxics Release Inventory was announced, the US media and environmental organizations honed in on these large companies, ranking them based on the amount of pollutants discharged, and creating strong public pressure.

Such pressure also encouraged companies to take action to prevent and control pollution. For example, after the release of TRI in 1988, the president of Monsanto Corporation promised to make a 90% reduction in pollution emissions from its subsidiaries within five years. At that time, its subsidiaries thought that this goal would be difficult to achieve, but in fact, after five years, it had reduced discharges by 95%. This result in large part came about because self-determined emissions reductions are less rigid than emissions standards enforced by government departments, thus giving companies more autonomy and allowing them to innovate to find solutions that optimize costs.

In fact, many corporations adopted initiatives to voluntarily reduce their emissions. AT&T committed to halting all air emissions by the end of the century in 1993.[33] Dow announced that it planned to reduce overall emissions by 50% by 1995, and DuPont committed to reducing air emissions 60% by 1993 and cancer-causing components by 90% by the year 2000.

After ten years of disclosure, emissions of 340 chemicals reported on the TRI had dropped by 45.5 percent.[34] Of course, if a company can improve its TRI ranking, this can also create a basis for positive publicity and increase the public's trust toward the company.[35]

Applications for Governments

Experience has shown that the disclosure of factory-level environmental data can allow the public, society and the media to obtain basic information required for public supervision and participation, as well as allow researchers and scholars to collect baseline data needed for pollution control research. Government departments can then use this data to more accurately grasp the status of hazardous chemical releases and transfers.

For example, after the release of the first Toxics Release Inventory in the United States in 1988, the US Environmental Protection Agency was for the first time truly able to understand the status of companies' chemical release and transfer. At that time, 18,500 companies submitted reports, showing that they had collectively discharged 10.4 billion pounds of listed chemicals

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[33] https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P1004DTB.TXT

[34] Reinventing Environmental Regulation from the Grassroots Up: Explaining and Expanding the Success of the Toxics Release Inventory. *Environmental Management,* February 2000, Vol. 25, No. 2

[35] *Environmental Regulation and Impact Assessment*, Leonard Ortolano, 1996, p. 308

in 1987, of which 3.9 billion pounds had entered landfills, 3.3 billion pounds were sent to treatment plants and processing facilities. 2.7 billion pounds were released into the atmosphere, and 550 million pounds were released into bodies of water. This result even caused surprise among environmental management authorities. Linda Fisher, assistant director of the Environmental Protection Agency at the time, called the result "surprising," "highly unacceptable," and "far in excess" of the EPA's expectations. This result was later adjusted to 7 billion pounds after removing companies that were not required to report. [36]

The Toxics Release Inventory has also become an important basis for congressional legislation. Based on the information in the TRI, the U.S. Congress can adopt stricter control policies aimed at major emitters and those that pose a severe threat from hazardous chemicals usage. It also enables more targeted supervision of big polluters, thus virtually increasing the cost of pollution. Investors also use the information provided in the TRI to calculate the future pollution control costs of various companies. Many investors have sold off some of the top polluters' stocks,[37] since highly-polluting companies are less efficient.

The requirements of the Toxics Release Inventory have evolved over time,[38] making it difficult to conduct accurate comparisons. Consequently, the USEPA provided some comparative data on the original pollutants measured. Compared with the 1988 list of enterprises handling hazardous materials or conducting heavy industry, emissions from this same group were 2.616 billion pounds in 1995, 2.577 billion pounds in 1997, and 2.371 billion pounds in 2000.[39] This data clearly shows a marked decline from 1988. Total emissions in 2000 were 7.41 billion pounds, a drop of 8 percentage points from 1999.

Experience from disclosure systems in developing countries, such as the 1995 Program for Pollution Control Evaluation and Rating (PROPER) in Indonesia[40] and the NGO-led Green Rating Project[41] established in India in 1996, have similarly helped spur emissions reductions,

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[36] *Environmental Regulation: Law, Science and Policy*, 2003, Robert V. Percival, Cristopher H. Schroeder, Alan S. Miller, and James P. Leape, p. 337

[37] *Exercising Property Rights to Pollute: Do Cancer Risks and Politics Affect Plant Emission Reductions?* James Hamilton, 1999. From *Environmental Regulation: Law, Science and Policy*, 2003, Robert V. Percival, Cristopher H. Schroeder, Alan S. Miller, and James P. Leape

[38] For example, in 1998, the publication requirements of enterprises releasing hazardous substances were expanded to include mining companies, all enterprises with coal-fired power plants, companies under the "Resources Protection and Reuse Act" under Item C, and chemical solvent recycling companies in the scope of environmental management. Chemical varieties have also greatly increased, including the addition of a variety of persistent bioaccumulative toxics (PBTs) in 2000. Pollutants listed on this register increased from 329 in 1988 to 650 in 2000.

[39] *Environmental Regulation: Law, Science and Policy*, 2003, Robert V. Percival, Cristopher H. Schroeder, Alan S. Miller, and James P. Leape, p. 337

[40] http:// siteresources.worldbank.org/ INTEMPOWERMENT/ Resources/14825_Indonesia_Proper-web.pdf

[41] Nicholas Powers et al., "Does Disclosure Reduce Pollution? Evidence from India's Green Rating Project",

although these programs have been critiqued for lacking detailed disclosure of raw data and other factors. Still, evidence of positive results underscores that disclosure poses benefits across both the developed and developing world alike.

Applications for NGOs and Media

Although policies and data play a crucial role in managing chemicals, they alone cannot solve the problem. Effective change also requires motivating people and businesses to sustainably change their behavior. In countries where effective PRTR systems for corporate information disclosure have been established, NGOs and media have leveraged disclosed information to pressure corporations to reduce their emissions and release and transfer of hazardous materials.

Shortly after the first TRI was released, the U.S. media and environmental organizations exposed companies with the largest discharges of toxic substances, forcing the public to pay attention to these massive polluters. On August 1, 1989, USA Today published the "The Toxic 500" across a full two-page spread. The list used the TRI to determine the 500 counties in the U.S. most polluted by industrial chemicals. The National Wildlife Federation published a book that exposed 500 of the world's largest toxics-emitting companies that release 39 known or possible carcinogens. The Natural Resources Defense Council (NRDC) also used the data from the TRI to produce its "Who's Who of American Toxic Air Polluters," exposing 1,500 companies with major emissions. [42]

Case Study: Scorecard

Perhaps one of the most well-known and effective examples of NGO advocacy is "Scorecard" (www.scorecard.org), a website launched in April 1998 by an American environmental NGO called the Environmental Defense Fund (EDF). The website acts as a free information portal for the public about environmental and health risks from hazardous substances and pollutants. Scorecard aims to expose those companies with the worst pollution records in order to push for improvements. Among many features, the website features a zip code search function, "Zip to Your Community," that provides tailored information about individual communities, making the "local environment as easy to check on as the local weather." [43] *Thus, part of the effectiveness of Scorecard is the platform's ability to translate complex information into a user-friendly and searchable form that different stakeholders could easily access and understand.*

An analysis conducted by EDF five years after the launch of Scorecard found that releases of cancer-causing industrial pollutants fell by 20% in 2001, while those pollutants linked to birth defects and developmental issues fell by 24%. Furthermore, the TRI lowered the threshold for

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Environmental & Resource Economics, 50 (1):131-155 (2011).

[42] *Environmental Regulation: Law, Science and Policy*, 2003, Robert V. Percival, Cristopher H. Schroeder, Alan S. Miller, and James P. Leape, p. 485

[43] http://scorecard.goodguide.com/about/txt/history.html

lead reporting, which greatly increased relevant data showing lead pollution and revealing that lead pollution was more widespread than previously believed. According to Dr. John Balbus, the director of EDF's environmental health program at the time, "The more people know about the health risks they face the more pressure the industry will feel to reduce harmful chemicals or replace them with safer ones."[44]

In addition, disclosure can facilitate direct action by NGOs and media against polluters. For example, after the Massachusetts Public Interest Research Group (MassPIRG) identified Raytheon as the state's biggest emitter of chlorofluorocarbons (CFCs) and methyl chloroform, MassPIRG pressured Raytheon into committing to using water-based alternatives.[45] In another example, Syntex Chemicals Corporation in Boulder, Colorado eventually signed a pledge to reduce its toxic emissions levels by 50% between 1991 and 1994. In fact, through 1998, over 800 TRI blacklists had appeared in newspapers and magazines, leading not only to promises from companies but also concrete emissions reductions.

The EPA's July 2013 report, "The Toxics Release Inventory in Action: Media, Government, Business, Community and Academic Uses of TRI Data"[46] outlines some of the more recent efforts of third-party stakeholders to apply TRI data as a means of pushing for environmental improvements and protecting public health. The report's appendices list examples of media coverage directly drawing on the TRI for such purposes as assessing workplace safety, campaigning for environmental policy, outreach and education, and also outlines a range of tools created by both government and other non-governmental organizations with the aim of making the information in the TRI more accessible and more applicable.

[44] https://www.edf.org/news/environmental-defense-still-shining-bright-light-polluting-companies

[45] "Reinventing Environmental Regulation from the Grassroots Up: Explaining and Expanding the Success of the Toxics Release Inventory." Archon Fung and Dara O'Rourke, *Environmental Management*, 2000.

[46] https://www.epa.gov/toxics-release-inventory-tri-program/toxics-release-inventory-action-media-government-business

4. Global Policy Framework for Chemicals Management

Beginning with the movement to enshrine environmental policies into law in the 1960's and 1970's, there has been a growing international consensus toward the importance of information transparency and public participation in environmental protection. A significant milestone internationally came in 1992, when over 170 countries ratified the Rio Declaration on Environment and Development, which includes clauses concerning citizen access to environmental information and the concept of the public's environmental "right-to-know." Article 10 of the Rio Declaration stipulates:

> Environmental issues are best handled with **participation of all concerned citizens**, at the relevant level. At the national level, each individual shall have **appropriate access to information concerning the environment** that is held by public authorities, including information on hazardous materials and activities in their communities, and the **opportunity to participate in decision-making processes**. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.[47]

While national- and regional-level policies improve local chemicals management, global policy frameworks help to further high-level management priorities. Below, we examine recent progress in the global push for improved chemicals management and specifically management of adverse impacts stemming from the electronics industry.

Aarhus Convention

The Convention on Access to Information, Public Participation in Decision Making and Access to Justice on Environmental Matters (the Aarhus Convention) was adopted on June 25, 1998, at the Fourth Ministerial Conference of the UN Economic Commission for Europe. The Aarhus Convention makes clear stipulations for enterprises on information disclosure as related to the environmental right-to-know for hazardous wastes: "Each Party shall encourage operators whose activities have a significant impact on the environment to inform the public regularly of the environmental impact of their activities and products, where appropriate within the framework of voluntary eco-labelling or eco-auditing schemes or by other means."

It also requires consumer protection of the right to environmental knowledge: "Each Party shall develop mechanisms with a view to ensuring that sufficient product information is made available to the public in a manner which enables consumers to make informed environmental choices."

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[47] http://www.unesco.org/education/pdf/RIO_E.PDF

The Convention emphasizes the importance of establishing a pollution inventory system and opening it to the public: "Each Party shall take steps to establish progressively, taking into account international processes where appropriate, a coherent, nationwide system of pollution inventories or registers on a structured, computerized and publicly accessible database compiled through standardized reporting. Such a system may include inputs, releases and transfers of a specified range of substances and products, including water, energy and resource use, from a specified range of activities to environmental media and to on-site and offsite treatment and disposal sites."

Strategic Approach to International Chemicals Management (SAICM)

Most significantly for hazardous chemicals, the Strategic Approach to International Chemicals Management (hereinafter referred to as the SAICM) is a policy framework which promotes and advances global chemical safety objectives. SAICM was adopted by a consensus of environment ministers, health ministers and other delegates from more than one hundred governments at the International Conference on Chemicals Management (ICCM1) in Dubai, United Arab Emirates, on February 6, 2006.[48]

SAICM aims to support the achievement of one of the goals of the 2002 Johannesburg World Summit on Sustainable Development that seeks to minimize the adverse effects of chemical production and usage on human health and the environment. Its implementation has since helped guide the development of government and corporate policies on chemicals and waste management across the globe.

In adopting SAICM, governments and other participants in the ICCM agreed that improved measures are needed to prevent harmful effects of chemicals on the health of children, pregnant women, fertile populations, the elderly, the poor, workers and other vulnerable groups and susceptible environments. They noted that some progress has been made in chemicals management, but declared that progress has not been sufficient globally, and that the environment worldwide continues to suffer from air, water and land contamination that impairs the health and welfare of millions. SAICM is comprised of three core texts: the *Dubai Declaration on International Chemicals Management,* SAICM *Overarching Policy Strategy* and the SAICM *Global Plan of Action*. The SAICM Secretariat is based in the Geneva office of the United Nations Environment Programme (or "UN Environment," formerly referred to as UNEP).

The Dubai Declaration delineates high-level political commitments to the SAICM. The Overarching Policy Strategy outlines the scope, needs, objectives, financial considerations underlying principles and approaches, and implementation and review arrangements. Its key objectives comprise five overarching areas: risk reduction; knowledge and information; governance; capacity-building and technical cooperation; and illegal international traffic.

[48] http://www.saicm.org/About/SAICMOverview/tabid/5522/language/en-US/Default.aspx

Electronics Pollution as an Emerging Policy Issue

The SAICM serves as a platform to draw attention to emerging policy issues (EPI) and issues of concern which may have significant adverse effects on human health and/or the environment and to call for unified and coordinated action toward these areas. One of SAICM's emerging policy issues focuses on "hazardous substances within the life cycle of electrical and electronic products" (sometimes referred to as HSLEEP). In 2011, the Secretariat of the Basel Convention, the United Nations Industrial Development Organization (UNIDO), on behalf of the participating organizations of the Inter-Organization Programme for the Sound Management of Chemicals, and the Secretariat of the Stockholm Convention held an international workshop on hazardous substances within the life-cycle of electrical and electronic products at UNIDO headquarters in Vienna. The meeting included 32 governments, the electronics industry, and public interest NGOs.

