

Reducing Mercury Releases from Auto Switches and Thermostats

**Final Report to
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The Product Stewardship Institute

The Product Stewardship Institute (PSI) is a national, membership-based nonprofit committed to reducing the health, safety, and environmental impacts of consumer products across their lifecycle with a strong focus on sustainable end-of-life management. Headquartered in Boston, Mass., we take a unique product stewardship approach to solving waste management problems by encouraging product design changes and mediating stakeholder dialogues. With 47 state environmental agency members, hundreds of local government members, and nearly 100 corporate, business, academic, non-U.S. government, and organizational partners, we work to design, implement, evaluate, strengthen, and promote both voluntary and legislative product stewardship initiatives across North America.

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EXECUTIVE SUMMARY

During the 2014 calendar year, approximately 128,000 mercury auto switches¹ and 82,000 mercury thermostats² will be taken out of service by Illinois residents and businesses. These devices, if not collected and sent to a specialized processing facility, could introduce 1,000 pounds of mercury³ into the Great Lakes Watershed, posing a significant risk to human health and the environment.

Illinois law attempts to mitigate these risks. The 2006 Mercury Switch Removal Act⁴ requires the recycling of mercury auto switches, and the 2010 Mercury Thermostat Collection Act⁵ prohibits the disposal of mercury thermostats. Both programs require manufacturers to fund and manage a collection system for their respective products. The thermostat law also requires heating and cooling wholesalers to serve as collection points for thermostats, and requires service technicians to recycle mercury thermostats. Two national, industry-funded product stewardship organizations, End-of-Life Vehicle Solutions (ELVS) and the Thermostat Recycling Corporation (TRC), collect and process mercury auto switches and thermostats, respectively. However, recent data show that the ELVS program captures about 27 percent of all estimated auto switches, and TRC collects approximately 16 percent of all available thermostats.⁶

Between October 1, 2012 and September 30, 2014, PSI embarked on a project with the Illinois Environmental Protection Agency (IEPA) to design, implement, and evaluate a variety of tools to improve

¹ This report covers auto switches contained in airbag sensors, antilock brake sensors, and convenience lights. The National Vehicle Mercury Switch Recovery Program has developed a model that estimates the number of switches removed from automobiles, by state, each year. The model is available at <http://elvsolutions.org>.

² A 1994 US EPA study (Mercury Usage and Alternatives in the Electrical and Electronics Industries. Office of Research and Development, EPA/600/R-94/047) estimated that 2 to 3 million thermostats are available for collection each year in the US. In 2012, 4.1 percent of the US population (313.9 million people) resided in Illinois (12.87 million people). By scaling US EPA's estimates to Illinois, 82,000 to 123,000 thermostats are available annually for collection in Illinois. We used the low end of this range to estimate the number of thermostats available for collection. More recent data are not available.

³ Each auto switch contains, on average, one gram of mercury, whether the switch is in an airbag sensor, antilock brake sensor, or convenience light. <http://www.epa.state.il.us/mercury/auto-switch/guidance-manual.pdf>. Each mercury thermostat contains, on average, four grams of mercury. <http://www.ilga.gov/legislation/publicacts/fulltext.asp?Name=096-1295>.

⁴ Illinois Mercury Switch Removal Act of 2006, Public Act 094-0732, <http://www.ilga.gov/legislation/ilcs/ilcs3.asp?ActID=2779&ChapterID=36>, accessed on Dec. 29, 2014.

⁵ Illinois Mercury Thermostat Collection Act of 2010, Public Act 096-1295, <http://www.ilga.gov/legislation/publicacts/fulltext.asp?Name=096-1295>, accessed on Dec. 29, 2014.

⁶ TRC reported collecting 13,061 thermostats in 2012, or 16 percent of the 82,000 thermostats available for collection (see *Thermostat Recycling Corporation's 2012 Annual Report*, available at http://www.thermostat-recycle.org/files/mediacenter/2012_Illinois_Report.pdf, accessed Dec. 29, 2014). The NVMSRP estimates that 153,000 auto switches were available for collection in 2012 (NVMSRP model available at http://elvsolutions.org/?page_id=1298, accessed Dec. 29, 2014). ELVS reports that 40,693 switches were collected within this same time period (annual switch collection data, by state, available at <https://www.egonline.com/services/ELVS-Mercury-Switch-Recovery-Program/annual-report.asp?year=all>, accessed Dec. 29, 2014). This results in a 27 percent collection rate for auto switches in Illinois in 2012.

auto switch and thermostat collection program performance. The project's goal was to prevent 190 pounds of mercury from entering Illinois's environment by increasing collections of mercury-containing auto switches (including convenience lights, airbag sensors, and antilock brake sensors), as well as thermostats. The auto switch financial incentive pilot ran for a 13-month period (May 2013 through May 2014), while the thermostat pilot ran for 12 months (May 2013 to April 2014). The project also included a multi-stage outreach campaign, which was in addition to outreach activities undertaken by TRC or ELVS. The project was funded by the U.S. Environmental Protection Agency Region 5's Great Lakes Regional Initiative (GLRI).

Results

Pounds of Mercury Collected

In the 12-month period during which the two pilot programs ran concurrently (May 2013 to April 2014), **188 pounds of mercury were collected—an increase of 38 pounds, or 25 percent, from the 2011 calendar year baseline.** During the project period, auto recyclers collected 89 pounds of mercury through the ELVS program,⁷ while heating, ventilation, and air conditioning (HVAC) contractors collected 99 pounds of mercury through the TRC program.⁸ Including an additional 7 pounds collected during the thirteenth month of the auto switch pilot (May 2014),⁹ the project resulted in the total collection of 195 pounds of mercury.

Mercury is no longer used to make auto switches or thermostats. U.S. auto manufacturers ceased installing mercury switches in vehicle models 2003 and newer. And as of July 1, 2008, legislation prohibited the sale of mercury thermostats in Illinois. As a result, the stock of mercury-containing auto switches and thermostats declines each year. Therefore, the 25 percent *increase* in mercury collections during this project (compared to the 2011 baseline) is particularly noteworthy.

Auto switches

- **The collection rate for convenience light switches increased from 26 percent to 30 percent with the introduction of an additional incentive.** In the year prior to our pilot program, the collection rate for convenience light switches was 26 percent. During the second half of the pilot period (November 2013 to May 2014), in which an additional \$2 was added to the incentive for convenience light switches, the collection rate increased to 30 percent. Overall, during the program period, 86 pounds of mercury was collected from 38,809 convenience light switches, with an annual collection rate of 27 percent. (See Tables ES-1 and ES-2).

⁷ ELVS contracts environmental management services, including switch collection data management, to the Environmental Quality Company (EQ). PSI used EQ's online database during the project period to acquire monthly data on the number of switches returned to ELVS, disaggregated by individual automobile recycler and switch type.

⁸ Becky Jayne, IEPA, personal communication, Nov. 27, 2014.

⁹ *Ibid.*

Table ES-1: Auto Switch Incentives Offered

	Period 1: May 2013-Oct. 2013	Period 2: Nov. 2013-May 2014
Convenience Light	\$2 per switch*	\$4 per switch*
Anti-lock Brake System (ABS) Sensor	\$6 per switch*	
Air Bag Crash Sensor	\$4 per switch	
“Bucket Bonus”	\$100 one-time bonus for vehicle recyclers who had not sent in a mercury switch collection bucket since September of 2011. Bucket must have contained 20 or more switches to qualify.	

*includes the \$2 per switch that recyclers already receive from ELVS, as required by IL law

Table ES-2: Convenience Light Switch Collections

Time Period	Number of Switches Collected	# Switches available for collection ¹⁰	Collection Rate	Pounds of Mercury Collected ¹¹	
Baseline Year May 2012-April 2013	39,148	149,930	26%	86	
May 2013-May 2014 <i>(Pilot Project Period)</i>	Period 1: May-Oct 2013: <i>(No Light Switch Incentives)</i>	20,379	84,195	24%	45
	Period 2: Nov 2013-May 2014: <i>(With Light Switch Incentives)</i>	18,430	60,587	30%	41
	Total (Periods 1 & 2):	38,809	144,782	27%	86

- The number of ABS switches collected increased by seven percent relative to projections.** During the project, the incentive offered for ABS switches was increased from \$4 to \$6. From the pre-project to the project period, annual switch collections were projected to decrease by 8.2. Instead, collections during the project year decreased by only 0.1 percent to 4,539 switches, a seven percent increase in ABS switch collection compared to the projected quantity (4,216 switches).¹² (See Table ES-3.)

¹⁰ The NVMSRP provides an annual estimate of number of convenience light switches available for collection, which uses a switch retirement model. http://elvsolutions.org/?page_id=1298. ABS and air bag switches are not included in this model, as only convenience switches were included in the initial NVMSRP MOU (August, 2006).

¹¹ ELVS contracts environmental management services, including switch collection data management, to the Environmental Quality Company (EQ). PSI used EQ’s online database during the project period to acquire monthly data on the number of switches returned to ELVS, disaggregated by individual automobile recycler and switch type.

¹² The NVMSRP model (available at http://elvsolutions.org/?page_id=1298), over the 13 month project timeline, predicts an 8.2 percent decline in the number of convenience light switches available for collection between May 2012 – 2013 (pre-pilot project) and May 2013 – 2014 (during the pilot project). During May 2012 – 2013, 4,545 ABS switches were returned by Illinois auto recyclers (data from EQ’s online database at <https://www.eqonline.com/Home.aspx>). In recent years (2011 – 2013), ABS switches have comprised 10 percent of the total number of switches collected in Illinois (data from EQ’s online database at *Reducing Mercury Releases from Auto Switches and Thermostats* Final Report to EPA Region 5 – Product Stewardship Institute, December 29, 2014

Table ES-3: ABS Switch Collections

	Pre-Project (May 2012-May 2013)	Projected for Project Period (May 2013- May 2014) ¹³	Actual for Project Period (May 2013- May 2014)	Percent Change (Actual to Pre-Program)	Percent Change (Actual to Projected)
Number of switches collected	4,545	4,172	4,539	-0.1%	+8.8%
Pounds of mercury collected	10	9	10	N/A	N/A

- Incentives resulted in an increase in the return of airbag sensor switches from 28 to 188 switches over the project period.** Illinois law neither requires airbag switches to be removed nor includes an incentive for these switches. Therefore, in the 12-month period prior to project start-up (May 2012 to April 2013), Illinois auto recyclers only returned 28 mercury auto switches from airbag sensor units. After introducing the bucket bonus and \$4 per switch incentive, 188 airbag sensor switches were returned, an increase of over 500 percent. (See Table ES-4.)

Table ES-4: Airbag Sensor Switch Collections

	Pre-Project (May 2012-May 2013)	Project Period (May 2013-May 2014)	Percent Change
Number of switches collected	28	188	+571%
Pounds of mercury collected	.06	.41	+583%

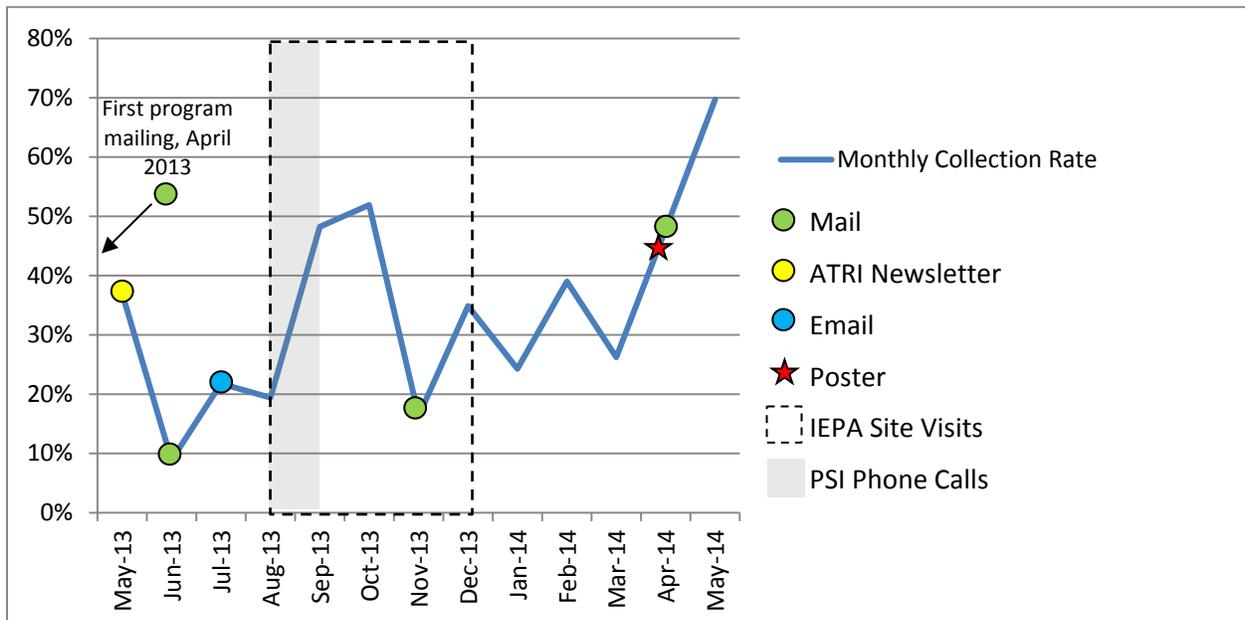
- The \$100 “First Bucket Bonus” enticed 60 non-compliant auto recyclers to collect and return auto switches:** The project offered a one-time \$100 bonus to auto recyclers that met the following criteria: (a) returned at least 20 switches in their designated collection bin (or “bucket”), and (b) had previously not returned any switches since September 2011. Sixty out of 281 eligible auto recyclers (21 percent) sent in switches over the course of the pilot. The majority of auto recyclers who responded were those who had never returned switches in the past.
- Targeted recurrent mailings, on-site visits, and phone calls were the most effective outreach strategies.** PSI charted the effectiveness of various outreach efforts, including mailings, emails, an article in a trade association publication, phone calls, and site visits (see Figure ES-5). Changes in collection rates in the month following each outreach effort indicate that targeted recurrent mailings, phone calls, in-person agency visits, and posters are effective means of outreach to

<https://www.egonline.com/Home.aspx>). Assuming no change in the composition of switches collected, the number of ABS switches collected in May 2013 – 2014 should also decline by 8.2 percent to 4,172.

¹³ *Ibid.*

auto recyclers. Site visits provide an opportunity for one-on-one technical assistance and enforcement.

Figure ES-5: Impact of Outreach on Monthly Auto Switch Collection Rate (all switches)



Thermostats

- **The amount of mercury collected in the TRC program increased by 24 percent.** The amount of mercury collected by TRC program participants increased from 80 pounds during the 12 months preceding the project (May 2012 to April 2013) to 99 pounds during the project period—an increase of 24 percent. (See Table ES-6)

Table ES-6: Thermostat Collections

	Pre-Project (May 2012-April 2013)	Project Period (May 2013-April 2014)	Percent Change
Number of thermostats collected	9,580	12,737	+33%
Pounds of mercury collected	80	99	+24%
Number of collection locations	256	396	+54%

- **140 new thermostat collection locations were added in Illinois.** More than one-third of the current TRC collection locations in Illinois (140 out of 396, or 35 percent) registered through the pilot program.

- **Thermostat collection locations registered through PSI recovered 16.3 pounds of mercury.** From May 2013 to November 2014 (18 months), the 140 HVAC wholesalers and contractors who signed up for the TRC program through PSI returned 69 collection bins, recovering 16.3 pounds of mercury from 1,741 thermostats.¹⁴ With the addition of thermostats collected in the remaining 71 bins but not yet returned, the actual quantity of mercury recovered by these sites would likely exceed 16.3 pounds by a significant margin.
- **Mailings were a more effective outreach mechanism than phone calls.** PSI's outreach mailings, which explained wholesaler and contractor responsibilities under Illinois law, corresponded with surges in mercury recovery. Phone outreach was generally not effective.

Findings

Auto switches

- **In many states, higher financial incentives drive collection of auto switches.** Many of the states with the highest annual recycling rates for mercury switches are those that, like Illinois, maintained incentive programs after NVMSRP funding was depleted in 2009. To further increase collection, Illinois should look to other states with high collection rates. North Carolina, Rhode Island, and Maine, which each offer a \$4 or \$5 incentive per convenience switch recovered, have collection rates above 40 percent¹⁵. Illinois may also be able to learn from the practices of Minnesota and California, which each implemented successful non-regulatory technical assistance programs.
- **Up to 25 percent of auto recyclers are unaware of which vehicles contain mercury switches and how to access them.** Despite outreach and education efforts by ELVS and IEPA, some Illinois auto recyclers are unaware of which vehicles contain mercury switches and how to access them. Anecdotal information collected during IEPA site visits suggests that approximately one quarter of auto recyclers visited were uninformed and requested additional information. (From August to December 2013, IEPA visited 205 recyclers out of 456 recyclers licensed in the state.)
- **Penalties for noncompliance of auto switch recycling are seldom enforced.** While the Illinois Mercury Switch Removal Act includes penalties for noncompliance—\$250 at first and \$500 for subsequent violations—these fines are seldom assessed by IEPA. This lack of enforcement is due both to resource constraints and IEPA's lack of authority to prosecute cases.

Thermostats

- **Forty-five percent of collection sites did not return their collection bins to TRC within the project period.** TRC thermostat collection sites are required to return bins at least once per year

¹⁴ An 18-month time frame is used for thermostat collection data to account for time necessary to order bins, collect thermostats, and return bins to TRC. Collection sites are required to return bins at least once a year. Of the 140 collection locations registered through PSI, 89 were registered between May 2013 and November 2013, and 51 were registered between November 2013 and May 2014.

¹⁵ Collection rates are calculated using annual switch collection data, by state, available at the ELVS website, <https://www.egonline.com/services/ELVS-Mercury-Switch-Recovery-Program/annual-report.asp?year=all>, accessed Dec. 29, 2014 and annual projections of number of switches available for collection from the NVMSRP model, also available at the ELVS website, http://elvsolutions.org/?page_id=1298, accessed Dec. 29, 2014.

to avoid hazardous waste storage violations. From May 1, 2013 to April 30, 2014, only 153 of the 279 collection sites in place for one year or longer (including HVAC wholesalers, contractors, and HHW collection sites) returned bins, a return rate of 55 percent. This occurred despite postcard reminders from TRC to all collection sites reminding them of the requirement to return bins once per year.

- **Businesses in Illinois stockpile mercury devices and elemental mercury.** The project uncovered 10 businesses that stored mercury thermostats, loose mercury switches, and—in some cases, elemental mercury (i.e., liquid mercury stored in jars or other containers) on premises. In cases where businesses were storing elemental mercury, PSI referred them to IEPA and their local hazardous waste management authority.

Recommendations

Auto switches

- **Increase the mercury auto switch incentive to a minimum of \$4.** Illinois auto recyclers increased their collection of switches when the pilot program increased the incentive from \$2 to \$4 per switch. States with higher collection rates than Illinois, such as North Carolina (60 percent), Rhode Island (42 percent), and Maine (40 percent) provide a \$4 to \$5 per switch bounty. We recommend increasing the per switch incentive in Illinois to a minimum of \$4.
- **Add a collection incentive for airbag switches and requirement for airbag switch collection.** Mercury auto switches from airbags are not currently required to be collected, and do not earn an incentive under Illinois law. By adding an incentive during the pilot project, PSI prompted a year-over-year increase in collection from 28 switches (pre-pilot) to 188 switches (post-pilot). We recommend the introduction of an incentive for airbag switches in Illinois for a minimum of \$4. A state requirement for airbag switch collection would further increase collection volumes and prevent improper disposal of the mercury-bearing switches.
- **ELVS should conduct outreach via mail at regular intervals to all auto recyclers to ensure that they continue collecting mercury-containing units and return buckets at least once per year.** Post cards with bright, eye-catching text and images and a simple message work well and could be sent quarterly. IEPA site visits should also encourage regular return of collection containers.

Thermostats

- **TRC should provide free collection bins.** Although TRC considers the \$25 one-time payment for collection bins to be a show of commitment on the part of those collecting thermostats, this payment actually represents a barrier to participation. After PSI paid for the bins, the number of collection locations for mercury thermostats in Illinois increased by 54 percent. Removing the financial barrier to participation for the 140 new collection sites, along with increased outreach, contributed to a 24 percent increase in collection of mercury thermostats during the project period. TRC should provide free collection bins for mercury thermostats just as ELVS provides free collection bins for mercury auto switches.
- **Establish a \$5 collection incentive for thermostats.** Thermostat collection rates could be further increased by offering a \$5 per thermostat bounty. States such as Maine and Vermont, which offer this incentive, have per-capita collection rates that are substantially higher than states without incentives.

- **Develop more effective outreach to ensure that all participants send in bins at least once per year, full or not.** During the pilot period, only 55 percent of TRC sites established for one year or longer returned collection bins, leaving them out of compliance with state hazardous waste management laws. More effective outreach methods may increase the percentage of locations that return bins on an annual basis.
- **Develop a new program targeted for those who stockpile mercury devices.** The project uncovered 10 businesses that stored mercury thermostats, loose mercury switches, and—in some cases, elemental mercury (i.e., liquid mercury stored in jars or other containers) on premises. To encourage the collection of loose mercury switches, mercury ampoules, and elemental mercury stockpiled at some businesses and homes, a special outreach program should be developed to reduce the risk of dangerous mercury releases.