Consensus agreement was reached on a series of recommendations for the upstream (design), midstream (production) and downstream (waste) parts of the electronics lifecycle, including a number of recommendations concerning information disclosure and availability. The recommendations for the midstream part of the lifecycle provide a basis for NGOs and other actors to launch voluntary efforts promoting disclosure of information about hazardous chemicals and other related pollutants.

As part of the SAICM process, UN agencies convened a meeting in March 2011 in Vienna focusing on hazardous substances within the life cycle of electrical and electronic products. The meeting included 32 governments (including China), the electronics industry, and a small group of public interest NGOs. A number of the outcomes of the working groups specifically mention the role of non-governmental organizations in supporting implementation of the SAICM and/or the importance of transparency regarding hazardous chemicals. One of the recommendations specifically focuses on promoting the development of PRTR disclosure systems:

> **Information:**
> 18) Governments, intergovernmental organizations, and non-governmental organizations including the producers and manufacturers and others **should formulate, promote, and implement legislative as well as voluntary initiatives to adopt and implement Pollutant Release and Transfer Registries (PRTR)**. Governments that have not yet ratified the Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters are encouraged to do so.[49]

[49] UNIDO, Basel Convention, Stockholm Convention (2011) International workshop on hazardous substances within the life-cycle of electrical and electronic products, 29 -31 March 2011 http://old.saicm.org/images/saicm_documents/iccm/ICCM3/Meeting%20documents/INF%20Documents/ICCM3_INF24_Report%20e-waste%20workshop.pdf

In 2012, at the 3rd session of the International Conference on Chemicals Management (ICCM3), more than 100 governments encouraged implementation of the Vienna recommendations on hazardous substances in electronics. ICCM3 decided to continue further work on developing best practice resources including development of designs that reduce and eliminate the use of hazardous chemicals in production; business standards and practices for tracking and disclosing the presence of hazardous chemicals in the manufacturing, use and end-of-life stages of electrical and electronic products; tools and information on potential safer substitutes for chemicals of concern; green purchasing strategies; extended producer responsibility policies of businesses and governments; and provisional strategies and actions in design and manufacturing that should be implemented until elimination is possible or safer substitutes are available.[50]

ICCM3 also added new activities on hazardous substances in electronics to the SAICM Global Plan of Action.[51] These activities include work areas on green design, environmentally sound manufacturing of e-products, and awareness-raising. The awareness-raising work area activities are to promote awareness, information, education and communication for all relevant stakeholders along the supply chain of hazardous chemicals with the life-cycle of e-products.

At ICCM4 in 2015, more than 100 governments reiterated the call for implementation of the Vienna recommendations on hazardous substances in electronics. The resolution included meaningful engagement of all stakeholders to promote advocacy, awareness, information, education and communication about hazardous chemicals in e-products; encouraging original equipment manufacturers to develop and implement take-back programs; facilitating implementation of procurement initiatives that favor improved safety and sustainability; encouraging original equipment manufacturers to collect and provide health and safety information to workers on chemicals they handle or are exposed to; and encouraging stakeholders to implement the SAICM chemicals in products programme to provide access to information on hazardous chemicals in the lifecycle of e-products.[52]

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[50] UNEP (2012) Hazardous substances within the life cycle of electrical and electronic products**,** III/2 Emerging Policy Issues, Report of the International Conference on Chemicals Management on the work of its third session, SAICM/ICCM.3/24

51 UNEP (2012) Annex III. Inclusion of new activities relating to the environmentally sound management of nanotechnologies and manufactured nanomaterials and hazardous substances within the life-cycle of electrical and electronic products in the Global Plan of Action of the Strategic Approach; Report of the International Conference on Chemicals Management on the work of its third session, SAICM/ICCM.3/24

[52] UNEP (2015) Hazardous substances within the life cycle of electrical and electronic products**,** IV/2 Emerging Policy Issues, Report of the International Conference on Chemicals Management on the work of its fourth session, SAICM/ICCM.4/15

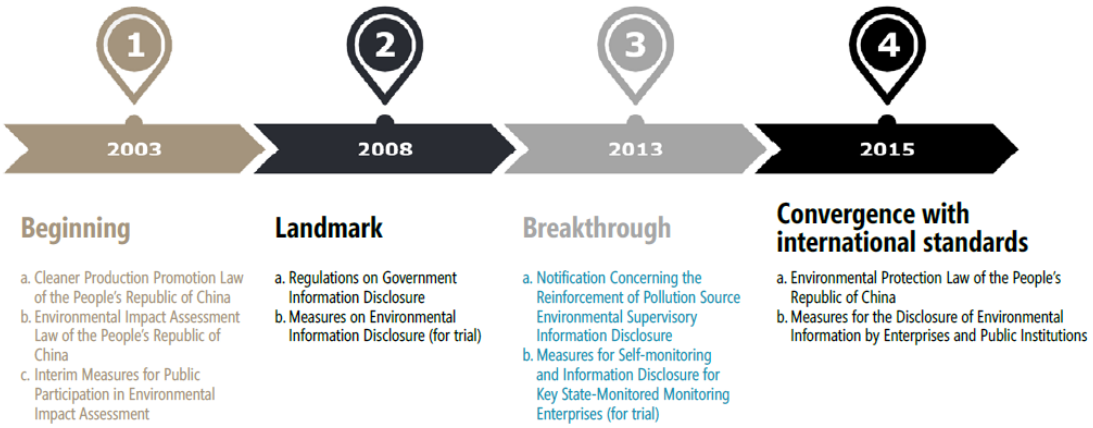
5. Building a PRTR in China: Progress & Gaps

Over the past decade, China has introduced many rules, regulations and measures to greatly expand the disclosure of environmental information. However, progress to date has focused on disclosure of government environmental information and the disclosure of corporate monitoring information on conventional pollutants. The disclosure of factory-level information on hazardous chemicals is still very limited.

China Strives to Promote Corporate Environmental Information Disclosure

As early as in 2008, China's State Environmental Protection Agency (SEPA) – which later became the Ministry of Environmental Protection (MEP) and was upgraded into the current Ministry of Ecology and Environment (MEE) in March 2018 – released the Measures on Environmental Information Disclosure (Trial). The Measures encourage enterprises to voluntarily publish data on pollutant type, quantity, concentration and transfer, as well as waste treatment and recycling. Article 20 requires enterprises whose pollution discharge exceeds national or local emission standards or total discharge control targets to openly publish the aforementioned environmental information, and accepts no excuses on the pretext of "commercial secrets."

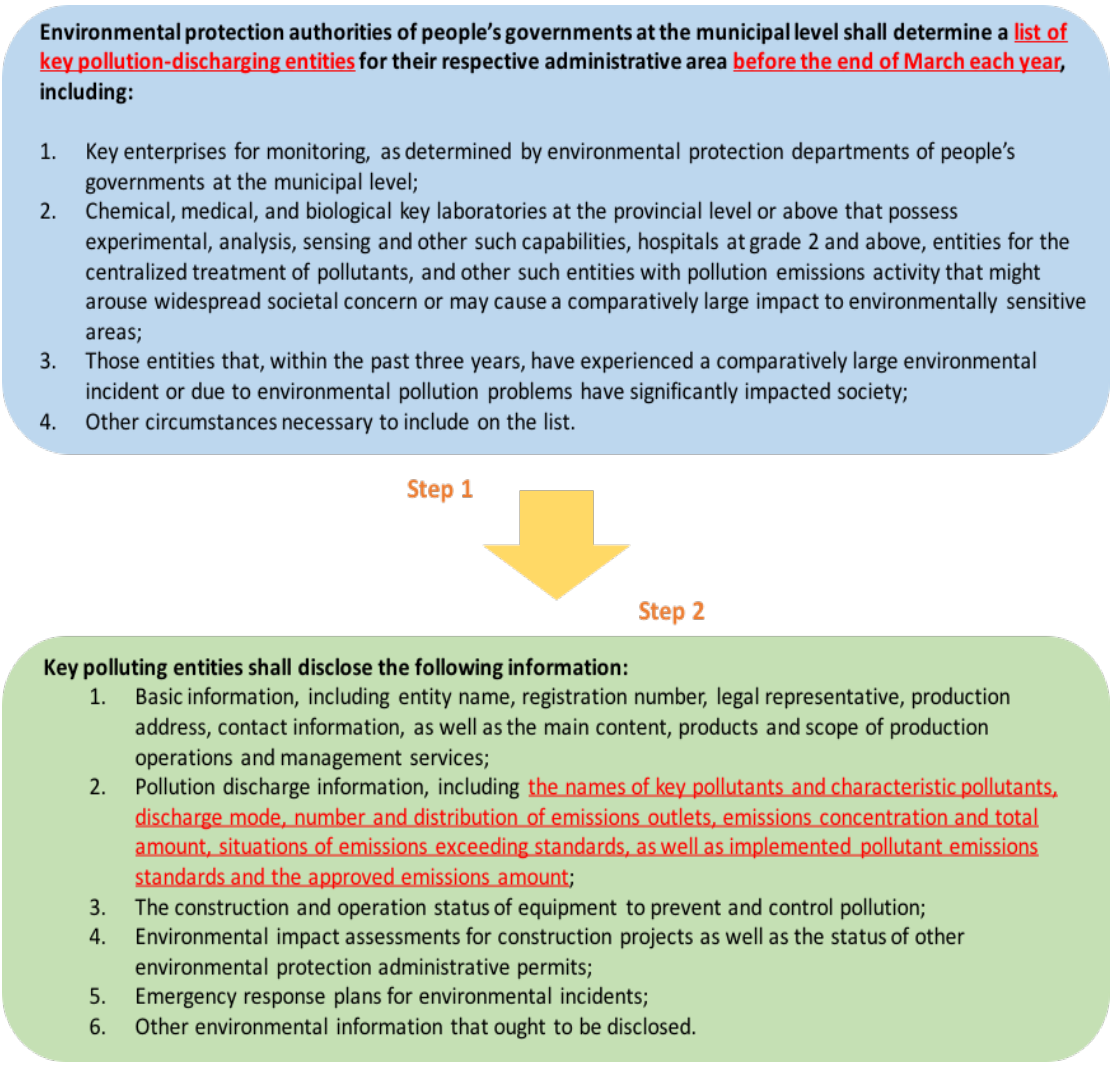
Figure 5. Milestones in China's Environmental Information Disclosure Legislation



Six years after this first move on environmental information transparency, the MEP issued the Measures on Self-Monitoring and Information Disclosure for Key State-Monitored Enterprises (Trial), which require over 14,000 large industrial emitters to publish their real-time and manual monitoring data, monitoring plans, as well as annual discharge reports to the public via the platforms of provincial or city-level environmental protection bureaus. Even though this policy resulted only in the public release of information on conventional pollution parameters such as chemical oxygen demand (COD), ammonia nitrogen (NH_3-N), sulfur dioxide (SO_2), nitrogen oxides (NO_x) and particulate matters (PM), it created a system that is still the first of its kind worldwide, reflecting the Chinese government's innovation toward environmental information transparency.

In addition to this, the Measures on Environmental Information Disclosure for Enterprises and Public Institutions, which went into effect on January 1, 2015, marks another significant step towards environmental information disclosure in China. Figure 6 illustrates the two steps by which key pollution-discharging entities are required to disclose their environmental information.

Figure 6. Two Steps to Environmental Information Disclosure



This can be seen as a concrete implementation work plan following the introduction of China's new Environmental Protection Law (EPL), which went into effect on January 1, 2015. Article 55 of the "new EPL" stipulates that key pollution-discharging entities shall truthfully disclose to the public the names of their key pollutants, manner of discharge, discharge concentration and total volume, status of whether emissions exceeded limits, as well as the construction and operation status of pollution prevention and control facilities, and [shall] accept societal supervision. The 2016-2017 PITI assessment found[53] that 230 of the 338 prefecture-level cities had released their list of key local pollution-discharging entities in 2016.

[53] http://www.ipe.org.cn/reports/Reports.aspx?cid=18336&year=0&key

In June 2017, the Legislative Affairs Office of the State Council released the Regulations of the People's Republic of China on the Disclosure of Government Information (Revised Draft for Comment), which establishes the principle of "disclosure as the norm, and non-disclosure as the exception." The State Council also released Several Opinions of the General Office of the State Council on Strengthening the Service for and Supervision of Market Subjects by Applying Big Data, which proposes the establishment of a unified information disclosure platform for industry. This prospect is promising, but realizing this goal will require significant effort.

To further advance environmental information disclosure of enterprises and public institutions, and to improve flexibility and practicality, China's MEP revised the Measures on Environmental Information Disclosure for Enterprises and Public Institutions (MEP Order No. 31) and released the draft revisions for public comment through September 18, 2017.[54] The draft revisions stipulate that the MEP establish an integrated environmental information disclosure platform for enterprises and public institutions. They also require that key pollution-discharging entities install automatic monitoring equipment and connect their monitoring data with the integrated MEP platform to be disclosed in real-time. MEP shall develop unified criteria for the formulation of directories of key pollution-discharging entities.

The 2016-2017 Pollution Information Transparency Index (PITI) assessment results show that China still has yet to establish a unified platform and impel pollutant-discharging entities to disclose such environmental information to the public.

Information Disclosure in China's Management of Hazardous Chemicals

As illustrated above, China's ten years of efforts toward leveraging information disclosure as a means of pollution control have been continuously strengthened. However, these efforts have mainly focused on conventional pollution parameters, while largely overlooking the role of persistent and accumulative pollutants that directly threaten human health.