Auto Switches and Thermostats

- **Increase penalties for violations of mercury auto switch and thermostat laws such that local agencies will pursue collection.** Under the mercury auto switch and mercury thermostat laws, local agencies—including local solid waste management agencies, departments of public health, zoning departments, and publicly owned treatment works—have the authority to pursue penalties for violation of collection requirements against entities in their jurisdiction. However, penalty amounts—\$250 to \$500—appear too low to justify the cost of pursuing collection. Raising penalty amounts could encourage more enforcement, and therefore lead to higher collection totals.
- **Provide IEPA with authority to issue administrative citations.** Currently, IEPA must work through the Attorney General’s office to issue violations of the auto switch and thermostat laws, as IEPA does not have the authority or resources to prosecute cases. Extending IEPA’s authority to issue administrative citations—which the agency already has for tires and other solid waste violations—would strengthen IEPA’s ability to enforce the law. Enforcement levels the playing field and eliminates “free riders.”
- **Identify and implement elements found in other states with high-performing auto switch and thermostat collection programs.** While states offering financial incentives tend to have the highest collection rates, several states without incentives have also successfully elevated the collection rates of thermostats and auto switches. Minnesota, Colorado, California, Wisconsin, and Georgia all report auto switch collection rates above that of Illinois, despite not providing a financial incentive for collection. Similarly, Rhode Island, New Hampshire, Minnesota, and Iowa report higher per capita thermostat collection rates than Illinois, despite not offering a financial incentive. Illinois may benefit from a study that explores the factors that led to their successes (e.g., educational activities, enforcement, technical assistance, etc.). This could be done through a survey and a series of facilitated calls.

I. INTRODUCTION

Mercury's Health and Environmental Threats

Mercury, a potent neurotoxin, poses a dangerous health and environmental threat in the U.S. As a result, government and health agencies across the country have instituted mandatory mercury reduction regulations across multiple industries and products. Even in small amounts, mercury can cause permanent brain, nervous system, and kidney damage, especially in pregnant mothers, fetuses, and young children. Because mercury compounds bioaccumulate and biomagnify in aquatic food chains, ingestion of mercury-contaminated fish is the most common exposure route for most Americans. Federal scientists have estimated that between 200,000 and 460,000 children are born in the U.S. annually with mercury levels associated with the loss of IQ at later ages.¹⁶

Mercury enters the environment from many sources, including coal combustion, industrial processes, and the disposal of mercury-containing consumer products, such as auto switches and thermostats,¹⁷ which are the focus of this report. During the 2014 calendar year, approximately 128,000 mercury auto switches¹⁸ and 82,000 mercury¹⁹ thermostats will be taken out of service by Illinois residents and businesses. These devices, if not collected and sent to a specialized processing facility, could introduce 1,000 pounds of mercury into the Great Lakes Watershed, posing a significant risk to human health and the environment.

Existing Laws and Collection Programs

The best way to prevent mercury contained in products from entering the environment is to keep the products themselves out of the waste stream. State and local hazardous waste programs consider mercury thermostats and auto switches to be high-priority items, since these mercury-bearing products are no longer being manufactured and there is a limited window of time in which they can be recovered. Illinois currently has laws in place that prohibit the disposal of mercury-containing thermostats and require the recycling of mercury-containing thermostats and automobile switches. The Illinois Environmental Protection Agency (IEPA), which served as PSI's main partner during this project, administers these laws. Two nationwide industry-run product stewardship organizations, the

¹⁶ Mahaffey KR, Clickner RP, Jeffries RA. Adult women's blood mercury concentrations vary regionally in the U.S. : association with patterns of fish consumption (NHANES 1999-2004). *Environ Health Perspect.* 2009 Jan; 117(1):47-53. Epub 2008 Aug 25. Estimate based on national estimates in Table 1 applied to the 2009 national birth rate reported by CDC at <http://www.cdc.gov/nchs/births.htm>.

¹⁷ Each auto switch contains, on average, one gram of mercury, whether the switch is in an airbag sensor, antilock brake sensor, or convenience light. <http://www.epa.state.il.us/mercury/auto-switch/guidance-manual.pdf>. Each mercury thermostat contains, on average, four grams of mercury. <http://www.ilga.gov/legislation/publicacts/fulltext.asp?Name=096-1295>.

¹⁸ This report covers auto switches contained in airbag sensors, antilock brake sensors, and convenience lights. The National Vehicle Mercury Switch Recovery Program has developed a model that estimates the number of switches removed from automobiles, by state, each year. The model is available at <http://elvsolutions.org>.

¹⁹ A 1994 US EPA study (Mercury Usage and Alternatives in the Electrical and Electronics Industries. Office of Research and Development, EPA/600/R- 94/047) estimated that 2 to 3 million thermostats are available for collection per year in the US. In 2012, 4.1 percent of the US population (313.9 million people) resided in Illinois (12.87 million people). By scaling US EPA's estimates to Illinois, 82,000 to 123,000 thermostats are available annually for collection in Illinois. We use the low end of this range for estimating the number of thermostats available. More recent data are not available.

Thermostat Recycling Corporation (TRC) and End-of-Life Vehicle Solutions (ELVS), collect and process thermostats and auto switches, respectively, under the Illinois laws. TRC charges a \$25 one-time fee for each thermostat collection container that it provides to heating and cooling contractors and wholesalers, as well as municipal agencies and retailers. TRC pays to transport and process all mercury thermostats collected. ELVS provides free auto switch collection buckets to collection sites and covers shipping and processing costs for all auto switches collected.

Available data for Illinois show that the TRC program collects approximately 16 percent of available mercury thermostats and the ELVS program collects approximately 27 percent of available auto switches.²⁰

Project Goal and Objectives

The goal of this project was to **prevent 190 pounds of mercury from being released into the Illinois environment** from thermostats and auto switches. PSI and IEPA successfully achieved this goal by both increasing the collection of mercury-containing thermostats through the TRC program and by increasing the collection of auto switches through the ELVS program.

In addition to project goals, we set, and accomplished, objectives for outreach and collection infrastructure. We contacted 5,400 heating, ventilation, and air conditioning (HVAC) contractors and 380 auto dismantlers to educate them about their responsibilities under Illinois law. We increased collection infrastructure in Illinois by adding 75 new collection locations for both mercury thermostats and auto switches across the state. The project also sought to identify outreach strategies that could expand collection, and that could be replicated elsewhere in the Great Lakes region and across the country. We introduced increased incentives for auto switch recovery and provided free collection bins to thermostat collection sites to determine whether the effects of these efforts on mercury recovery rates.

II. AUTO SWITCH PROGRAM

Overview

Prior to 2003, automobile manufacturers used mercury switches for multiple applications on many vehicle makes and models. Primary uses of mercury switches include:

- Convenience hood and trunk lighting assemblies, used in most General Motors models in years 1999 and prior, many Ford models in years 2000 and prior, and all Chrysler models in years 1998 and prior;
- Anti-lock brake system (ABS) G-force sensors—each containing up to three individual switches—used in many Audi, Chrysler, Ford, Mitsubishi, Nissan, and Subaru model years from the 1980s through the early 2000s and through model year 2002 for Chrysler/Jeep products;

²⁰ TRC reported collecting 13,061 thermostats in 2012, or 16 percent of the 82,000 thermostats available for collection (see *Thermostat Recycling Corporation's 2012 Annual Report*, available at http://www.thermostat-recycle.org/files/mediacenter/2012_Illinois_Report.pdf, accessed Dec. 29, 2014). The NVMSRP estimates that 153,000 auto switches were available for collection in 2012 (NVMSRP model available at http://elvsolutions.org/?page_id=1298, accessed Dec. 29, 2014). ELVS reports that 40,693 switches were collected within this same time period (annual switch collection data, by state, available at <https://www.egonline.com/services/ELVS-Mercury-Switch-Recovery-Program/annual-report.asp?year=all>, accessed Dec. 29, 2014). This results in a 27 percent collection rate for auto switches in Illinois in 2012.

- Airbag crash sensor modules, mostly found on luxury model cars, including many Toyota, Lexus, Volvo, Audi, and Mercedes-Benz model years in the late 1980s and early 1990s. Airbag crash sensors typically contain two mercury switches.

The photo below shows examples of a variety of mercury auto switches.



Photo courtesy Matt Frevel, Minnesota Pollution Control Agency

In response to state²¹ and national laws targeting mercury reduction and removal in a variety of consumer products, automakers began phasing out the use of mercury switches in the late 1990s and early 2000s, ceasing the use of mercury auto switches with the 2003 model year. Nevertheless, by 2007, nearly 5 tons of mercury remained in the pre-2003 model year cars still on the road. To address the environmental risks posed by the mercury contained in legacy auto switches, between 2004 and 2009, 15 states²² passed product stewardship laws that required manufacturers to pay for the collection and processing of mercury auto switches. The [Illinois Mercury Switch Removal Act](#)²³ was signed into law in 2006.

²¹ Key policy drivers include a Vermont mercury labeling law (beginning with model year 2000 vehicles) ([10 V.S.A., Chapter 159 §6621a, §6621d, §6621e](#), 1998) and a 2001 statement from more than 25 state attorneys general calling on Ford Motor Company to replace mercury-containing auto switches (<http://www.ipsnews.net/2001/07/environment-us-states-call-for-removal-of-toxic-car-parts/>). In 2003, Maine passed the nation's first ban on the use of mercury in auto switches ("[An Act to Prevent Mercury Emissions when Recycling and Disposing of Motor Vehicles](#)," 2006).

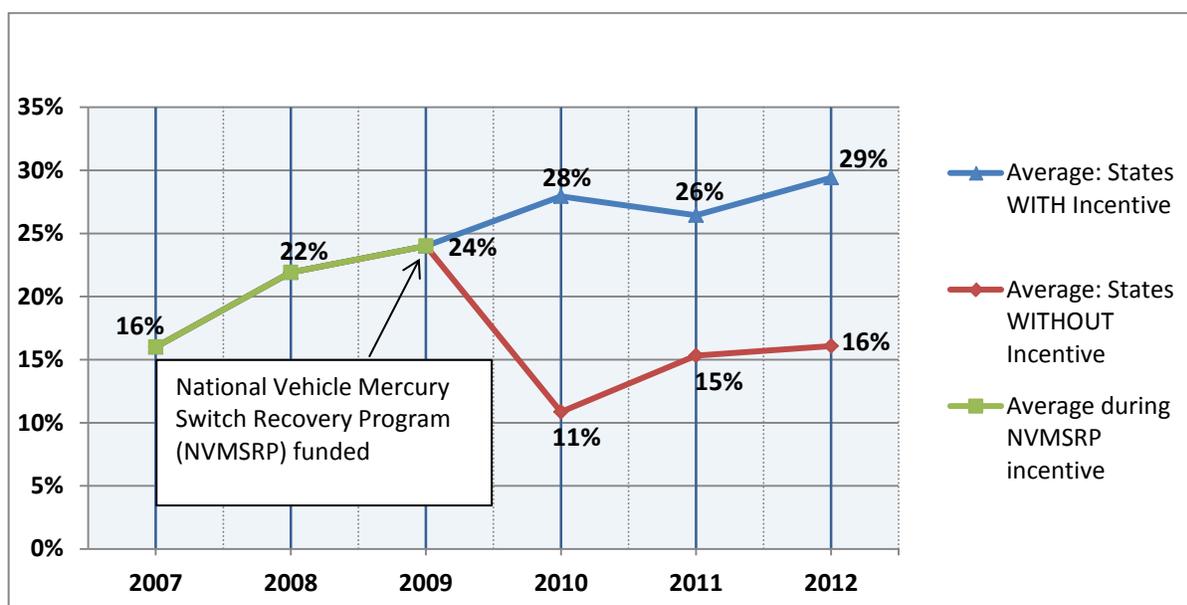
²² The 15 states that passed auto recycling laws (2004-2009) are: AK, IA, IL, IN, MA, MD, ME, NC, NJ, RI, SC, UT, VA, VT, and WA. SC's program sunset in 2013.

²³ Illinois Mercury Switch Removal Act of 2006, Public Act 094- 0732, <http://www.ilga.gov/legislation/ilcs/ilcs3.asp?ActID=2779&ChapterID=36>, accessed on Dec. 29, 2014.

The National Vehicle Mercury Switch Recycling Program (NVMSRP), formed in 2006 through a Memorandum of Understanding between ELVS, U.S. EPA, auto dismantlers, automotive steel and scrap industries, environmental groups, and the Environmental Council of the States, set out to recover the remaining auto switches. The NVMSRP's goal was to reduce mercury emissions from electric arc furnaces that melt vehicle scrap metal to make new steel by encouraging auto recyclers and scrap processors to remove mercury switches prior to vehicle shredding.

Because steel companies would not purchase scrap from auto recyclers not participating in ELVS,²⁴ NVMSRP was successful in driving registration early in the program. NVMSRP also provided a national incentive to auto recyclers in states without mandatory bounties, paying them a bounty of \$1 initially, and then increasing it to \$4 in 2008 for each mercury switch returned to ELVS. The NVMSRP was moderately effective at driving collection of mercury auto switches, with annual collection rates²⁵ climbing from 16 percent in 2007 to a peak of 24 percent in 2009, and dropping to 17 percent in 2010 after the national incentive program funding was depleted in August 2009. Today, auto recyclers nationwide can continue sending mercury switches to ELVS, which provides free collection bins. However, the incentive is no longer offered to auto recyclers, except in states that have an auto switch recycling law mandating that either industry or the state fund a recovery incentive. Since 2009, the average annual combined collection rate in the 13 states with auto switch recycling laws providing incentives for recycling²⁶ is higher than that of states with no collection incentive (see Figure 1). The average annual combined collection rate in states with incentives ranged from 26 percent to 29 percent between 2010 and 2012. In contrast, the average annual combined collection rate in states without incentives ranged from 11 to 16 over the same time period.

Figure 1: Average Collection Rate of Mercury Auto Switches Over Time



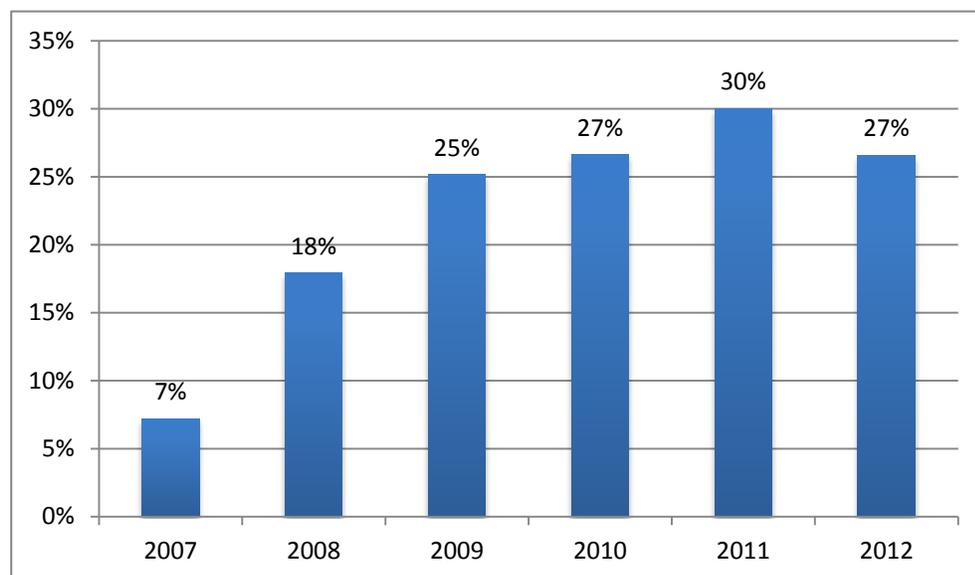
²⁴ Pending regulations at the time for limiting mercury emissions from electric arc furnaces, which are capable of using a large percent of scrap steel to make new steel, drove this requirement.

²⁵ The collection rate is calculated by dividing the number of auto switches collected by the amount of switches available for collection.

²⁶ Of the 14 current states with auto switch EPR laws, only VA and VT do not require an incentive for recycling.

The Illinois auto switch law requires vehicle manufacturers to implement a recovery and recycling program for mercury-containing switches before vehicles are scrapped. The law established annual collection rate goals that, if not met, would trigger a requirement that auto manufacturers pay a \$2 per switch incentive fee to vehicle recyclers for each mercury switch they collect. (The program does not provide any incentive for airbag switches or other miscellaneous mercury switches.) When the 30 percent collection rate goal was not attained during the Illinois program’s second year, auto recyclers received a \$2 bounty for each convenience light switch and ABS switch recovered. The law has successfully increased the collection of mercury switches, with the current collection rate at more than four times the level prior to when the law took effect (see Figure 2).

Figure 2: Illinois Auto Switch Collection Rates 2007-2012



PSI’s project goal was to increase the collection of mercury auto switches in Illinois by offering monetary incentives to auto recyclers that went beyond the requirement of the Illinois law. PSI also set specific outreach objectives, including establishing 75 additional participating collection locations for mercury auto switches (including new locations and locations that had not returned a bin in over 18 months), and contacting 380 auto dismantlers directly by mail, phone, and email up to three times with targeted information about auto switch recycling.

Incentives and Outreach

PSI’s incentive and outreach program for auto switches ran for 13 consecutive months—from May 1, 2013 to May 31, 2014 (see Table 1). During this project period, we tested two different incentive structures—the first from May 2013 to October 2013, and the second from November 2013 to May 2014—to determine the degree to which a financial incentive would boost auto switch collections for convenience lights, air bags, and anti-lock brake systems. During the first period, we attempted to increase the number of ABS sensor switches and airbag switches, and increase overall participation from nonparticipating auto recyclers.

ABS Sensors: We provided a \$6 incentive for each switch from ABS sensors, which included the \$2 per switch incentive required under Illinois law. The \$6 incentive was offered to compensate auto recyclers for the additional time required to remove these sensors.

Airbag Switches: We also offered a \$4 per switch incentive for airbag switches. Currently, auto recyclers do not receive any incentive for airbag switches, as these switches are not included in the [Illinois Mercury Switch Removal Act](#). Recyclers can remove these switches and recycle them through ELVS, but no compensation is provided. Our goal, therefore, was to increase removal of these switches by offering the \$4 per switch incentive.

Bucket Bonus for Nonparticipating Auto Recyclers: The third incentive offered was a “bucket bonus” – a one-time \$100 bonus to auto recyclers who had not returned any mercury switches since September 2011. The bonus applied only to the first bucket that a participant sent to ELVS *and* it had to contain more than 20 switches (to ensure that participants did not send in an empty bucket or one with only a few switches).

Table 1: Auto Switch Incentives Offered

	Period 1: May 2013-Oct. 2013	Period 2: Nov. 2013-May 2014
Convenience Light	\$2 per switch*	\$4 per switch*
Anti-lock Brake System (ABS) Sensor	\$6 per switch*	
Air Bag Crash Sensor	\$4 per switch	
“Bucket Bonus”	\$100 one-time bonus for vehicle recyclers who had not sent in a mercury switch collection bucket since September of 2011. Bucket must have contained 20 or more switches to qualify.	

**includes the \$2 per switch that recyclers already receive from ELVS, as required by IL law.*

Convenience Lights: During the second pilot period (November 2013 to May 2014), we increased the per switch incentive from the \$2 that recyclers currently receive by law to \$4 to attempt to increase the number of convenience light switches returned.

Outreach: Concurrent with offering monetary incentives, PSI implemented a multi-stage outreach campaign to raise awareness among automobile recyclers of their obligations under Illinois law, inform them of PSI’s incentive program, and convey the importance of keeping mercury out of the waste stream (see Appendix A). PSI sent letters, postcards, and emails to recyclers, created a [webpage](#) explaining additional incentives for mercury auto switches, contacted auto recyclers via phone, and sent recyclers an 18”x24” laminated wall poster denoting the location of mercury switches by model, make, and year. Example outreach materials can be found in Appendix B. Our outreach targeted the following recyclers:

- 281 auto recyclers who had not returned a collection bucket since September 2011, and thus were eligible for a “bucket bonus”; and
- 175 auto recyclers not eligible for a “bucket bonus,” but who were eligible for other program incentives.

IEPA also conducted site visits to 205 auto recyclers during this time period to check compliance with the auto switch law and promote the bonus incentive program.

Results

The following results are based on the actual number of auto switches collected per year and, when available, estimates of the number of auto switches available for collection.²⁷ (See Appendix C.)

1. **When an additional incentive was added, the collection rate for convenience light switches increased.** In the year prior to our pilot program, the collection rate for convenience light switches was 26 percent. During the second half of the pilot period (November 2013 to May 2014), in which an additional \$2 was added to the incentive for convenience light switches, the collection rate increased to 30 percent. Overall, during the program period, 86 pounds of mercury was collected from 38,809 convenience light switches, with an annual collection rate of 27 percent. (See Table 2).