The control of hazardous chemicals in China is mainly carried out through management of *weixian huaxuepin,* which is sometimes translated as "hazardous chemicals" but actually translates more accurately as "dangerous chemicals." According to the Regulations on the Safety Administration of Dangerous Chemicals, *weixian huaxuepin* refers to highly toxic chemicals and other chemicals that are toxic, corrosive, explosive, flammable, and combustible, and that are harmful to humans, facilities, and the environment. China's current Catalogue of Hazardous Chemicals lists 2,828 substances that are supervised through safety production licenses.

Since 2013, China has issued a number of policies aiming to increase the level of transparency of facilities engaging in hazardous chemical production, storage, transfer and treatment as a means of enabling governmental and public supervision on hazardous chemicals discharge and reducing the potential risks posed to the surrounding environment and communities.

[54] http://hjj.mep.gov.cn/dtxx/201708/t20170818_420023.shtml

Figure 7. List of Policies and Conventions on Hazardous Substance Management Signed and/or Issued by China

	Regulation	**Issued by**	**Time**	**Highlights**
1	Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and Their Disposal		Signed on March 22, 1990 by the Chinese government; went into effect in China on May 5, 1992	Aims to protect human health and the environment against adverse effects caused by the production, transfer and disposal of hazardous wastes.
2	Regulation on the Environmental Management of the First Import of Chemicals and the Import and Export of Toxic Chemicals	Former SEPA, General Administration of Customs, former Ministry of Foreign Trade and Economic Cooperation	Published on March 16, 1994; on July 6, 2007, the regulation was reviewed and revised by the former SEPA; at its second meeting in 2007, Articles 9, 10, 11 were deleted as a result	Regulates environmental management of the first import of chemicals and the import and export of toxic chemicals.
3	Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade		Signed on August 24, 1999 by the Chinese government; went into effect in China on June 20, 2005	Aims to protect human health and the environment, including the health of consumers and workers, from the potential harmful effects of certain hazardous chemicals and pesticides in international trade.
4	Stockholm Convention on Persistent Organic Pollutants (and related amendments)		Signed by the Chinese government on May 23, 2001; went into effect in China on November 11, 2004	Aims to protect human health and the environment, taking measures to eliminate and/or restrict the production and use of persistent organic pollutants (POPs).

5	Regulations on the Safety Administration of Dangerous Chemicals	Order of the State Council (No. 591)	Announced by the State Council (No. 344) on January 26, 2002; amended at the 144th executive meeting of the State Council on February 16, 2011; came into force on December 1, 2011	The personnel chiefly in charge of the units that produce, store, management, use, and transport dangerous chemicals and dispose of waste dangerous chemicals (hereinafter referred to as the dangerous chemical units) shall be fully responsible for the safety management of dangerous chemicals in their units. Relevant departments engaged in safety supervision and management on production, storage, use, operation and transportation of dangerous chemicals shall fulfill their duties.
6	List of Priority Chemicals for the Prevention and Control of Environmental Risks (as part of the 12th Five–Year-Plan, 2010-2015)	Former Ministry of Environmental Protection (MEP)	Went into effect on February 7, 2013	Prioritizes groups of chemicals, enterprises and regions to be controlled for their environmental risks.
7	Measures on the Environmental Management and Registration of Hazardous Chemicals (Trial) (and related supporting documents)	Former MEP	Went into force on March 1, 2013; repealed on July 13, 2016	Clarifies the requirements of environmental management registration and information disclosure for the production of hazardous chemicals, and clarifies the environmental management registration requirements for import and export of hazardous chemicals listed in the Catalogue of Hazardous Chemicals strictly restricted in China.
8	Inventory of Enterprise Risk Assessment for Environmental Incident (Trial)	Former MEP	Went into effect on April 3, 2014	Specifies chemical substances and their threshold quantities for enterprise to identify and assess environmental risks in the case of incidents.

9	Catalogue of Priority Hazardous Chemicals for Environmental Management	Former MEP	Published on April 4, 2014; repealed by the State of Council on July 13, 2016	Lists information on persistent, bioaccumulative and toxic chemicals that require long-term environmental management.
10	Catalogue of Hazardous Chemicals (2015 Edition)	SWAS (with 9 ministries)	Went into effect on February 27, 2015	Provides a list of 2828 hazardous chemicals and information about their toxicity.
11	National Catalogue of Hazardous Wastes	Former MEP, NDRC	Went into effect on August 1, 2016	Lists national hazardous waste categories, industry sources, code and hazardous characteristics, and hazardous waste exemption management lists
12	Minamata Convention on Mercury		Came into effect in China on August 16, 2017	Aims to protect the human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds.
13	Water Pollution Prevention and Control Law	Order of the President (No. 70)	Went into effect on January 1, 2018	Enterprises, institutions, other producers and operators with toxic and hazardous water pollutants discharge, shall monitor the sewage outlets and the surrounding environment, assess environmental risks, and disclose information on toxic and hazardous water pollutants.
14	Inventory of Strictly Restricted Toxic Chemicals in China (2018)	Former MEP, Department of Commerce, General Administration of Customs	Went into effect on January 1, 2018	Entities that touch upon any of the ten types of toxic chemicals listed in the inventory shall apply to the MEP (MEE) for Clearance Notification of Environmental Management on Import/ Export of Toxic Chemicals. Importers and exporters shall submit Clearance Notification to Customs and handle import and export formalities.

The crux of these policies is the Measures on the Environmental Management and Registration of Hazardous Chemicals (Trial), which went into effect on March 1, 2013. Article 22 of these Measures stipulates that enterprises that produce and use hazardous chemicals shall in January of each year publish an annual report on the environmental management of hazardous chemicals, disclose to the public the status of the types of hazardous chemicals produced and used during the previous year, harmful characteristics, relevant pollutant discharge and accident information, and measures for pollution prevention and control. Meanwhile, enterprises producing and using priority hazardous chemicals for environmental management shall still publish information on the transfer and release of priority hazardous chemicals for environmental management and characteristic pollutants, as well as monitoring results.

In spite of its pioneering move towards requiring publication of facility-level information on the transfer and release of priority hazardous chemicals, this piece of legislation had never been seriously implemented before it was annulled in July 2016. Shortly afterwards, the State Council released the Hazardous Chemicals Safety Comprehensive Management Plan in November 2016 to increase the level of hazardous chemicals safety management. Notably, the new legislation emphasizes safety regulation information on the management of hazardous chemicals, which includes:

- Optimizing the hazardous chemical registry mechanism;
- Constructing a national hazardous chemical supervision information sharing platform; and
- Building a national public service platform for hazardous chemical safety on which information related to registered hazardous chemicals is to be published.

All three platforms were slated to reach initial implementation by March 2018 and will continue to be optimized through October 2019. Since China still lacks a centralized disclosure platform for hazardous chemicals, the implementation of these policies may help close this gap and address urgent concerns. However, not until these platforms are fully implemented will we be able to assess their effectiveness and whether or not their implementation scope is adequate to address current concerns with lack of mandatory disclosure on hazardous chemicals.

Disclosure of Chemicals is Crucial to Water and Soil Pollution Prevention

Once contaminated, soil and groundwater are very difficult to restore. Toxic and hazardous substances, including heavy metals and persistent organic matters, can cause serious and long-term damage. A PRTR system is therefore especially important for preventing controlling pollution from hazardous substances to soil and groundwater because it tackles pollution at the source.

Article 32 of amendments to China's Water Pollution Prevention and Control Law that went into effect on January 1, 2018 requires the publication of a list of toxic and hazardous water pollutants. The same article of the amended law also stipulates, "Enterprises, public

institutions and other producers and operators that discharge toxic and hazardous water pollutants on the aforementioned list shall carry out monitoring, environmental risk assessment, and inspection of hidden environmental and safety risks at discharge points and their surrounding environments, as well as disclose information about toxic and hazardous water pollutants and adopt effective measures to protect against environmental hazards." As legislation passed by the National People's Congress, the new Water Law thus provides a high-level legislative basis for the disclosure of toxic substances released into water.

Also encouraging is that the first public draft of China's pending Soil Pollution Prevention and Control Law, released to the public in 2017, also stipulates requirements concerning disclosure of key toxic and harmful substances in soil. Article 18 of the draft law requires for environmental authorities to "announce a directory of key toxic and harmful substances in soil, and update this as appropriate," while Article 19 requires the publication of "a directory of key industries for soil pollution supervision and the corresponding management measures, on the basis of the directory of toxic and the environmental impact of the production, use, storage, transport, recycling, and disposal of soil pollutants."

Article 20 of the draft Soil Pollution Prevention and Control Law builds on this by stipulating requirements for those enterprises designated for soil pollution supervision and management:

Article 20 The competent department of environmental protection of provincial people's governments shall develop and publish a list of enterprises for key soil pollution supervision and management in the administrative region on the basis of the directory of industries for key soil pollution regulation, the distribution of industrial and mining enterprises, and the state of pollutant emissions, and update it as appropriate.

Enterprises included in the list of the preceding paragraph shall perform the following obligations:

(1) Control the emissions of toxic and harmful substances;
(2) prevent leakage, seepage, of toxic and harmful substances, scattering and dispersion of toxic and harmful substances;
(3) Formulate and implement an annual monitoring planning;
(4) Report on the annual emissions and transference of toxic and harmful substances to the environment.

The obligations provided for in the preceding paragraph shall be indicated in relevant licenses such as discharge permits, permits for the disposal of domestic waste, and permits for the disposal of construction waste.

The competent departments for environmental protection of provincial people's government shall periodically conduct monitoring of the soil surrounding key supervision and management enterprises, and use the monitoring results as the basis for environmental law enforcement and risk early warnings, and promptly upload it to the national soil environmental information platform.

Unlike the requirements of the Water Pollution and Prevention Law for "disclosing information on toxic and hazardous water pollutants," the Soil Pollution Prevention and Control Law (Draft) requires "reporting of the annual release and transfer of toxic and hazardous substances to the environment," but has not clarified whether relevant reports shall be publicly disclosed.

Efforts to Implement Disclosure Policies in China

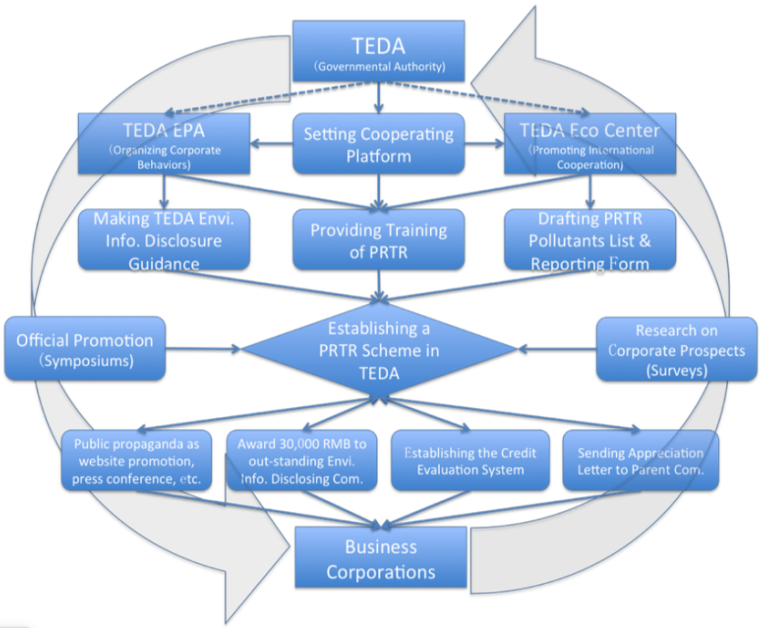
Given the severity of pollution in China from hazardous substances and the fact that management and control cannot wait, some local governments and NGOs in China have carried out several projects to pilot the establishment of a PRTR system.

Tianjin TEDA's Pilot PRTR System

In 2009, Tianjin's Economic and Technology Development Area (TEDA) first announced that the area would disclose enterprise environmental information. Four years later, in 2013, the TEDA Eco Center, TEDA's Environmental Protection Bureau (EPB), the Institute of Public & Environmental Affairs (IPE), and Sweden's International Institute for Industrial Environmental Economics (IIIEE) at Lund University co-implemented the "EU-China Environmental Governance Programme: Developing a Pilot Regional Pollutant Release and Transfer Register in Tianjin Binhai New Area, China," with the plan of drawing on the European Union's relevant experience and management expertise to implement a PRTR system within TEDA.

The program encouraged the enterprises in TEDA to voluntarily disclose environmental information, improve their environmental management strategies, and reduce pollutant emissions. Part of the aims of the project were to serve as a pilot project for the establishment of a nationwide PRTR disclosure system that could strengthen information disclosure and safeguard the public's environmental right-to-know.

Figure 8. TEDA Promotion Mechanism for PRTR



Source: *Examining Business Perceptions of a Pollutant Release and Transfer Register in China, A Case Study in Tianjin Economic-Technological Development Area*

As of 2015, the number of enterprises disclosing information on pollution and pollutants had increased from an initial number of 29 enterprises in 2013 to 129 enterprises in 2015. These participating enterprises regularly published environmental information disclosure reports to inform the public about the discharge and transfer of primary pollutants and characteristic pollutants. One of the major lessons learned from the project is that the corporate sector requires significant training and guidance due to a lack of general understanding about environmental information disclosure.

Since the pilot project concluded in 2015, however, the project website has not been updated with any new data.[55] Still, the project demonstrates that PRTR disclosure in China is feasible, and its working model could potentially be replicated in other economic development areas and/or industrial parks in China as a means of training enterprises on how to systematically measures emissions and comprehensively disclose PRTR data.

NGO and Media Advocacy

Pollution reduction results due to NGO and media advocacy based on corporate environmental information disclosure pose implications for the Chinese context. Because environmental information disclosure in China has traditionally emphasized corporate disclosure only for those entities that are out of compliance or exceed certain thresholds, corporations regularly and easily flout disclosure requirements by simply not disclosing information in what amounts to an "innocent until proven guilty" fashion. For example, according to Ker,[56] "A 2009 Greenpeace study on the implementation of mandatory corporate information disclosure found that none of the 500 Fortune Global and the 100 Fortune China companies found to be in violation of pollutant discharge standards disclosed environmental information within the required period of 30 days."

Although some provinces, such as Jiangsu and Inner Mongolia, have experimented with "Green Watch" programs that assign enterprises color-coded environmental ratings, these initiatives are still government-led and only contain summary data, so their implications for NGO, media and other third-party advocacy is limited. Without compulsory disclosure of hazardous chemicals information, environmental organizations can only choose to advocate for voluntary disclosure from enterprises. And when information disclosure is voluntary, it is difficult to exert pressure via rankings, because companies that disclose of their own will may receive additional pressure, while companies that refuse to disclose will not be exposed. To solve this problem, it is necessary for information on hazardous chemicals be made public and to severely punish companies that refuse to disclose.

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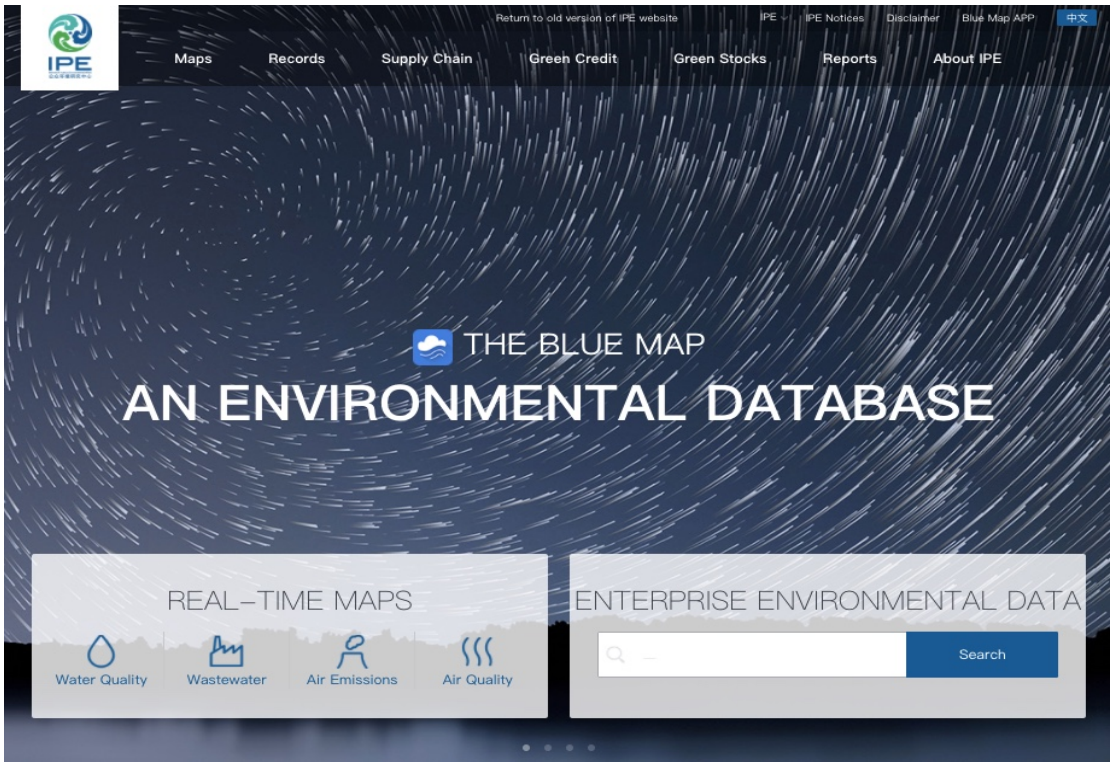
[55] http://prtr.ecoteda.org/

[56] Ker, Michelle. "Getting Down to Business: Deepening Environmental Transparency in China." *The Solutions Journal.* 2014. Vol. 5, No. 4.

IPE's PRTR Disclosure Platform

Since its establishment in 2006, IPE has operated the Blue Map Database (previously referred to as the "China Pollution Map Database"), which collects publicly-available environmental information from official government sources and collates it into a user-friendly database so that stakeholders can search for and easily locate relevant environmental information. The database currently contains two main sections: 1) four real-time maps respectively displaying air quality, water quality, air emissions sources and wastewater sources; 2) a database of "enterprise environmental data" that as of May 2018 includes over 970,000 environmental supervision records issued by environmental and other authorities, as well as enterprise responses to these records and enterprises' self-disclosed emissions data.

Figure 9. IPE Blue Map Database Landing Page



To confront hazardous chemicals pollution and other related environmental issues from electronics production, in 2010, IPE launched a series of investigations into pollution from IT industry manufacturers. The initial campaign, which engaged 29 major IT brands, eventually succeeded in motivating many of these companies to check publicly-available environmental violation record data and motivate suppliers with violations to issue public statements about corrective actions and/or undergo supervised third-party audits to verify the effectiveness of corrective actions. Based on the Green Choice supply chain management standards, enterprises that desire to "de-list" (i.e. remove their violation record) from IPE's database via on-site audit are required to publish the past two years' emissions data and to commit to continue publishing their annual emissions data.

IPE launched its own platform for voluntary disclosure of pollutant release and transfer data (PRTR) in August 2013 to promote high environmental impact manufacturers to disclose their emissions data, including for hazardous chemicals. Since then, IPE has encouraged electronics companies and companies from other industries that source from China to require their high environmental impact suppliers to publish their annual data on the portal.

IPE Develops a PRTR Reporting Template

IPE has long advocated for the establishment of a nationwide Pollutant Release and Transfer Registry (PRTR) system suitable for China's national situation. Beginning with the first Pollution Information Transparency Index (PITI) report published in 2009,[57] IPE has studied and analyzed international experiences in implementing PRTR in order to introduce an effective and efficient system for China that takes into account the industrial makeup of polluters and effectively furthers information transparency.

In 2013, IPE developed a "Proposed Pollutant Inventory for China Priority Pollutant Release and Transfer Register (PRTR)." The list is based on China's National Register of Hazardous Wastes, as well as the hazardous substances from the US TRI and EU PRTR lists that are most relevant to industries in China. Thereafter, IPE launched a PRTR information disclosure database for enterprises, allowing them to publish PRTR data online on IPE's website in a section dedicated to enterprises' annual emissions disclosure.

Figure 10. IPE's Proposed Pollutant Inventory for China Pollutant Release and Transfer Register

中国环境优先污染物转移登记制度建议物质清单

Proposed Pollutant Inventory for China Priority Pollutant Release and Transfer Register

物质分类 Category	序号 No.	中文名称	化学文摘号 CAS No.	English Name
分类 1：持久性有机污染物 Persistent Organic Pollutants (POPs)	1	六氯苯	118-74-1	Hexachlorobenzene
	2	氯丹	57-74-9	Chlordane
	3	灭蚁灵	2385-85-5	Mirex
	4	五氯苯	608-93-5	Pentachlorobenzene
	5	滴滴涕	50-29-3	DDT
	6	多氯联苯	1336-36-3	PCBs
	7	多氯代二噁英，多氯代苯并呋喃	N/A	PCDD + PCDF (Dioxins + Furans)
	8	林丹(γ-六六六)	58-89-9	Lindane
	9	氯代环烷烃（六六六）	608-73-1	HCH
	10	四溴联苯醚及五溴联苯醚	N/A	PBDEs
	11	全氟辛酸	335-67-1	PFOA
	12	全氟辛烷磺酸	1763-23-1	PFOS
	13	全氟辛烷磺酸盐类		PFOSA
	14	全氟辛基磺酰氟	307-35-7	PFOSF
分类 2：金属类 Metals	15	总镍	N/A	Nickel
	16	六价铬	N/A	Hexavalent Chromium
	17	总铜	N/A	Total Copper
	18	总锌	N/A	Total Zinc
	19	总汞	N/A	Total Mercury
	20	总铅	N/A	Total Lead
	21	总镉	N/A	Total Cadmium
	22	总砷	N/A	Total Arsenic

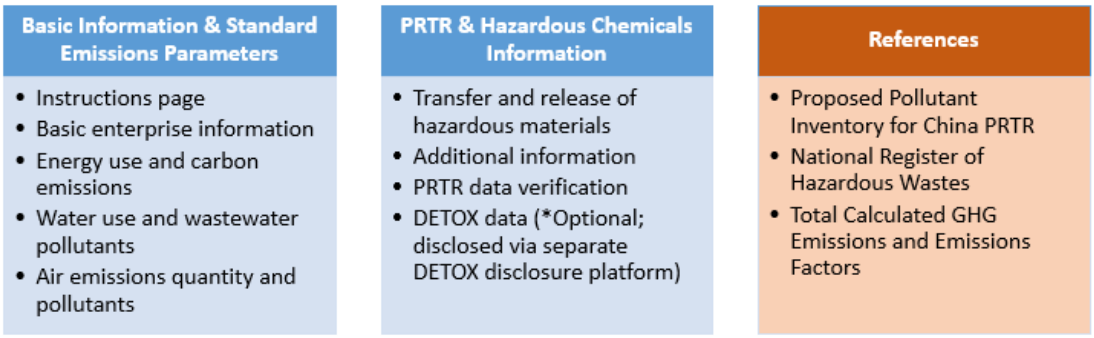
Note: See Appendix I for full proposed pollutant inventory.

[57] http://www.ipe.org.cn/reports/Reports.aspx?cid=18336&year=0&key=

Since its launch in 2013, IPE's Proposed Pollutant Inventory has undergone one round of revision, with the current version being adopted on August 1, 2014. The inventory contains 104 substances across nine different categories of pollutants: persistent organic pollutants (POPs), metals, inorganic substances, chlorinated and brominated organic substances, greenhouse gases (GHGs), other gases, polycyclic aromatic hydrocarbons (PAHs), other organic substances, and active substances of plant protection products or biocidal products. The full pollutant inventory can be found in Appendix I.

Unlike most PRTR reporting and disclosure systems, IPE's PRTR reporting template and disclosure platform covers a more comprehensive set of pollutants, including not only harmful chemicals, but also conventional pollutants, as well as water consumption, water efficiency, energy efficiency, and carbon emissions information.

Figure 11. Information Included in IPE's PRTR Disclosure Platform

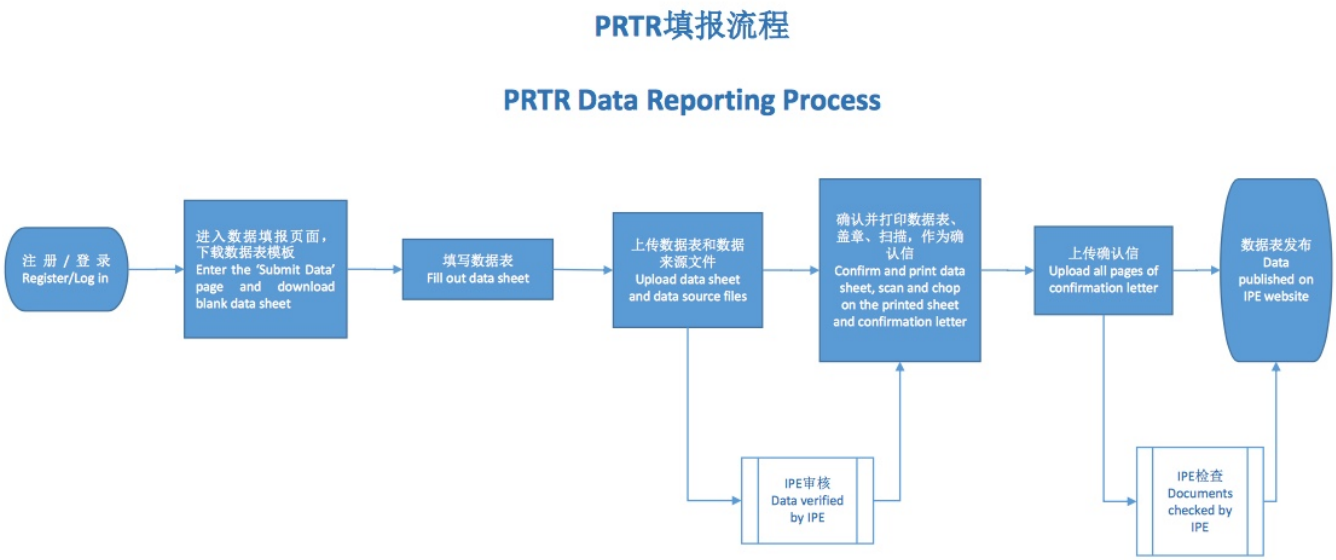


The reason why IPE has included more indicators in the information reporting and disclosure platform is that China is currently facing a full range of environmental and resource challenges. Corporate general pollutants, as well as information disclosure on energy efficiency and greenhouse gas emissions, are as serious as harmful chemicals. Integrating these disclosure indicators into a single table can make corporate information disclosure more comprehensive and efficient.

To submit data on IPE's disclosure platform, enterprise users must first register for a corporate user account on IPE's website.[58] Once registered, a user may download the reporting template and complete it with data, including information about the source of each piece of data. As shown below, all data sources are verified by IPE and a sealed confirmation letter must be provided by the enterprise before data is officially published on the IPE platform.