Table 2: Convenience Light Switch Collections

	Time Period	Number of Switches Collected	# Switches available for collection ²⁸	Collection Rate	Pounds of Mercury Collected ²⁹
Baseline Year	May 2012-April 2013	39,148	149,930	26%	86
May 2013- May 2014 <i>(Pilot Project Period)</i>	Period 1: May-Oct 2013: <i>(No Light Switch Incentives)</i>	20,379	84,195	24%	45
	Period 2: Nov 2013-May 2014: <i>(With Light Switch Incentives)</i>	18,430	60,587	30%	41
	Total (Periods 1 & 2):	38,809	144,782	27%	86

2. **Incentives resulted in an increase in the return of airbag sensor switches from 28 to 188 switches.** Illinois law neither requires airbag switches to be removed, nor includes an incentive for these switches. Airbag sensor switches are also found in a more limited number of vehicles as only four automobile manufacturers (Audi, Mercedes-Benz, Toyota, and Volvo) manufactured vehicles containing mercury airbag switches.³⁰ Therefore, in the year prior to project start-up (May 2012 to April 2013), Illinois auto recyclers only returned 28 mercury auto switches from airbag sensor units.

²⁷ ELVS contracts environmental management services, including switch collection data management, to the Environmental Quality Company (EQ). PSI used EQ's online database during the project period to acquire monthly data on the number of switches returned to ELVS, disaggregated by individual automobile recycler and switch type. The estimated number of auto switches available for collection is based on National Vehicle Mercury Switch Recovery Program (NVMSRP) projections. The NVMSRP takes into consideration economic factors when projecting switches available for recovery from each state. See Appendix C for the calculation of the amount of auto switches available for collection.

²⁸ The NVMSRP provides an annual estimate of number of convenience light switches available for collection, which uses a switch retirement model. http://elvsolutions.org/?page_id=1298. ABS and air bag switches are not included in this model, as only convenience switches were included in the initial NVMSRP MOU (August, 2006).

²⁹ Information downloaded from EQ's online database. See reference 22 for further information.

³⁰ ELVS Website Air Bag Crash Sensor Module Information, at http://elvsolutions.org/?page_id=591. Accessed on December 29, 2014.

After introducing the bucket bonus and \$4 per switch incentive, the number of airbag sensors switches recovered increased by over 500 percent to 188 switches (see Table 3 and Figure 3).

Table 3: Airbag Sensor Switch Collections

	Pre-Project (May 2012-May 2013)	Project Period (May 2013-May 2014)	Percent Change
Number of switches collected	28	188	+571%
Pounds of mercury collected	.06	.41	+583%

Figure 3: Number of Returned Mercury Auto Switches from Airbag Sensors, Before and After Incentive

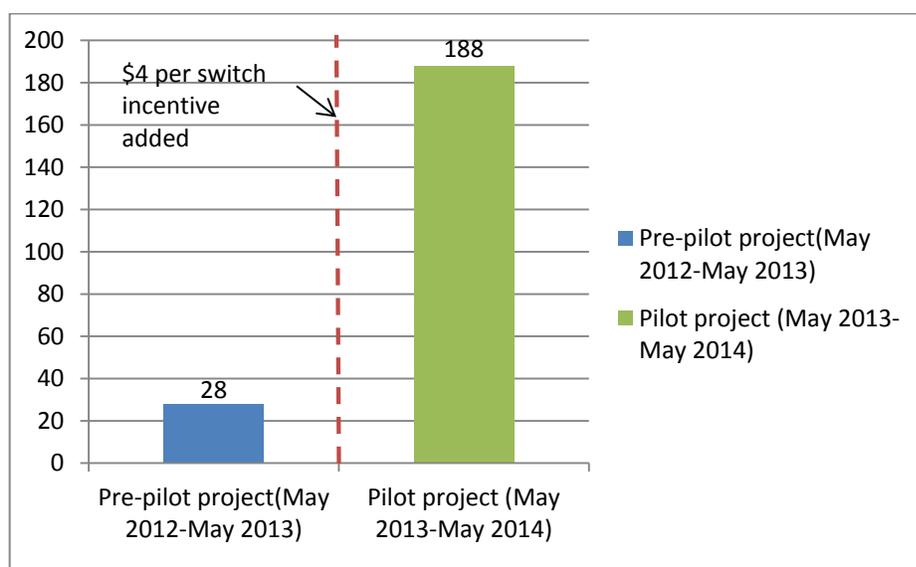


Figure 4, below, illustrates that bucket bonus-eligible recyclers (new recyclers or those that had not returned a bucket in the 18 months prior to project start-up) were among those most likely to return airbag switches, indicating that the increased use of a bucket bonus incentive structure could lead to increased collection in Illinois and other states. Recyclers eligible for the bucket bonus returned 174 out of the 188 total airbag switches (93 percent).

- 3. With an increase in incentive offered, the number of ABS switches collected increased relative to projections.** During the project, the incentive offered for ABS switches was increased from \$4 to \$6. From the pre-project to the project period, annual switch collections were projected to decrease by 8.2 percent. Instead, collections during the project year decreased by only 0.1 percent to 4,539 switches, a seven percent increase in ABS switch collection compared to the projected quantity (4,216 switches).³¹ (See Table 4.)

³¹ The NVMSRP model (available at http://elvsolutions.org/?page_id=1298), over the 13 month project timeline, predicts an 8.2 percent decline in the number of convenience light switches available for collection between May 2012 – 2013 (pre-pilot project) and May 2013 – 2014 (during the pilot project). During May 2012 – 2013, 4,545 ABS switches were returned by Illinois auto recyclers (data from EQ’s online database at *Reducing Mercury Releases from Auto Switches and Thermostats* Final Report to EPA Region 5 – Product Stewardship Institute, December 29, 2014

Figure 4: Number of Airbag Switches Returned by “Bucket Bonus” Recyclers vs. All Recyclers

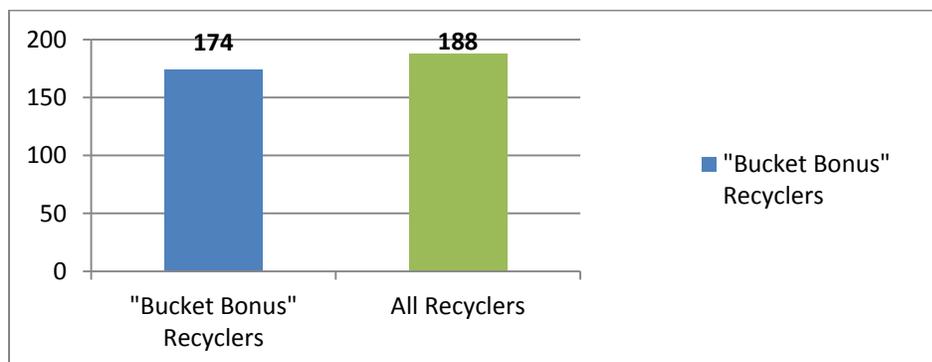


Table 4: ABS Switch Collections

	Pre-Project (May 2012-May 2013)	Projected for Project Period (May 2013- May 2014) ³²	Actual for Project Period (May 2013- May 2014)	Percent Change (Actual to Pre-Program)	Percent Change (Actual to Projected)
Number of switches collected	4,545	4,172	4,539	-0.1%	+8.8%

4. PSI’s \$100 “First Bucket Bonus” enticed 60 non-compliant auto recyclers to collect and return auto switches. As shown in Table 5, 60 recyclers eligible for the bucket bonus sent in buckets during the 13-month project. Bucket bonus eligibility was limited to recyclers that (1) had no history of returning switches to ELVS, or (2) had no recent history (i.e., within the 18 months prior to the project start date) of returning switches. Seventy percent of the recyclers (42 out of 60) responding to the bucket bonus challenge had never returned switches to ELVS; the remaining 30 percent (18 out of 60) had submitted switches prior to the 18-month cut-off of October 2011, but had lapsed in ELVS program participation for at least two years. Recyclers continued participating in the ELVS program, even after receiving the one-time incentive. The 60 bucket bonus participants returned a total of 93 buckets during the project period.

<https://www.egonline.com/Home.aspx>). In recent years (2011 – 2013), ABS switches have comprised 10 percent of the total number of switches collected in Illinois (data from EQ’s online database at <https://www.egonline.com/Home.aspx>). Assuming no change in the composition of switches collected, the number of ABS switches collected in May 2013 – 2014 should also decline by 8.2 percent to 4,172.

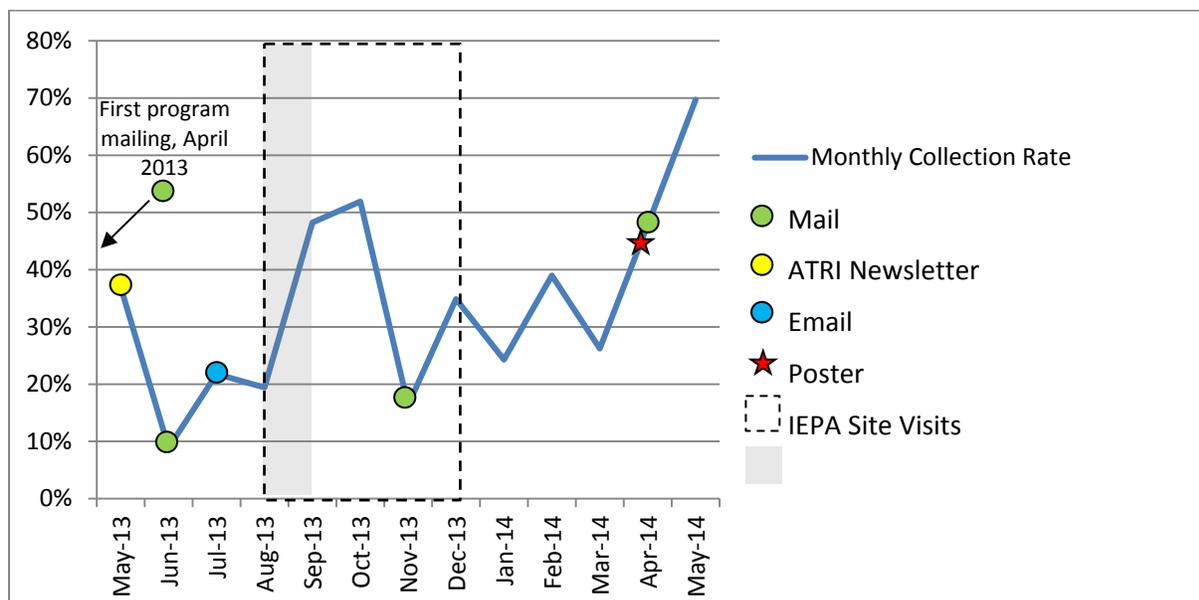
³² *Ibid.*

Table 5: Bucket Bonus Program Response

Bucket Bonus Program Response	
Number of Auto Recyclers Eligible for Bucket Bonus	281
Number of Auto Recyclers that Received Bucket Bonus	51
Total Bonus-Eligible Auto Recyclers Participating in Pilot Program	60 ³³
Percent of Bonus-Eligible Auto Recyclers Participating in Pilot Program	21%

5. Targeted recurrent mailings, on-site visits, and phone calls are the most effective outreach strategies. Figure 5, below, illustrates how the monthly auto switch collection rate was influenced by various outreach efforts, including mailings, emails, an article in a trade association publication, phone calls, site visits, newsletter, and posters. Auto switch collection rates repeatedly increased in the one to two months after mailings were sent to collection sites (June, August, and November 2013 and April 2014). This indicates that targeted recurrent mailings serve as an effective means of outreach to auto recyclers. The second highest collection rate (52 percent) was attained during the period of IEPA site visits and in the month following PSI phone calls, suggesting that site visits, phone calls, or both visits and calls may also contribute to an increase in auto switch collections. Email and newsletter outreach were not followed by an increase in collection rate. Since the posters were distributed at the same time as a mailing, it may have contributed to boosting collections to the highest rate achieved during the project period. More research is necessary to determine the effectiveness of each strategy in isolation and to evaluate the relative cost of providing these strategies.