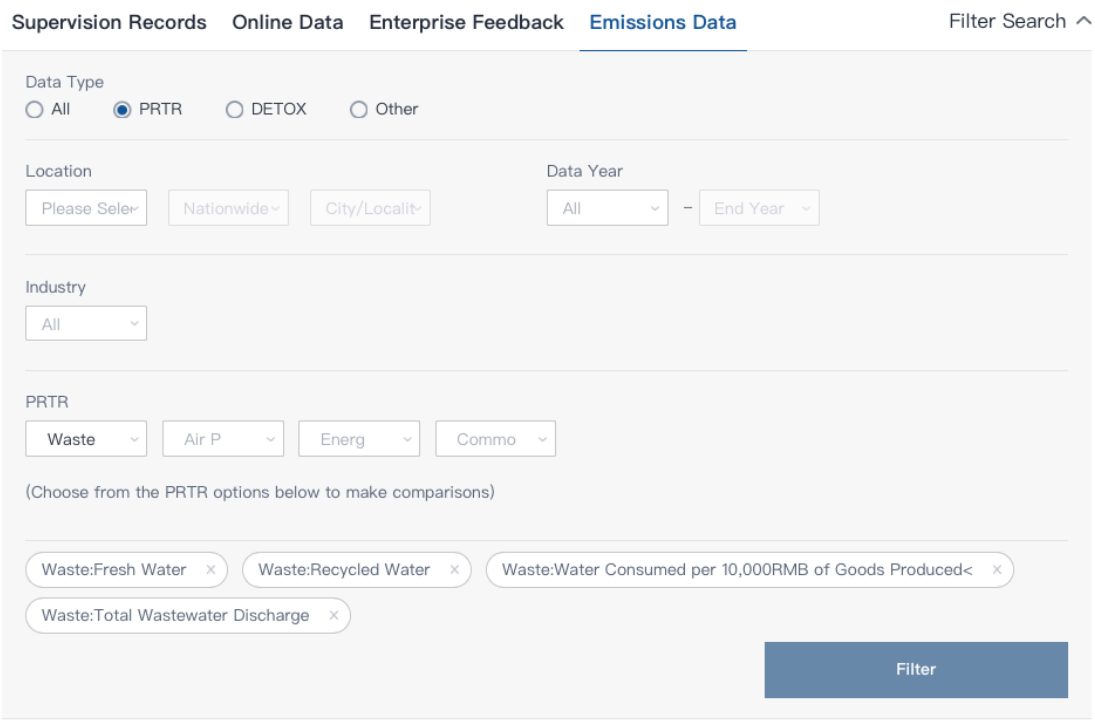
[58] http://wwwen.ipe.org.cn/

Figure 12. Data Reporting Process for IPE's PRTR Disclosure Platform



In addition to providing a platform for data submission, IPE's website also allows users to select individual indicators from the PRTR chart and conduct comparison across suppliers and years. This allows the public to view a single supplier's environmental performance over several years, as well as to compare and contrast the performances of different suppliers within one industry.

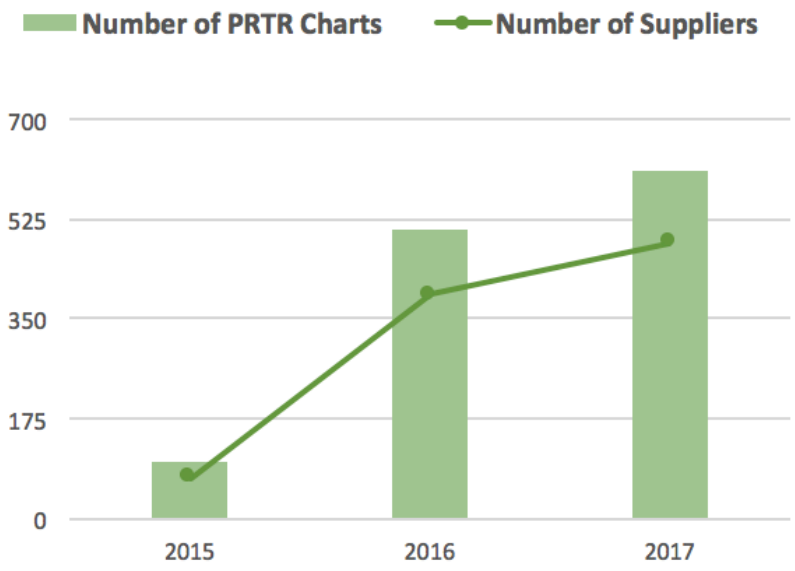
Figure 13. IPE's PRTR Viewing Page



Scope and Impact

Since its launch in 2013, IPE's PRTR disclosure system has seen a significant increase in the number of suppliers publishing their annual resources and energy usage data, as well as pollutant release and transfer data.

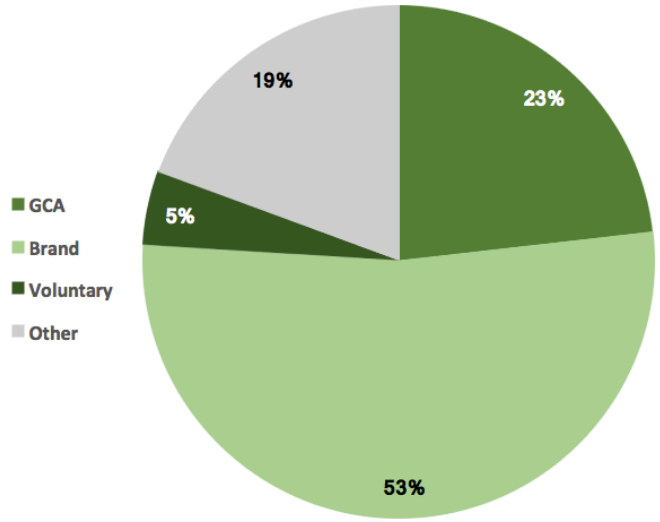
Figure 14. Number of Suppliers Submitting PRTR Data to IPE's Platform



This rising trend can be attributed to the combined result of the following factors:

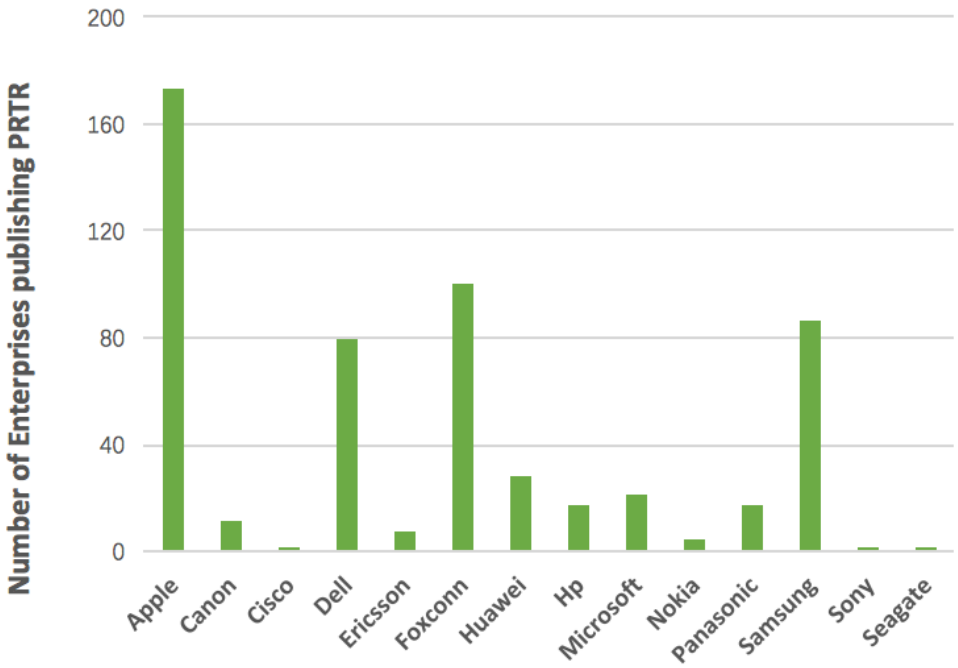
a. Strengthened legislation on environmental information disclosure;
b. IPE's continued efforts to support Chinese People's Political Consultative Conference (CPPCC) delegates to submit proposals calling for the establishment of a nation-wide mandatory environmental informational disclosure platform;
c. IPE's Green Choice Alliance (GCA) green supply chain program, which requires suppliers undergoing on-site audits conducted by third-parties to publish PRTR data for the most recent two years;
d. Rising number of brands who embrace the idea of supply chain transparency and integrate PRTR disclosure into their supplier environmental management mechanisms;
e. Increased level of public and media supervision.

Figure 15. Main Motivating Factors for Suppliers to Publish on IPE's PRTR Disclosure System[59]



In the electronics sector specifically, a total of 14 brands have motivated suppliers to use the PRTR platform developed by IPE to disclose their PRTR data. These brands to varying degrees all require suppliers to disclose their annual environmental data.

Figure 16. Number of Suppliers Publishing via IPE's PRTR Disclosure Platform[60]

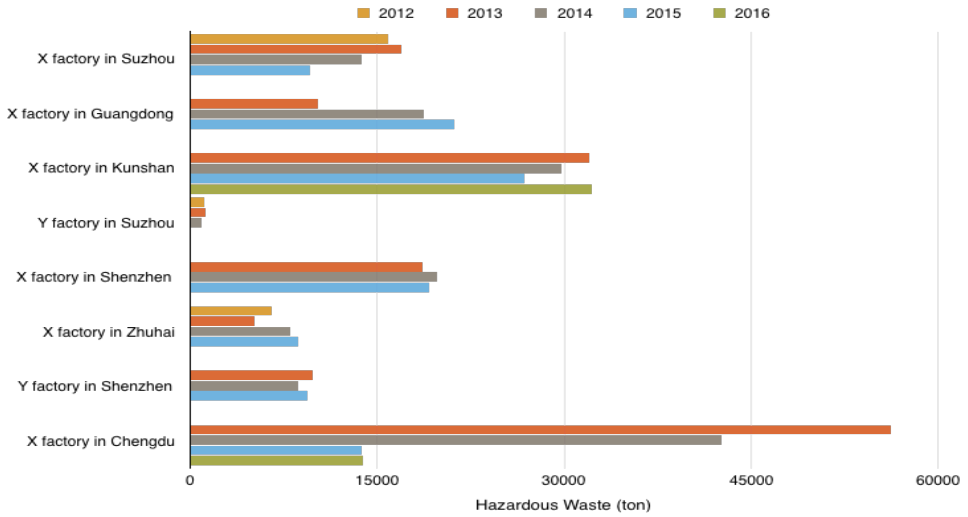


59 In this figure, "GCA" refers to suppliers that were required to publish data as part of the requirements to pass a Green Choice Alliance audit to remove a violation record from IPE's database. Facilities that undergo this process must publish the past two years' emissions data, and commit to publishing their annual PRTR data going forward.

60 Data as of May 2018.

We selected to analyze eight suppliers to an IT industry brand that published their annual PRTR data for at least three years in a row. Calculations based on their PRTR data indicates that the total amount of hazardous waste produced can vary greatly among suppliers. This phenomenon, as well as the reduction or increase of discharges over several years at one supplier, requires deeper analysis of the underlying causes and should motivate suppliers to improve their performance.

Figure 17. Hazardous Waste Produced by Suppliers Selected for Analysis[61]



Case Study: Pushing Suppliers to Treat Heavy Metals in River Basin Sediment[62]

In 2013, investigations by the Suzhou-based environmental protection organization, Lvse Jiangnan, uncovered that a large electronics factory had been discharging wastewater into an internal channel, causing a pungent odor, darkened water and thick foam. This problem attracted the attention of senior staff at the company. Under requests from one of its brand customers, the factory began to investigate the problem in the channel, and launched a remediation project for the channel, which unfolded in five stages.

The first four stages were completed over six months and included cutting off the water sources to the channel, completely diverting storm-water, drying up sediment in the riverway, and developing a river sediment monitoring and treatment scheme (which passed an expert review on May 2014). Stage 5 was the launch of sediment dredging treatment work and implementation of experts' recommendations for the "hydraulic digging, remote exposure" dredging plan. In November 2014, construction of the sediment exposure tanks was completed, and on December 20, 2014, all dredging work was finished. As part of its remediation efforts and commitment to compliance, the factory continues to disclose its annual PRTR data on IPE's platform.[63]

[61] Data as of March 2017.

[62] 2015 CITI annual report: http://wwwen.ipe.org.cn/reports/Reports.aspx?cid=18334&year=0&key=

[63] http://wwwen.ipe.org.cn/IndustryRecord/regulatory-record.aspx?companyId=6947&dataType=3&selfdata=prtr-

Among these brands, Panasonic was one of the first to adapt a PRTR system for environmental management of its subsidiary factories in China. Beginning in 2016, the Japanese electronics giant started to publish the annual data of ten of its subsidiary companies in China on its own official website. Published data include wastewater and exhaust gas emissions, energy consumption, hazardous waste production, and the names of the centralized wastewater and hazardous waste treatment facilities that receive waste; hazardous wastes include nickel, lead, mercury and organic resin. Such disclosure therefore increases the transparency of the production and treatment of hazardous waste.

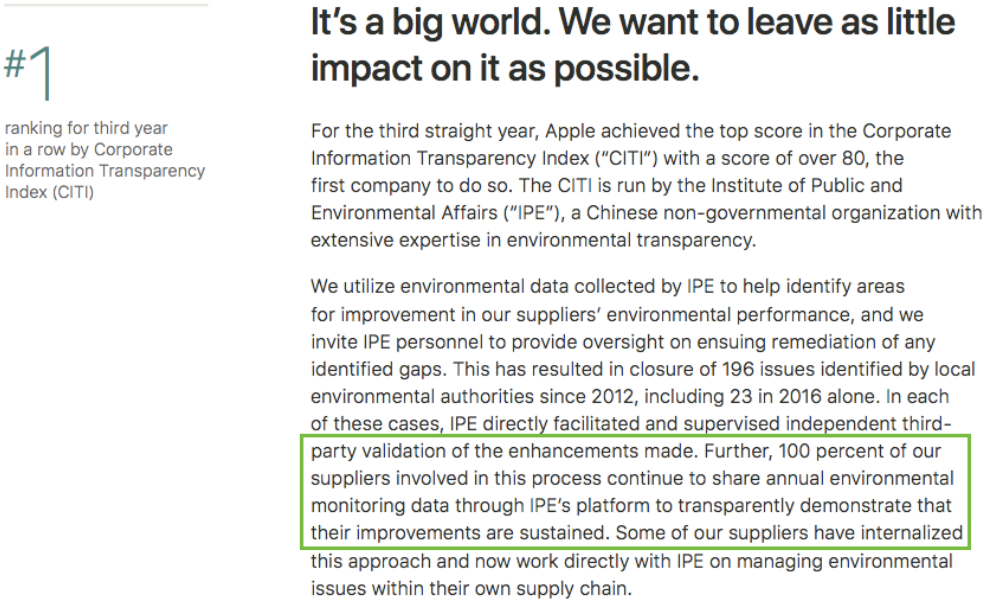
Figure 18. Panasonic Discloses Subsidiary Enterprise Environmental Information

Source: Panasonic China official website

group&dataId=0&isyh=0

Another IT brand that actively promotes transparency and traceability of hazardous chemicals is Apple. In its *Supplier Responsibility 2017 Progress Report*[64], Apple states that all of its Chinese suppliers who have removed their violation records following GCA audits fill in and publish their annual environmental monitoring data via IPE's PRTR platform to demonstrate their sustained compliance in accordance with Chinese laws and regulations.