Figure 5: Impact of Outreach on Monthly Auto Switch Collection Rate (all switches)



³³ Nine of these recyclers returned switches, but not in sufficient quantities (at least 20) to earn the bucket bonus.

Key Findings

While Illinois has taken the first step toward effectively managing mercury switches by passing and implementing a law, its annual switch recycling rates have hovered around 30 percent. The following findings, many of which are also applicable in other states with auto switch collection programs, represent key changes that would help Illinois increase its auto switch collection rate.

1. **Higher incentives drive additional collection.** The results of the project indicate that incentive programs lead to increased collection rates for mercury auto switches. These results parallel national findings that most of the states with the highest annual recycling rates for mercury switches are those that, like Illinois, maintained incentive programs after NVMSRP funding was depleted in 2009. Table 6 (below) summarizes the incentives offered by each state auto switch collection program and the collection rates for 2012³⁴. In 2012, North Carolina, Rhode Island, and Maine, which each offer a \$4 or \$5 incentive per convenience switch recovered, achieved the top three collection rates, each above 40 percent. To further increase collection, Illinois should look to other states with high collection rates, such as North Carolina (which established a 90 percent collection goal and offers a \$5 incentive for each mercury auto switch returned), as well as Minnesota and California (which implemented successful non-regulatory technical assistance programs).

Table 6: State Auto Switch Incentives and Collection Rates – By Switch Type

State	2012 collection rate (%)	\$/convenience switch	\$/ABS switch	\$/ABS assembly	\$/airbag switch
North Carolina	60	\$5	\$0	\$0	\$0
Rhode Island	42	\$5	\$0	\$0	\$0
Maine	40	\$4	\$4	\$8 – 12**	\$4
Utah	35	\$5	\$0	\$0	\$0
Indiana	31	\$3	***	\$5	\$0
Iowa	30	\$5	\$0	\$0	\$0
Maryland	28	\$4	***	\$6	\$0
Washington	28	\$3	***	\$9	\$0
Illinois	27	\$2	\$2	\$4 – 6**	\$0
New Jersey	22	\$2	***	\$2	\$0
Arkansas	21	\$5	\$5	\$10 – 15**	\$0
Massachusetts	19	\$3	\$3	\$6 – 9**	\$0
South Carolina*	14	\$2.50	\$0	\$0	\$0

Notes:

*South Carolina's incentive ended on June 30, 2013.

**ABS switch incentive is offered on a per switch basis. ABS assemblies contain 2 to 3 switches.

***Incentive is provided for the ABS assembly, and not on the number of switches.

³⁴ Collection rates are calculated using annual switch collection data, by state, available at the ELVS website, <https://www.eqonline.com/services/ELVS-Mercury-Switch-Recovery-Program/annual-report.asp?year=all>, accessed Dec. 29, 2014 and annual projections of number of switches available for collection from the NVMSRP model, also available at the ELVS website, http://elvsolutions.org/?page_id=1298, accessed Dec. 29, 2014.

2. **Up to 25 percent of recyclers are uneducated about switch locations and removal processes.** Despite outreach and education efforts by ELVS and IEPA, some Illinois auto recyclers are unaware of which vehicles contain mercury switches and how to access them. Anecdotal information collected during IEPA site visits suggests that approximately one quarter of auto recyclers visited were uninformed and requested additional information. (From August to December 2013, IEPA visited 205 recyclers out of 456 recyclers licensed in the state.)

3. **Penalties for noncompliance of auto switch recycling are seldom enforced.** While the Illinois Mercury Switch Removal Act includes penalties for noncompliance—\$250 at first and \$500 for subsequent violations—these fines are seldom assessed by IEPA. This lack of enforcement is due both to resource constraints and IEPA’s lack of authority to prosecute cases.

III. MERCURY THERMOSTAT PROGRAM

Overview



The thermostat manufacturer Honeywell ceased production of mercury-containing thermostats in 2006. Other major thermostat manufacturers ceased producing mercury-containing units by 2010.³⁵ Because mercury thermostats have a life span of 20 to 40 years,³⁶ most thermostats still in use today contain mercury switches that monitor and control temperature by communicating with HVAC equipment. The photos above show two of the more common mercury thermostats found on the walls of homes and businesses throughout the U.S.; the cover has been removed from the thermostat on the right to expose the glass ampoule, which contains the silver mercury. Although electronic non-mercury thermostats were introduced several decades ago, mercury thermostats continued to hold a major market share until 15 states banned the sale of new mercury thermostats in the late 2000s.

While mercury use in new thermostats has dropped to virtually zero, previously installed units can remain in place for decades and, therefore, continues to be a noteworthy source of mercury pollution. The most recent available estimates from the U.S. EPA indicate that between 2 and 3 million mercury

³⁵ Northeast Waste Management Official’s Association, 2014. “IMERC Fact Sheet: Mercury Use in Thermostats,” Jan. <http://www.newmoa.org/prevention/mercury/imerc/factsheets/thermostats> TRC Thermostat Bin
2014.

³⁶ USEPA 2002, *Use and Release of Mercury in the United States*, EPA/600/R-02/104 accessed at <https://clu-in.org/download/contaminantfocus/mercury/use-and-release-of-mercury-in-usP1001P4H.pdf>, Dec. 29, 2014.

thermostats³⁷ are removed from use and enter the waste stream each year. For Illinois, that means approximately 80,000 to 123,000 thermostats.

Honeywell, White Rogers, and General Electric formed the Thermostat Recycling Corporation (TRC) in 1998 as a voluntary collection program in nine states, including Illinois. Under the TRC program, thermostat wholesalers, HVAC contractors, HHW facilities, and retailers make a one-time \$25 payment to receive a reusable collection and shipping container (pictured at right). Once full, TRC pays for the container to be shipped to a processing facility, and provides the collection sites with a free replacement container. Over the next few years, TRC's voluntary program expanded, providing service to states that adopted the federal Universal Waste rule, which enabled TRC to ship small quantities of waste thermostats via common carrier. By 2001, the program had expanded to serve all 48 contiguous states.



In 2004, PSI began to work with TRC to expand the voluntary national program to wholesaler chains, contractors, HHW facilities, and retailers. However, due to a national thermostat collection rate of below 5 percent, state and local governments became interested in developing extended producer responsibility (EPR) legislation to significantly boost that rate. Since 2006, when PSI established a model thermostat EPR bill, 13 states (including Illinois) have passed thermostat EPR laws.³⁸ Unfortunately, as much as 85 percent of mercury thermostats coming out of service annually in Illinois continue to enter the solid waste stream.³⁹

The [Illinois Mercury Thermostat Collection Act](#),⁴⁰ which took effect on July 1, 2011, bans the disposal of mercury-containing thermostats and requires HVAC contractors to recover them from job sites for recycling. The law also requires wholesalers of HVAC equipment to act as mercury thermostat collection points. In addition, it requires thermostat manufacturers to make collection containers available to all thermostat wholesalers and qualified contractors in the state, although TRC is allowed to charge a \$25 one-time fee for each container. Furthermore, the law requires thermostat manufacturers to develop and distribute educational materials to help make wholesalers and contractors aware of the requirements of the law, and to provide an annual report to IEPA on program performance in Illinois. TRC is the stewardship organization that finances and manages the program on behalf of thermostat manufacturers.

³⁷ A 1994 US EPA study (Mercury Usage and Alternatives in the Electrical and Electronics Industries. Office of Research and Development, EPA/600/R-94/047) estimated that 2 to 3 million thermostats are available for collection each year in the US. In 2012, 4.1 percent of the US population (313.9 million people) resided in Illinois (12.87 million people). By scaling US EPA's estimates to Illinois, 82,000 to 123,000 thermostats are available annually for collection in Illinois. We use the low end of this range for estimating the number of thermostats available. More recent data are not available.

³⁸ These states include CA, CT, IL, IA, MA, ME, MN, MT, NH, NY, PA, RI, VT.

³⁹ TRC reported collecting 13,061 thermostats in 2012, or 16 percent of the 82,000 thermostats available for collection.

⁴⁰ Illinois Mercury Switch Removal Act of 2006, Public Act 094-0732, <http://www.ilga.gov/legislation/ilcs/ilcs3.asp?ActID=2779&ChapterID=36>, accessed on Dec. 29, 2014.

To increase the thermostat collection rate in Illinois, PSI, in cooperation with IEPA, set an objective to establish 75 additional TRC collection locations and contact 5,400 HVAC contractors to inform them about the PSI program.

Incentives and Outreach

PSI allocated grant funding to pay the one-time \$25 fee for TRC collection bins on behalf of new participants, thereby removing a barrier to participation. We also educated wholesalers and contractors about their thermostat collection responsibilities under the Illinois Mercury Thermostat Collection Act. PSI targeted the following entities in adding new collection sites (see Appendix D for further details on the outreach plan and Appendix B for examples of outreach material):

- **595 HVAC wholesalers**, who are required by law to participate in the TRC program.
- **5,482 HVAC contractors**, who are required to properly recycle mercury thermostats, but who are not required to have their own TRC collection bin. This category also includes other contractors who periodically remove thermostats, such as plumbing contractors and electricians.⁴¹
- **226 demolition contractors**, who might remove mercury thermostats prior to building demolition but did not have collection bins. These individuals have not traditionally been the focus of TRC outreach, and may therefore have been unaware at the time this project started that thermostat collection bins were available to them.

PSI's thermostat pilot ran for 12 months (May 2013 to April 2014), and was promoted through a series of phone calls and mailings (including post cards with bright, eye-catching text and images, and with a simple message). Recipients of the TRC collection bins were encouraged to continue collecting thermostats after the pilot program ended.

Results

The program's success was evaluated by the increase in mercury recovered, along with the increase in the number of collection sites established. The specific results for each of these metrics are as follows:

1. **PSI's project resulted in a 24 percent increase in thermostat collections and total mercury recovered.** Overall recovery of mercury by TRC program participants increased from 80 pounds during the 12 months preceding PSI's pilot project (May 2012 to April 2013) to 99 pounds during PSI's project—a 24 percent increase. The number of bins returned to TRC also rose from 174 during the 12 months before the project to 212 during the project (an increase of 22 percent). Since the number of mercury thermostats available for retirement is decreasing each year, these collection increases are significant. (See Table 7, below.)

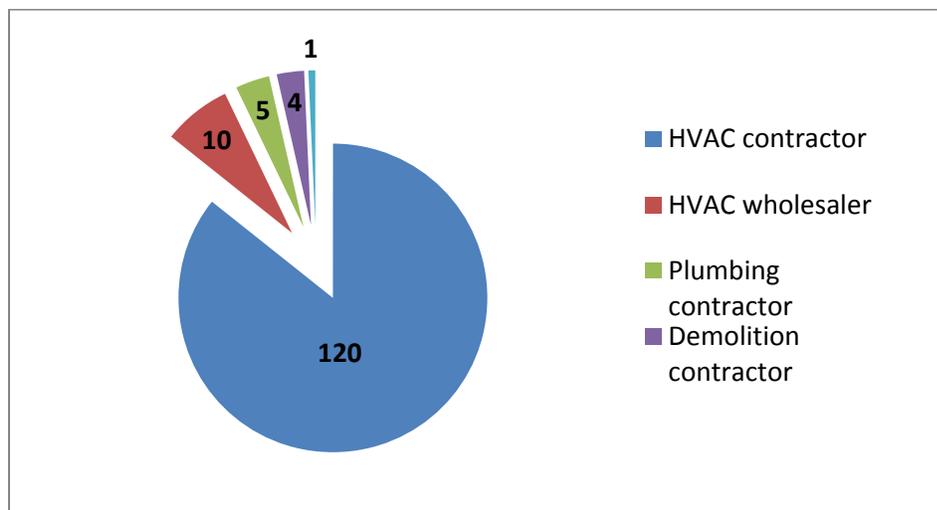
⁴¹ Only HVAC or demolition contractors that employ at least seven people or are located in a rural region qualify for a TRC bin.

Table 7: Thermostat Collection – Before and After Project Period⁴²

	Pre-Project (May 2012-April 2013)	Project Period (May 2013-April 2014)	Percent Change
Number of thermostats collected	9,580	12,737	+33%
Pounds of mercury collected	80	99	+24%
Number of bins returned	174	212	+22%
Number of collection locations	256	396	+54%

2. PSI increased the number of thermostat collection locations in Illinois by 54 percent. During the project, 140 businesses registered as collection sites through PSI, increasing the total number of collection locations in Illinois by 54 percent, to 396. Figure 6 shows a breakdown of the types of businesses that registered for the TRC program during the project. The majority of bin requests came from HVAC contractors. This finding is to be expected: while Illinois law requires TRC to make collection bins available to both wholesalers and contractors, only wholesalers are required to act as collection locations. While contractors are not required to act as collection locations, they are required to recycle thermostats.

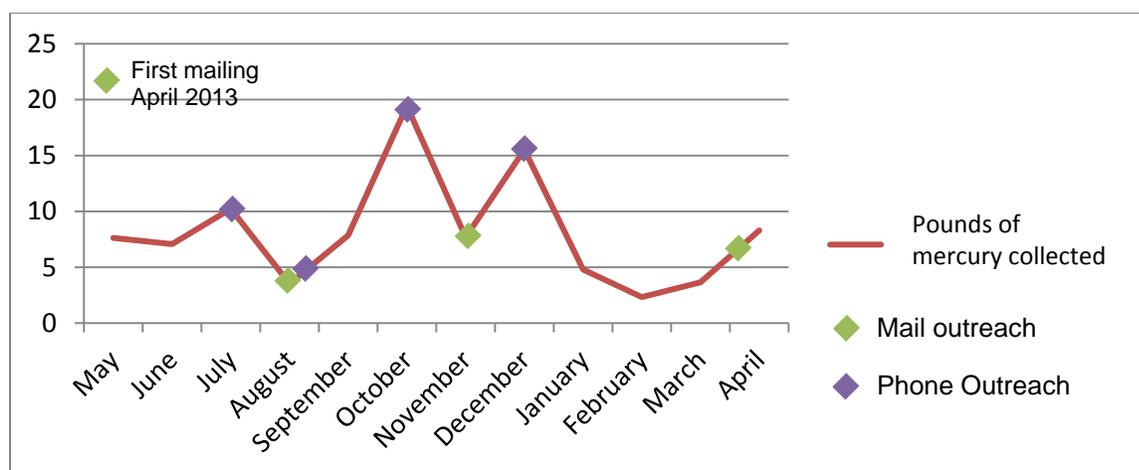
Figure 6: Types of Businesses Registered with TRC through Free Bin Program



⁴² IEPA requires TRC to submit annual reports identifying the Illinois collection locations that operate under its program. TRC must also provide the number of thermostats and loose mercury switches collected by each location during the year, along with the total weight of collected mercury. In August 2014, TRC began providing this information to IEPA on a quarterly basis to aid in evaluating the success of the Illinois thermostat law.

- 3. Thermostat collection locations registered through PSI recovered 16.3 pounds of mercury.** From May 2013 to November 2014 (18 months), the 140 HVAC wholesalers and contractors who signed up for the TRC program through PSI returned 69 collection bins, recovering 16.3 pounds of mercury from 1,741 thermostats.⁴³ With the addition of thermostats collected in the remaining 71 bins but not yet returned, the actual quantity of mercury recovered by these sites would likely exceed 16.3 pounds by a significant margin.
- 4. Mailings were a more effective outreach mechanism than phone calls. Figure 7 illustrates the monthly breakdown of mercury collected via the TRC program during the project.** In April 2013, August 2013, and November 2013, PSI sent outreach mailings to wholesalers and contractors, outlining their legal responsibility to return collection bins on an annual basis. Increases in collection rates in the month following each mailing indicate that mailings are an effective means of outreach to these businesses. (These mailing were in addition to mailing from TRC.) Phone outreach did not have the same effect on collection rate; calling campaigns in July, October, and December were followed by drops in collection amounts in subsequent months.

Figure 7: Monthly Pounds of Mercury Collected During Pilot Program (May 2013-April 2014)



Key Findings

- 1. Forty-five percent of collection sites did not return their collection bins to TRC within the project period.** From May 1, 2013 to April 30, 2014, only 153 of the 279 collection sites in place for one year or longer (including HVAC wholesalers, contractors, and HHW collection sites) returned bins, a return rate of 55 percent. This occurred despite postcard reminders from TRC to all collection sites reminding them of the requirement to return bins. As participation among smaller businesses grows, it will be important for TRC to encourage participants to send their bins in at least once per year, whether they are full or not, to maintain TRC program activity, maximize collections, and avoid any hazardous waste storage violations. This outreach will be especially important for new contractor participants, as each contractor will likely not collect as many thermostats as the typical wholesaler.

⁴³ An 18-month time frame is used for thermostat collection data to account for time necessary to order bins, collect thermostats, and return bins to TRC. Collection sites are required to return bins at least once a year. Of the 140 collection locations registered through PSI, 89 were registered between May 2013 and November 2013, and 51 were registered between November 2013 and May 2014.

2. **Businesses in Illinois stockpile mercury devices and elemental mercury.** The project uncovered 10 businesses that stored mercury thermostats, loose mercury switches, and—in some cases, elemental mercury (i.e., liquid mercury stored in jars or other containers) on premises. In cases where businesses were storing elemental mercury, PSI referred them to IEPA and their local hazardous waste management authority.

IV. RECOMMENDATIONS

Our pilot programs demonstrated how various financial incentives can boost collection rates of mercury-containing auto switches and thermostats. Based on our results and key findings, we offer the following recommendations, organized by product type:

Auto switches

- **Increase the mercury auto switch incentive for convenience light switches to a minimum of \$4.** The collection rates for convenience light switches increased from 24 to 30 percent when the pilot program increased the incentive to \$4 per switch. States with higher collection rates than Illinois, such as North Carolina (60 percent), Rhode Island (42 percent), and Maine (40 percent) provide a \$4 to \$5 per switch bounty. We recommend increasing the per switch incentive in Illinois to a minimum of \$4.
- **Add a collection incentive for airbag switches and requirement for airbag switch collection.** Mercury auto switches from airbags are not currently required to be collected, and do not earn an incentive under Illinois law. By adding an incentive during the pilot project, PSI prompted a year-over-year increase in collection from 28 switches (pre-pilot) to 188 switches (post-pilot). We recommend the introduction of an incentive for airbag switches in Illinois for a minimum of \$4. A state requirement for airbag switch collection would further increase collection volumes and prevent improper disposal of the mercury-bearing switches.
- **ELVS should conduct outreach via mail at regular intervals to all auto recyclers to ensure that they continue collecting mercury-containing switches and return buckets at least once per year.** Mailings to collection sites corresponded with increases in collection rates. Quarterly postcards to all collection sites would ensure regular return of collection containers. IEPA site visits and phone calls were also linked with increased collection rates, and should be encouraged as outreach strategies.

Thermostats

- **Establish a \$5 collection incentive for thermostats.** While PSI was able to increase collection through the education of HVAC wholesalers and contractors, Illinois's collection rate still lags behind other states that have mandatory collection programs. Table 8, below, summarizes the 13 thermostat recycling laws and the number of thermostats collected per 10,000 residents in each state. The two states with the highest collection rates, Vermont and Maine, both offer a \$5-per-unit financial incentive to residents and contractors who return mercury thermostats through the TRC program. We recommend the introduction of a \$5 collection incentive for thermostats in Illinois to further drive collections.

Table 8: State Thermostat EPR Laws – Comparison of Thermostats Collected (2013)

State	Date Implemented	Financial Incentive	Performance Goals	Thermostats Collected in 2013 (per 10,000 persons)	National Rank (Per 10,000 persons)
Vermont	2009	\$5/thermostat	Yes	33.7	1
Maine	2007	\$5/thermostat	Yes	31.9	2
Rhode Island	2011	❖	Yes	24.9	3
New Hampshire	2009	None	❖	13.9	10
Minnesota*	2014	❖	No	13.8**	11**
Iowa	2009	None	❖	11.2	13
Pennsylvania	2009	None	❖	10.3	14
Illinois	2011	❖	Yes	10.2	15
Massachusetts	<i>To be implemented</i>	None	No	9.9**	16**
California	2009	❖	Yes	6.0	21
Montana	2010	None	Yes	4.1	29
Connecticut	2013 (April)	None	No	4.5	27
New York	2014	❖	Yes	1.3**	40**

❖ Referenced in the law and within the authority of the state to implement.

* State previously enacted a disposal ban. Legislation expanded in 2014, requiring manufacturers to fund collection and recycling program.