Figure 19. Apple Requesting Suppliers to Conduct Information Disclosure



#1

ranking for third year in a row by Corporate Information Transparency Index (CITI)

It's a big world. We want to leave as little impact on it as possible.

For the third straight year, Apple achieved the top score in the Corporate Information Transparency Index ("CITI") with a score of over 80, the first company to do so. The CITI is run by the Institute of Public and Environmental Affairs ("IPE"), a Chinese non-governmental organization with extensive expertise in environmental transparency.

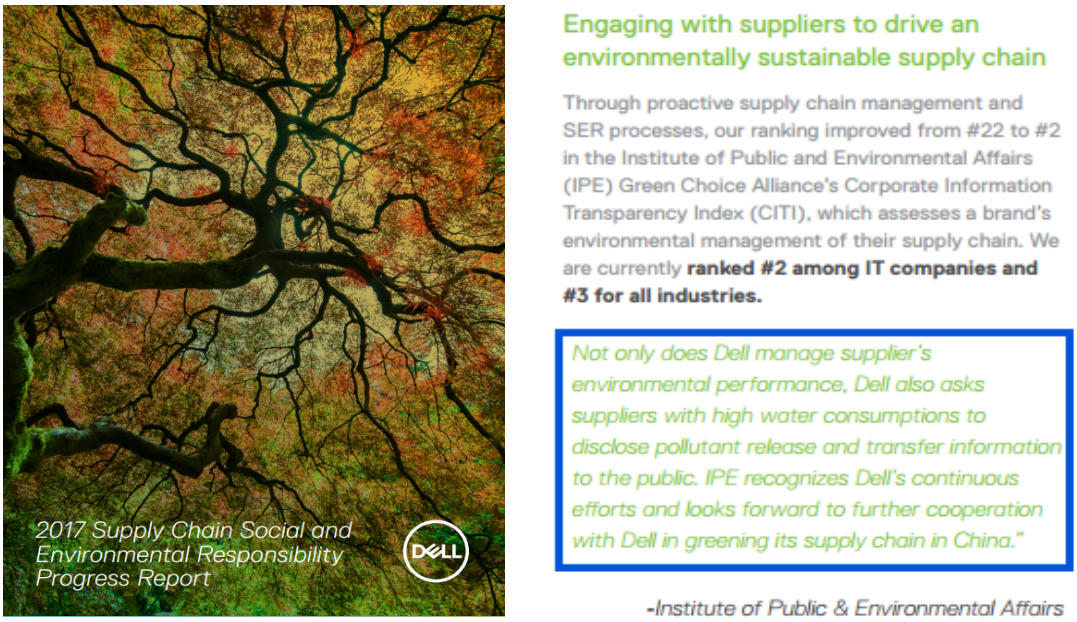
We utilize environmental data collected by IPE to help identify areas for improvement in our suppliers' environmental performance, and we invite IPE personnel to provide oversight on ensuing remediation of any identified gaps. This has resulted in closure of 196 issues identified by local environmental authorities since 2012, including 23 in 2016 alone. In each of these cases, IPE directly facilitated and supervised independent third-party validation of the enhancements made. Further, 100 percent of our suppliers involved in this process continue to share annual environmental monitoring data through IPE's platform to transparently demonstrate that their improvements are sustained. Some of our suppliers have internalized this approach and now work directly with IPE on managing environmental issues within their own supply chain.

Source: Supplier Responsibility 2017 Progress Report, Apple

[64] https://www.apple.com/supplier-responsibility/pdf/Apple_SR_2017_Progress_Report.pdf

In addition to Apple and Panasonic, starting in 2015, Dell began actively requiring its suppliers to disclose data via IPE's PRTR disclosure platform as part of its supply chain management requirements. Suppliers that disclose data are rewarded in Dell's quarterly business reviews of key suppliers, which impact Dell's purchasing decisions. Dell highlighted the importance of its suppliers' PRTR disclosure in its *2017 Supply Chain Social and Environmental Responsibility Progress Report*.

Figure 20. Dell Requesting Suppliers to Conduct Information Disclosure[65]



Source: Dell 2017 Supply Chain Social and Environmental Responsibility Progress Report

Case Study: PRTR System Developed by IPE Helps Companies Successfully Reach New U.S. Procurement Standards

Disclosure can pose practical implications for corporate compliance with new laws and policies. For example, some companies have been exploring using PRTR data for suppliers in China disclosed via IPE's platform to fulfill certain requirements for disclosure of environmental impacts of electronics components via the Electronic Product Environmental Assessment Tool (EPEAT),[66] an initiative managed by the Green Electronics Council that came about following a stakeholder engagement process initiated by the U.S. Environmental Protection Agency.

In order to meet the EPEAT standard for Servers (NSF/ANSI 426-2017) criterion 12.2.3 (Optional - Public reporting of toxics release data (corporate)), the manufacturer must conform to the reporting format and chemicals listed on U.S. Toxics Release Inventory, United Nations Protocol on Pollutant Release and Transfer Registry, or applicable country/region registry for 3 of the manufacturer's top 6 suppliers of 3 specific components, if applicable to the product declared

[65] http://i.dell.com/sites/doccontent/corporate/corp-comm/en/Documents/ser-report.pdf

[66] http://www.epeat.net/about-epeat/

to conform to the Server Standard. Those three component types are principal storage devices, principle semiconductor devices, and printed circuit boards. Because many of Dell's top 6 suppliers of these three components have facilities located in China, Dell is exploring using the PRTR data that was submitted to IPE instead of requiring them to complete another form.

Remaining Gaps

Dr. Joe DiGangi, Senior Science and Technical Advisor at IPEN – which has long been a participant in multilateral initiatives on hazardous chemicals – said, "More than 100 countries have agreed that hazardous chemicals in electronics is an issue of global concern under the Strategic Approach to International Chemicals Management (SAICM) and formulating and implementing PRTR is a key recommendation. IPE's advancement of PRTR supports SAICM implementation and sets the stage for a comprehensive mandatory system that requires polluters to be accountable."

IPE's PRTR disclosure efforts and the voluntary participation of brands and suppliers from the electronics industry support the implementation of recommendations from the SAICM's 2011 Vienna Meeting on Electronics and have furthered information transparency on hazardous discharge in China. Still, the overall impact of their efforts remains limited because the disclosure platform is mainly employed by leading companies, while polluters are free not to disclose their data. Policies that require across-the-board disclosure would endow the disclosed data with greater comparability and thus open space for NGOs, media and other third parties to use the data as an effective tool to push for emissions reductions and improved environmental management.

Electronics companies' experiences with the PRTR disclosure system on IPE's Blue Map Database show that disclosure is feasible and beneficial. In order to truly bring about extensive improvements in management of hazardous chemical release and transfer, though, the adoption and full implementation of a mandatory PRTR disclosure system is needed.

6. Recommendations

As demonstrated by the experiences of the U.S., Europe and many other countries,[67] mandatory PRTR disclosure can play a crucial role in managing hazardous chemicals and reducing related pollution impacts so that compliance is no longer a cat-and-mouse game. Instead, publicizing information about the discharge of hazardous substances can motivate big emitters to voluntarily carry out significant emissions reductions under the pressure of public supervision.

China is currently confronting severe issues with hazardous chemical pollution. We hope that the government, the public and the private sector can all recognize that in addition to using traditional orders and controls to strengthen supervision, they can also take advantage of information disclosure and the establishment of a PRTR system in China to work together to promote reductions in the discharge of hazardous substances.

Building on the above, we raise the following recommendations:

1. **Begin the legislative process to launch a Pollutant Release and Transfer Register (PRTR) system as soon as possible.**

With requirements for corporate environmental disclosure currently scattered across different laws and policies, China should pass legislation that specifically mandates the implementation of a PRTR system.

Since 2013, IPE has worked on multiple occasions with entrepreneurs from the Society of Entrepreneurs & Ecology (SEE), as well as other partners such as NRDC, to raise the following recommendations regarding China's legislation on a PRTR system:

- Publish a list of hazardous chemicals for mandatory disclosure;
- All polluting facilities are required to register the release and transfer data of the listed pollutants on the given platform with standardized format;
- The scope and breadth of conventional pollutants and dangerous chemicals required for disclosure should be no less than the pollutants identified in environmental impact assessments (EIAs);
- Relevant agencies should strengthen supervision to ensure that polluters accurately and promptly report the release and transfer of toxic pollutants;
- Facilities who fail to publish or publish fraudulent data will be punished;
- The public has full access to the published data.

[67] See Appendix II for more details.

2. Publish existing pollutant discharge reports data through a unified platform.

Before PRTR legislation is in place, it should be clarified that existing pollution discharge reports data from enterprises should be published. The scope of this information should be no less than all characteristic pollutants and hazardous wastes identified in environmental impact assessment (EIA) reports.

Currently, the "National Discharge Permit Management Information Platform" has already been completed and put into use, and tens of thousands of companies have already disclosed their emissions permit information through the aforementioned platform. It is recommended for enterprises and public institutions to disclose their pollutants through the aforementioned platform, especially information on the release and transfer of characteristic pollutants and hazardous wastes.

It is also proposed to take advantage of the enterprise self-monitoring information disclosure platforms or the environmental information disclosure platforms for enterprises and public institutions built by environmental authorities at all levels.

3. Ensure the implementation of requirements for the disclosure of information on characteristic pollutants and toxic and hazardous substances in the new Environmental Protection Law and its supporting Measures on Environmental Information Disclosure for Enterprises and Public Institutions, as well as the new Water Pollution Prevention and Control Law.

The new Environmental Protection Law, which went into effect on January 1, 2015, as well as its supporting Measures on Environmental Information Disclosure for Enterprises and Public Institutions, clearly stipulate requirements for the disclosure of major pollutants and characteristic pollutants by key pollution-discharging entities.

The Water Pollution Prevention and Control Law, which began its implementation on January 1, 2018, stipulates for the first time that entities which discharge toxic and hazardous pollutants must disclose relevant information. Based on this law, we recommend the formulation of a register of toxic and hazardous water pollutants. With this foundation, companies should be encouraged to disclose information on water-related hazardous substances, creating a helpful attempt at implementing a more comprehensive PRTR system.

4. More companies and financial institutions should leverage green supply chain and green finance to promote PRTR data disclosure.

We eventually hope to see stronger legislation clarifying mandatory requirements for corporations to disclose relevant information about hazardous chemicals. But we also recognize that that it will take time for a mandatory PRTR system to be fully and effectively implemented. During this gap period, we hope that leading companies will proactively work to achieve compliance and be a part of the solution, rather than taking advantage of legislative loopholes.

We are encouraged to see that some leading brands are already doing so, as evidenced by disclosure on IPE's PRTR disclosure platform. We recommend for more brand companies to require their suppliers to voluntarily disclose their PRTR data, and to use green procurement to select suppliers that go transparent with their PRTR data. Then, based on the data, they can establish verifiable targets for emissions reduction.

We recommend that financial institutions learn from the successful implementation of green supply chain, and use green finance to promote the disclosure of PRTR data by lending and financial companies.

5. Environmental organizations should pay attention to published PRTR information.

In countries with mandatory disclosure, environmental organizations played a key role in promoting implementation and applying disclosed data to push for improvements in environmental performance. We recommend that Chinese environmental NGOs and other environmental organizations in China actively pay attention to disclosed data to help companies identify problems and promote the reduction of harmful chemicals, and create tools to help other stakeholders such as local communities and financial institutions better understand how data can be applied. At the same time, environmental groups can help to identify gaps and promote the full implementation of the PRTR system.

6. Increase legal means to handle those who violate information disclosure requirements.

The Opinion on Deepening Environmental Monitoring Reform to Improve Environmental Monitoring Data Quality also touches on public interest litigation by procuratorates and civil society organizations, as well as administrative environmental damage compensatory suits, as a tool that can supplement typical legal penalties to hold accountable those monitoring agencies and others who participate in data fraud.

We recommend to strengthen both administrative and judicial channels for legal relief to ensure that companies report their pollutant release and transfer data truthfully, promptly, and accurately.

Appendices

Appendix I: IPE Proposed Pollutant Inventory for China [68]

中国环境优先污染物转移登记制度建议物质清单

Proposed Pollutant Inventory for China Priority Pollutant Release and Transfer Register

物质分类 Category	序号 No.	中文名称	化学文摘号 CAS No.	English Name
分类 1：持久性有机污染物 Persistent Organic Pollutants (POPs)[69]	1	六氯苯	118-74-1	Hexachlorobenzene
	2	氯丹	57-74-9	Chlordane
	3	灭蚁灵	2385-85-5	Mirex
	4	五氯苯	608-93-5	Pentachlorobenzene
	5	滴滴涕	50-29-3	DDT
	6	多氯联苯	1336-36-3	PCBs
	7	多氯代二噁英，多氯代苯并呋喃	N/A	PCDD + PCDF (Dioxins + Furans)
	8	林丹(γ-六六六)	58-89-9	Lindane
	9	氯代环烷烃（六六六）	608-73-1	HCH

[68] This chart displays the pollutants suggested for disclosure via IPE's PRTR disclosure platform. The list was first developed in 2013 and is based on a combination of international experiences along with a review of the substances regulated on China's National Register of Hazardous Wastes: http://www.mep.gov.cn/gkml/hbb/bl/201606/t20160621_354852.htm.

[69] The POPs listed in this chart are those currently requested for reporting on IPE's PRTR disclosure platform. Parties that accept amendments for new listings will be required to report on the following 28 substances listed in the Stockholm Convention: Aldrin, Chlordane, Chlordecone, DDT, Decabromodiphenyl ether commercial mixture, Dieldrin, Endrin, Endosulfan, Heptachlor, Hexabromobiphenyl, Hexabromocyclododecane, Hexachlorobutadiene, Hexachlorobenzene, Alpha hexachlorocyclohexane, Beta hexachlorocyclohexane, Lindane, Mirex, Octabromodiphenyl ether commercial mixture (Hexabromodiphenyl ether and Heptabromodiphenyl ether), Pentachlorobenzene Pentabromodiphenyl ether commercial mixture (Tetrabromodiphenyl ether and Pentabromodiphenyl ether), Pentachlorophenol, PCBs, Perfluorooctane sulfonate and PFOSF, Polychlorinated naphthalenes, Short-chain chlorinated paraffins, and Toxaphene.

	10	四溴联苯醚及五溴联苯醚	N/A	PBDEs
	11	全氟辛酸	335-67-1	PFOA
	12	全氟辛烷磺酸	1763-23-1	PFOS
	13	全氟辛烷磺酸盐类		PFOSA
	14	全氟辛基磺酰氟	307-35-7	PFOSF
分类 2：金属类 Metals	15	总镍	N/A	Nickel
	16	六价铬	N/A	Hexavalent Chromium
	17	总铜	N/A	Total Copper
	18	总锌	N/A	Total Zinc
	19	总汞	N/A	Total Mercury
	20	总铅	N/A	Total Lead
	21	总镉	N/A	Total Cadmium
	22	总砷	N/A	Total Arsenic
	23	总锰	N/A	Total Manganese
	24	总铬	N/A	Total Chromium
	25	总铊	N/A	Total Thallium
	26	总钼	N/A	Total Molybdenum
	27	总锑	N/A	Total Antimony
	28	总钡	N/A	Total Barium
	29	总铍	N/A	Total Beryllium
	30	总钴	N/A	Total Cobalt
分类 3：无机物 Inorganic Substances	31	硫化物	N/A	Sulfide
	32	硫酸（雾）	7664-93-9	H_2SO_4
	33	铬酸（雾）	7738-94-5	H_2CrO_4
	34	氨/氨气	7664-41-7	NH_3
	35	氟化物	N/A	Fluoride
	36	氰化物	N/A	Cyanides
	37	四氯化硅	10026-04-7	Silcon Tetrachloride

	38	盐酸	7647-01-0	HCL
	39	硝酸/硝酸雾	7697-37-2	HNO_3
	40	氯磺酸	7790-94-5	HSO_3Cl
分类 4：氯化及溴化有机物 Chlorinated and Brominated Organic Substances	41	氯苯	108-90-7	Monochlorobenzene
	42	1,2-二氯乙烷	107-06-2	1,2-Dichloroethane (EDC)
	43	三氯乙烯	79-01-6	Trichloroethylene (TCE)
	44	对氯苯胺	106-47-8	p-Chloroaniline
	45	2-氯苯胺（邻氯苯胺）	95-51-2	o-Chloroaniline
	46	三氯乙酸	76-03-9	Trichloroacetic Acid
	47	1,2,3-三氯苯	87-61-6	1,2,3-Trichlorobenzene
	48	3,4-二氯苯胺	95-76-1	3,4-Dichloroaniline
	49	2,3,4-三氯丁烯	2431-50-7	2,3,4-Trichlorobutene
	50	六氯-1,3-丁二烯	87-68-3	Hexachloro-1,3-butadiene
	51	氯乙烯	75-01-4	Vinyl Chloride
	52	氯苯类	N/A	Chlorobenzenes
	53	六溴环十二烷	25637-99-4	HBCDD
分类 5：温室气体 Greenhouse Gases (GHGs)	54	二氧化碳	124-38-9	CO_2
	55	甲烷	N/A	CH_4
	56	氧化亚氮	10024-97-2	N_2O
	57	氢氟烃	N/A	HFCs
	58	全氟烃	N/A	PFCs
	59	六氟化硫	2551-62-4	SF_6
分类 6：其他气体 Other Gases	60	硫化氢	7783-06-4	H_2S
	61	氯化氢	7647-01-0	HCl (Gaseous Form)
	62	氯气	7782-50-5	Chlorine
	63	环氧乙烷	75-21-8	Ethylene Oxide
分类 7：多环芳烃 Polycyclic Aromatic Hydrocarbons (PAHs)	64	苯并[a]芘	50-32-8	Benzo(a)pyrene
	65	蒽	120-12-7	Anthracene

分类 8：其他有机物 Other Organic Substances	66	石油类	N/A	Petroleum
	67	酚类（挥发酚）	N/A	Phenols (Volatile Phenols)
	68	苯胺类	62-53-3	Anilines
	69	硝基苯类	98-95-3	Nitrobenzene
	70	丙烯腈	107-13-1	Acrylontrile
	71	丙二腈	109-77-3	Malononitrile
	72	光气	75-44-5	Phosgene
	73	二甲苯	1330-20-7	Xylene
	74	壬基酚/支链-4-壬基酚	25154-52-3, 84852-15-3	NP/4-NP
	75	邻苯二甲酸二辛酯	117-81-7	DEHP
	76	邻苯二甲酸二丁酯	84-74-2	DBP
	77	三溴苯胺	147-82-0	2,4,6-Tribromoaniline
	78	对苯二胺	106-50-3	p-Phenylenediamine
	79	环己烷	110-82-7	Cyclohexane
	80	二环己胺	101-83-7	Dicyclohexylamine
	81	丙烯醛	107-02-8	Acrolein
	82	丙烯酰胺	79-06-1	Acrylamide
	83	双酚 A	80-05-7	4,4'-Isopropylidenediphenol
	84	邻苯二甲酸二乙酯	84-66-2	Diethyl Phthalate (DEP)
	85	2,4,6-三叔丁基苯酚	732-26-3	2,4,6-Tri-tert-butylphenol
	86	对氨基苯酚	123-30-8	4-Aminophenol
	87	八氯苯乙烯	29082-74-4	Octachlorostyrene
	88	二苯酮	119-61-9	Benzophenone
	89	对硝基甲苯	99-99-0	p-Nitrotoluene
	90	三丁基氯化锡	1461-22-9	Tributyltin Chloride
	91	苯	71-43-2	Benzene
	92	甲苯	108-88-3	Methylbenzene (Toluene)

	93	乙苯	100-41-4	Ethylbenzene
	94	甲醛	50-00-0	Formaldehyde
	95	苯酚	108-95-2	Phenol
	96	2-甲基苯胺	95-53-4	o-Toluidine
	97	磷类	N/A	Phosphorus Compounds
	98	丙烯酸丁酯	141-32-2	Butyl Acrylate
	99	甲基丙烯酸甲酯	80-62-6	Methyl Methacrylate
	100	乙酸乙酯	141-78-6	Ethyl Acetate
	101	甲醇	67-56-1	Methanol
	102	苯乙烯	100-42-5	Styrene
	03	环己酮	108-94-1	Cyclohexanone
分类 9：杀虫剂或植物生长保护剂的活性物质 Active Substances of Plant Protection Products or Biocidal Products	104	硫丹及其异构体	115-29-7	Technical Endosulfan and its Related Isomers

Appendix II: Overview of PRTR Systems Worldwide

Western countries were the first to be affected by hazardous chemicals in the process of industrialization. The PRTR system for controlling hazardous chemicals through information disclosure was only formed after a long period of exploration. Experience sharing from developed systems – especially concerning the earliest system, the U.S. Toxics Release Inventory – has played an important role in spurring the global exchange and spread of PRTR usage. Other multilateral initiatives, including the PRTR Protocol to the Aarhus Convention and the Strategic Approach to International Chemicals Management (SAICM), have also prompted governments to strengthen their capacity for managing harmful chemicals including through PRTR disclosure. Below, we provide a brief overview some of the most prominent examples of PRTR systems worldwide.

The U.S. Toxics Release Inventory (TRI)

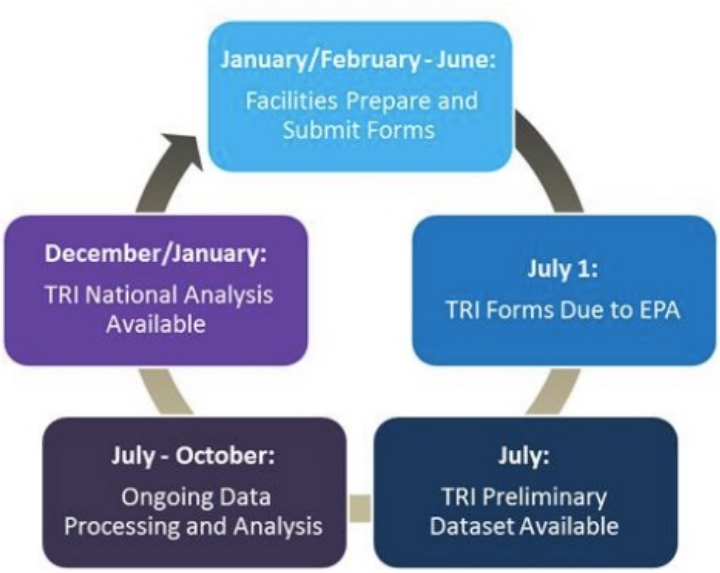
The U.S. Toxics Release Inventory (the "TRI") is a database that publishes information on toxic chemical releases and other waste management activities in the United States. It is the earliest major example of a PRTR system and heavily influenced the adoption of later systems worldwide.[70] It was established via Section 313 of the 1986 Emergency Planning and Community Right-to-Know Act (EPCRA) in the wake of several disasters involving releases of hazardous chemicals, most notably the 1984 Bhopal disaster at a Union Carbide pesticide plant in India that killed thousands, as well as a similar incident that followed shortly afterward at a Union Carbide plant in West Virginia. Due to the lack of available information about chemical releases and other toxic chemicals at the time, the EPCRA created TRI to require those facilities from specific industry sectors (such as manufacturing, mining and electrical power generation) that employ over 10 employees and manufacture, process or otherwise use a chemical listed on the TRI in levels above set thresholds to disclose relevant information on an annual cycle. The database was expanded to include waste management and source reduction activities in 1990 when U.S. Congress passed the Pollution Prevention Act.

The U.S. TRI has advanced since its early beginnings and paved the road to raise awareness about information transparency. Its current scope has grown to include over 650 chemicals and over 20,000 reporting facilities. While the data was originally somewhat difficult to access, efforts by NGOs and other groups have created tools to translate the data into forms that are helpful for everyday citizens. A remark by U.S. Senator Tom Udall sums it up well: "While it was a new approach in 1986, today more than fifty countries have established their own registries, using the TRI as a model. These registries, in the U.S and abroad, have allowed companies to learn best practices from each other and, simply by shining a spotlight on releases of toxic chemicals, have led to dramatic reductions."

[70] https://www.epa.gov/toxics-release-inventory-tri-program/learn-about-toxics-release-inventory

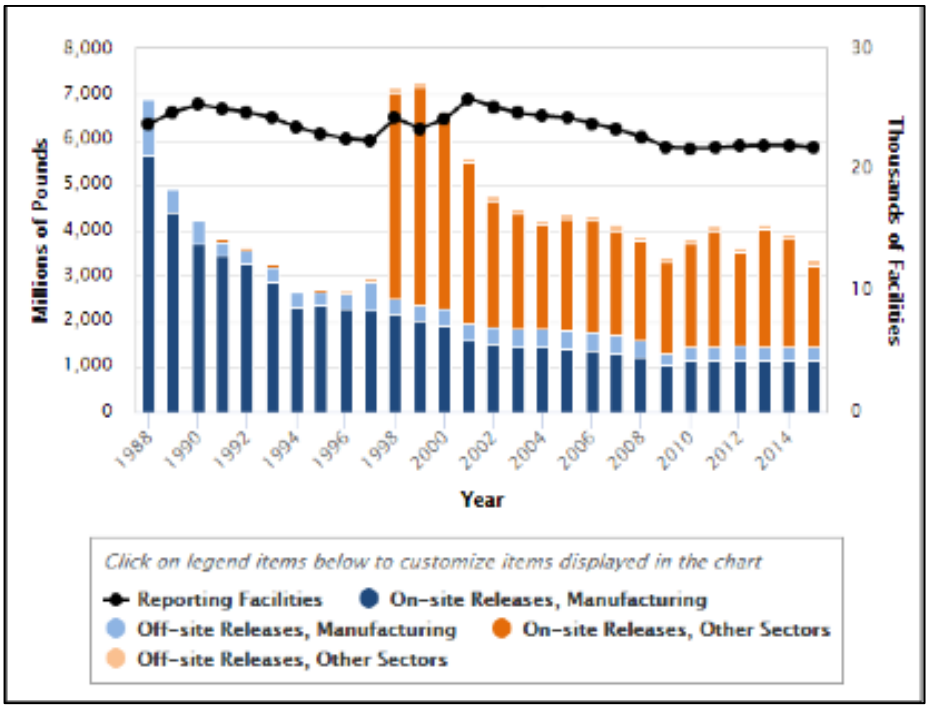
The TRI pioneered a range of benefits of disclosure that have proven consistent across other PRTR disclosure systems. From analyzing collected data to dispersing information about the effects of chemicals, waste management, emissions, and other pollution prevention, the TRI database informs the public about potential risks from toxic chemicals and pushes facilities to adopt more environmental-friendly and less harmful activities and methods. The database's information about health and environmental impacts is also helpful for environmental researchers and health organizers who can respectively assess environmental justice concerns and identify potential public health risks. Government officials use the data to evaluate the effectiveness of environmental policies and reconsider their environmental priorities. Furthermore, TRI offers valuable resources to inform media investigations on the current corporate environmental performance of TRI facility members.