** Program data not yet available. Latest available pre-program data used for comparison.

- TRC should provide free collection bins.** Although TRC considers the \$25 one-time payment for collection bins to be a show of commitment on the part of those collecting thermostats, this payment actually represents a barrier to participation. After PSI paid for the bins, the number of collection locations for mercury thermostats in Illinois increased by 54 percent. Removing the financial barrier to participation for the 140 new collection sites, along with increased outreach, contributed to a 24 percent increase in collection of mercury thermostats during the project period. TRC should provide free collection bins for mercury thermostats just as ELVS provides free collection bins for mercury auto switches.
- Develop more effective outreach to ensure that all participants send in bins at least once per year, full or not.** During the pilot period, only 55 percent of TRC sites established for one year or longer returned collection bins, leaving them out of compliance with state hazardous waste management laws. More effective outreach methods may increase the percentage of locations that return bins on an annual basis.

- **Develop a new program targeted for those who stockpile mercury devices.** The project uncovered 10 businesses that stored mercury thermostats, loose mercury switches, and—in some cases, elemental mercury (i.e., liquid mercury stored in jars or other containers) on premises. To encourage the collection of loose mercury switches, mercury ampoules, and elemental mercury stockpiled at some businesses and homes, a special outreach program should be developed to reduce the risk of dangerous mercury releases.

Both Auto Switches and Thermostats

- **Identify and implement elements found in other states with high-performing auto switch and thermostat collection programs.** While states offering financial incentives tend to have the highest collection rates, several states without incentives, including voluntary programs, have also successfully elevated the collection rates of thermostats and auto switches. Minnesota, Colorado, California, Wisconsin, and Georgia all report auto switch collection rates above that of Illinois, despite not providing a financial incentive for collection. Illinois may benefit from a study on the implementation of these programs, to address the factors that led to their successes (e.g., educational activities, enforcement, etc.). This could be done through a survey and a series of facilitated calls.
- **Increase penalties for violation of mercury auto switch and thermostat laws such that local agencies will pursue collection.** Under the mercury auto switch and mercury thermostat laws, local agencies—including local solid waste management agencies, environmental management agencies, and public health agencies—have the authority to pursue penalties for violation of collection requirements against entities in their jurisdiction. However, penalty amounts—\$250 to \$500— may be too low to justify the cost of pursuing collection. Raising penalty amounts could encourage more enforcement, and therefore lead to higher collection totals.
- **Give IEPA authority to issue administrative citations.** Currently, IEPA must work through the Attorney General or State’s Attorneys to issue violations for the auto switch and thermostat laws, as IEPA does not have the authority or resources to prosecute cases in court. Extending IEPA’s authority to issue administrative citations—which the agency already has for tires and other solid waste violations—would strengthen IEPA’s ability to enforce the law. Enforcement levels the playing field and eliminates “free riders.”

V. APPENDICES

Appendix A: Auto Switch Outreach

PSI implemented a multi-stage outreach campaign to raise awareness among automobile recyclers of their obligations under Illinois law, inform them of our incentive program, and convey the importance of keeping mercury out of the waste stream. Table A-1 (below) provides dates and details for each element of the outreach campaign. PSI also created a program [webpage](#) explaining additional incentives for mercury auto switches.

Table A-1: Outreach Methods and Details

Date	Method	Details
April 2013	Mail	PSI developed and mailed outreach materials to 281 auto recyclers who had not returned a collection bucket since September 2011, and were therefore eligible for the \$100 bucket bonus.
May 2013	ATRI Newsletter	The Automobile and Truck Recyclers of Illinois (ATRI), a statewide industry organization, distributes a newsletter to its members four times per year. PSI worked with IEPA to place a promotional letter for the incentive program in ATRI's May/June newsletter.
June 2013	Mail	PSI mailed a letter to 175 auto recyclers who did not qualify for the bucket bonus.
July 2013	Email	PSI sent targeted emails to 215 auto recyclers for whom email addresses were available, 91 of which were eligible for a bucket bonus, explaining the benefits of the program. Approximately 23 percent of recipients opened the message.
July-December 2013	Site Visits	The IEPA representative on the Advisory Group visited 205 auto yards to check their records for processed cars that should have contained mercury switches, and to see whether they were collecting switches. The representative also promoted the PSI incentive program. Ultimately, IEPA found that multiple yards needed to return ELVS buckets.
August 2013	Mail	PSI developed a set of postcards with information about the incentive program, and distributed them to all 456 Illinois automobile recyclers.
August 2013	Telephone	In August 2013, PSI developed a call script and made calls to 200 auto recyclers to explain the program and encourage them to send in switches for the bonus incentive. We reached 100 out of 281 recyclers eligible for the bucket bonus and 100 out of 175 recycler ineligible for the bonus. We placed specific emphasis on ABS and airbag switches, for which collection rates were historically low. We randomized call recipients within each group to avoid selection bias. We also tracked feedback received on each call, which is summarized in Table A-2, below.
November 2013	Mail	PSI developed and distributed a letter explaining that the incentive program had been extended through April 2014, and expanded to include a \$2 incentive on convenience light switches.
April 2014	Poster	In April 2014, PSI hired a professional graphic designer to create an 18"x24" full-color poster to hang in auto recyclers' offices. We distributed it to all Illinois automobile recyclers because calls and site visits indicated that they were not certain which model years have switches, or even where these switches are located within the vehicles. The poster, which is designed to be hung in a high-traffic, highly visible area, provides this information in a convenient, easy-to-understand way.
April 2014	Mail	Along with the poster, PSI sent a letter to the full mailing list explaining that the incentive program had been extended through May 2014.

Table A-2: Feedback from Telephone Calls to Auto Yards

Response	Percent of Responses
No answer/left voicemail	42%
“Don’t get many switches”/Not interested	20%
Send additional information	14%
Phone disconnected	11%
Already participate/“have all the information I need”	9%
Have already sent in switches in response to PSI mailing	4%

Appendix B: Sample Outreach Materials

(See attached materials.)

Appendix C: Estimating the Number of Auto Switches Available for Collection

NVMSRP developed, and continues to manage, the “NVMSRP Switch Retirement Model.”⁴⁴ Commonly referred to as the “NVMSRP model,” the goal of this model is to predict the number of mercury auto switches available for collection in each state on an annual basis. Auto switch program performance is based on calculating a collection rate that compares actual collections to this projection. The model uses vehicle registration information in combination with estimates of the average rate at which vehicles come off the road. It also adjusts for factors such as vehicle exports, switches rendered inaccessible due to damage, and economic recessions, all of which can reduce the number of switches available for collection in any given year. The model also accounts for the 2009 “Cash for Clunkers” incentive program, which created a surge in the number of used cars coming off the road for trade-in toward a new vehicle.

PSI faced challenges in analyzing the data and assessing the impacts of the work conducted during this project. We had to address a number of unusual factors specific to the nature of mercury auto switch collection in Illinois and the structure of this project. Most importantly:

- Auto switch returns in Illinois exhibit seasonal upward and downward swings within any given year, with collections dipping in May, then spiking in the summer and peaking in August, on average. While investigating the cause of these trends was not within the scope of this project, potential causes include seasonal business conditions within the automotive industry (e.g., end-of-model-year clearance sales) and recurring seasonal outreach campaigns by ELVS or IEPA.
- The number of switches available for collection each year is currently diminishing, per the NVMSRP projection model, making any comparison of switches collected from one year to the next more difficult. Furthermore, NVMSRP projections are only provided on a calendar year basis, with no monthly breakdown, while PSI’s program period lasted 13-months, and did not coincide with the calendar year.

⁴⁴ The complete model is available in Excel format from the ELVS website: http://elvsolutions.org/wp-content/uploads/2012/10/NVMSRP_Switch_Retirement_Model_Overview_V2_Feb_10.xls.
Reducing Mercury Releases from Auto Switches and Thermostats

To account for these factors and establish a valid method of comparing switch returns from the project period to prior years, PSI first established monthly projections for Illinois by finding the average percent of actual annual collections for each month, using data from 2010 to 2012. We then applied these percentages to the NVMSRP annual projections to generate monthly projections for each year. For example, February accounts for about 5.7 percent of switches returned each year, making the February 2014 share of the NVMSRP annual projection 7,260 switches. That month, IL recyclers returned 2,831 switches, a collection rate of 39. By comparison, the previous February saw a collection rate of 36.4—comparatively less successful than 2014, even though recyclers returned more than 70 additional switches.

Appendix D: Thermostat Outreach

PSI conducted a series of mail and phone campaigns to promote the free thermostat bin program and educate wholesalers and contractors about their responsibilities under the [Illinois Mercury Thermostat Collection Act](#). The timeline of activities is summarized in Table D-1 on the following page. Overall, outreach revealed that most wholesalers have bins in place, and that very few contractors are interested in having their own collection bin, even if it is provided for free. However, reaching these contractors to ensure that they have a convenient means to return mercury thermostats is important for maximizing collections. Mailings—including letters, but chiefly postcards—are a much more effective and cost-efficient way to sign up new collection points compared to direct phone calls. The effectiveness of mail campaigns depends largely on having an up-to-date and accurate mailing list; PSI received returned mail from approximately 500 addresses.

Table D-1: Summary of Outreach to Promote Free Mercury Thermostat Bin Program

Date	Method	Details
April 2013	Mail	PSI developed and mailed a letter to HVAC contractors and HVAC wholesalers, explaining the free thermostat collection bin program and how to enroll. PSI began receiving calls and online request forms for free bins two weeks after the letter was sent, and had approximately 65 orders by mid-June.
July 2013	Telephone	PSI called over 250 HVAC wholesalers and HVAC contractors in Illinois to promote the free thermostat collection bin program, leading to seven bin requests. Contractors were difficult to reach by telephone. Of those reached, the majority were not interested in receiving a collection bin, as they reported not encountering mercury thermostats frequently enough to justify having one, or because they said they brought thermostats to a wholesaler for recycling.
August 2013	Telephone	PSI made approximately 100 more calls with an adjusted script. Contractors remained very difficult to reach via phone.
August 2013	Mail	PSI developed and distributed postcards with information about the program to HVAC Contractors and HVAC Wholesalers. PSI also sent a letter about the program to demolition contractors. Twenty additional orders came in between August and September.
October & December 2013	Telephone	PSI made targeted phone calls to approximately 45 rural HVAC contractors. As with previous campaigns, contractors were very difficult to reach in the office during business hours. These calls resulted in one new bin request.
November 2013	Mail	PSI distributed another letter to HVAC contractors and HVAC wholesalers, and to demolition contractors. This letter informed recipients that the program had been extended through April 2014. Approximately 20 additional orders were received via telephone and web as a result of this mailing.
April 2014	Mail	PSI designed and distributed a larger postcard, again to HVAC and demolition contractors and HVAC wholesalers, reminding them to take advantage of the free bin program before it ended at the close of April. This mailing led to a surge of approximately 30 additional requests for free bins.