Figure 1. Reporting Cycle Chart for TRI



Source: USEPA website

Figure 2. Trends in TRI Releases, 1988-2015



Source: *Introduction to the 2015 TRI National Analysis*

In more concrete terms, researchers have gone so far as to draw links between TRI and market behavior by companies and other actors. When TRI was first released, stock prices of public companies experienced comparatively large declines, prompting outward efforts by many of these companies to reduce their emissions. One study found that reducing emissions by 10% can lead a company's market value to increase by $34 million. [71] High TRI releases are also found to negatively impact housing prices. And beyond market impacts, some studies have also found that decreases in chemical releases have saved billions of dollars in healthcare costs just for infants alone.

PRTR Systems in Europe, Japan and the Republic of Korea

The more recent European-wide European Pollutant Release and Transfer Register (E-PRTR) (originally called the European Pollutant Emission Register, or EPER) was established in 2000 on the basis of the 1998 Aarhus Convention,[72] an environmental agreement between the European Union and 46 states that establishes the public's environmental right-to-know and to participate in environmental governance. The implementation of the system was solidified through the 2003 Kiev Protocol on Pollutant Release and Transfer Registers, the first legally binding international agreement regarding PRTRs. It is the first regional-level PRTR system.

The E-PRTR provides data for pollutant releases to the air, water, waste, and wastewater from industrial facilities in European Union Member States and in Iceland, Liechtenstein, Norway, Serbia and Switzerland.[73] The database collects information on 91 pollutants from 30,000 industrial facilities across Europe and covering more than 65 economic activities.

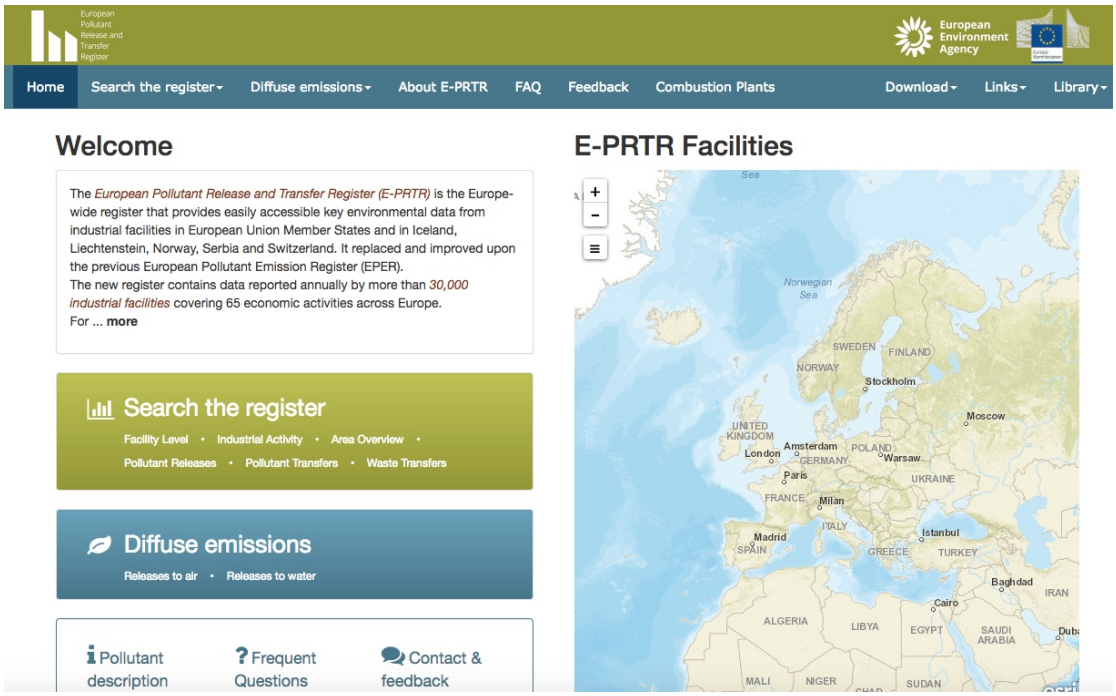
Easily accessed online and navigated, E-PRTR allows the public to locate emission release and waste transfer information on historical industrial sites as well as current monitors. E-PRTR also allows users to compare pollutant release and transfer information from different industrial facilities in order to better aid government officials and other members of authority in prioritizing environmental and health policies. As data is collected by industries, assessed and validated by national authorities, and published by the European Commission, E-PRTR has become a model for bringing awareness to environmental concerns for those residing in Europe and influences international protocols with its easy-to-access facility-level information.

[71] Reinventing Environmental Regulation from the Grassroots Up: Explaining and Expanding the Success of the Toxics Release Inventory. *Environmental Management,* February 2000, Vol. 25, No. 2

[72] http://www.unece.org/env/pp/introduction.html

[73] http://prtr.ec.europa.eu/#/static?cont=about

Figure 3. E-PRTR Homepage



In the case of Japan, shortly after the establishment of the 1999 "Act on Confirmation, etc. of Release Amounts of Specific Chemical Substances in the Environment and Promotion of Improvements to the Management Thereof," a PRTR system was launched in order to publicize information on businesses' handling of chemical substances.[74] The system covers 354 substances and aims to determine priorities in the case of administrative measures, promote voluntary management of chemical substances, and provide public information on chemical substances and their effects on environmental conservation. Notably, Japan PRTR collects data from not only large business, but also non-listed businesses, households, and mobile sources. This allows manufacturers and environmentalists alike to determine ways to reduce environmental and health costs.

Japan's PRTR system has helped to identify high levels of several pollutants that had not been monitored before the system was implemented, prompting several existing environmental monitoring programs to be re-designed. These results were facilitated in part by Japan's environmental ministry releasing a handful of materials to support implementation that engaged businesses and the public alike, including the Manual for PRTR Release Estimation Methods, Cases of Success toward Reduction of PRTR Substance Emissions, and the Guidebook for Citizens in the PRTR Information Plaza Japan online.[75]

74 http://www.env.go.jp/en/ chemi/prtr/prtr.html

75 Jens Hartmann, Norio Okada and Jason Levy, "Using PRTR Database for the Assessment of Surface Water Risk and Improvement of Monitoring in Japan," International Journal of Critical Infrastructures 1 (2/3):155-169 (2005).

In South Korea, 41 types of industries covering approximately 3634 companies are required to provide PRTR data including those involved in the manufacture of electrical equipment and electronic components, computer, radio, television and communication equipment.[76] The scope includes emissions to air, water, soil, wastes disposed onsite, and wastes transported off-site.[77] Substances are divided into two groups: sixteen substances are in Group 1 and 399 are present in Group 2 and releases from individual facilities can be searched with the most recent publicly available data from 2015. [78] [79] To qualify for reporting, each substance must be equal to or greater than a certain concentration (usually 0.1% or 1.0% by weight). [80] If the substance is in Group 1 it must be reported if used at levels of 1 ton or more per year; if in Group 2, then it must be reported if used at levels of 10 tons or more per year. [81] Substances include chemicals used in production processes even if not present in the final product.[82] The Chemical Control Act also grants authority to the Ministry of Environment to enter manufacturing facilities to investigate emissions. Data is publicly available via internet.[83]

NGOs can also play a role in pushing for the successful establishment of PRTR systems. In the Czech Republic, a coalition of NGOs including Arnika Association pushed for nearly ten years for the establishment of a PRTR system as the nation entered the E.U. Ultimately, in 2004, the government adopted legislation stipulating the establishment of the Integrated Pollution Register (IPR), which began to be implemented in 2005. Although the initial response from companies was poor compared to the actual number of companies that should have reported based on legislation, NGOs efforts pushed it to increase from 871 plants in the first year of implementation to 1327 plants by 2006.[84] In many ways the PRTR system that was established is even more rigorous than E-PRTR.

[76] http://ncis.nier.go.kr/triopen/ 대상업종

[77] http://ncis.nier.go.kr/triopen/ 조사절차

[78] http://ncis.nier.go.kr/triopen/ 대상물질

[79] http://ncis.nier.go.kr/triopen/ 배출.이동량정보

[80] http://ncis.nier.go.kr/triopen/ 대상물질

[81] http://ncis.nier.go.kr/triopen/ 대상물질

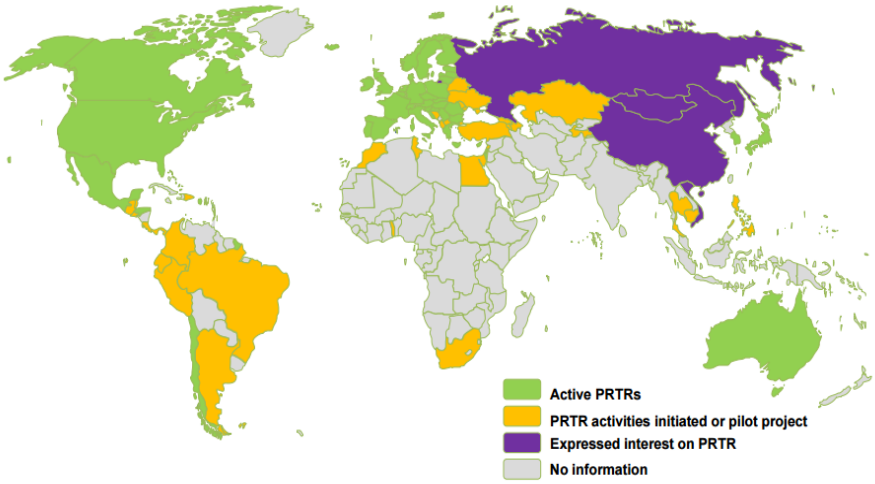
[82] http://ncis.nier.go.kr/triopen/ 대상물질

[83] https://icis.me.go.kr/prtr/prtrInfo/entrpsSearch.do

[84] http://www.ipen.org/project-reports/prtr-and-pops-czech-republic

Over 50 countries (see Figure 4) have fully established PRTR systems or have implemented pilot programs to track and disclose information about chemical releases. Many more countries are in the process of developing PRTR systems, particularly in South and Central America, or have expressed significant interest in developing PRTR.

Figure 4. Scope of Global PRTR Systems[85]



PRTR Thresholds

PRTR systems set thresholds for reporting whereby only entities that meet certain criteria are required to report. Setting thresholds allows governments to balance the benefits of receiving a PRTR report with the costs imposed on reporters and the authorities.

Different regions' PRTR systems set thresholds based on science and local parameters, including such factors as types and quantities of hazardous materials used and the size and output of the firm. The table below explores the threshold ranges for PRTR reporting determined by PRTR systems in different countries and regions.

[85] 10th International PRTR Coordinating Group, October 5, 2016.

Figure 5. Scope of Thresholds of Selected PRTR Systems Worldwide

PRTR / Kiev Protocol	General Thresholds		Sector-Specific Thresholds
	Employees	Activity	
Australia NPI	No employee threshold	Chemical usage[A] (5 to 25,000 kg/yr)[B] Annual fuel combustion[A] (400,000 to 2,000,000 kg/yr)[B] Hourly fuel combustion[A] (1,000 kg/hour)[B] Energy usage[A] (60 MWh) Power rating[A] (20 MW) Emission / transfers[A] (3,000 to 15,000 kg)[B]	Employee threshold applies to certain sectors
Canada National Pollutant Release Inventory (NPRI)	20,000 employee hours	Manufacture, process, or otherwise use[A] (5 to 10,000 kg/yr)[B] Release, disposal, or transfer for recycling[A] (50 kg/yr) Activity[C] Air releases[A] (300 to 20,000 kg/yr)[B]	Facilities in certain sectors must report regardless of employee threshold. Facilities in certain sectors are exempt from reporting if annual production falls below a threshold.
European Pollutant Release and Transfer Register	No employee threshold	Air releases[A] (0.0001 – 100,000,000 kg/yr)[B] Water releases[A] (0.0001 – 2,000,000 kg/yr)[B] Land releases[A] (0.0001 – 2,000,000 kg/yr)[B] Offsite transfers of waste[D]	Facilities in certain sectors are exempt from reporting if production capacity falls below threshold. Facilities in certain sectors are exempt from reporting if annual production falls below a threshold.
Kiev Protocol (Two Threshold Options)[E]	No employee threshold	Air release[A] (0.001 – 100,000,000 kg/yr)[B] Water release[A] (0.001 – 2,000,000 kg/yr)[B] Land release[A] (0.001 – 2,000,000 kg/yr)[B]	Facilities in certain sectors are exempt from reporting if production capacity falls below threshold. Facilities in certain sectors are exempt from reporting if annual production falls below a threshold.
	10 full-time employees	Manufacture, process, or use (0.0001 – 10,000 kg/yr)[B]	
Japan PRTR	21 regular employees	Annual amount handled (1 ton or 0.5 ton)[B]	Facilities in certain sectors must report regardless of annual amount handled threshold. Additional capacity and activity thresholds apply to facilities in certain sectors.
US TRI	10 full-time equivalent employees	Manufacture (0.0001 kg to 25,000 lbs / Around 11337 kg)[B] Process (0.0001 kg to 25,000 lbs / Around 11337 kg)[B] Otherwise use (0.0001 kg to 25,000 lbs / Around 4535 kg)[B]	Not Available (N/A)

Source: OECD, 2013