Data project for the FluoroCycle scheme

National Environment Protection Council

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Report

Report preparation

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1 Executive Summary

Net Balance Management Group Pty Ltd (Net Balance) was engaged by the Department of Sustainability, Environment, Water, Populations and Communities (DSEWPaC) through the National Environment Protection Council (NEPC) Service Corporation to establish an overall recycling rate of mercury-containing lamps and the portion of the recycling rate attributable to FluoroCycle by determining the amount of waste generated and recycled, and mercury recovered, each year. This data project fills an important gap in the knowledge of the market and current recycling rates for mercury-containing lamps. It will also allow for the determination of the impact of the FluoroCycle scheme.

The FluoroCycle scheme ("the scheme") is a national, voluntary scheme that contributes to Strategy 1 of the National Waste Policy. The scheme was established in 2010 with an intention to reduce the amount of mercury entering the environment from the disposal of waste mercury-containing lamps by continuously increasing the recycling of these lamps.

Based on data provided by the Lighting Council of Australia (Lighting Council) and the two recycling organisations, CMA EcoCycle (CMA) and Toxfree, we estimate that the overall recycling rate for mercury has ranged from about 8.5% to 9.5**%** over the 2009 to 2012 period, with a **recycling rate directly attributable to FluoroCycle of 1.7% for the 2012 calendar year.** There was insufficient granularity in the data to breakdown the recycling rates for 2010 and 2011 and attribute it to FluoroCycle.

While there is a high amount of confidence in the amount of imported lamps each year, the data on recycling does have limitations mainly due to both the way that the mercury-containing lamps are delivered to the recyclers and how the recycling and recovery of mercury is recorded internally by these recyclers.

Recommendations to improve the data collection and to inform future surveys by Lighting Council include:

- Lighting Council work with the recyclers on the Data Collection Templates (see Appendix 3), and how these can be incorporated into their business recording system. This will provide more defined information to support improvements in future calculations of scheme recycling rates. This also will require clearer information to be provided by signatories when lamps are delivered to recyclers.
- Lighting Council work with recyclers to establish pathways for measuring the actual mass of mercury recovered from mercury-containing lamps, as opposed to other mercury-containing items.
- Lighting Council was able to determine a market share breakdown of different lamp types by wattages within categories (i.e. compact fluorescent lamps (CFLs), tubes, mercury

vapour) by speaking with one supplier for calendar year (CY) 2012. We recommend that this breakdown be refined and updated by engaging with several suppliers.

- A pilot study could be conducted to test the accuracy of the reported mercury content in particular lamps.

2 Introduction

2.1 Background

2.1.1 Context

The *National Waste Policy: Less waste, more resources* sets Australia's waste management and resource recovery direction to 2020. The policy contains sixteen strategies for action towards achieving the policy aims. The FluoroCycle scheme ("the scheme") is a national, voluntary scheme that contributes to Strategy 1 of the National Waste Policy. The scheme was established in 2010 with an intention to reduce the amount of mercury entering the environment from the disposal of waste mercury-containing lamps by continuously increasing the recycling of these lamps. There is sufficient recycling infrastructure to process all waste mercury-containing lamps in Australia. The focus of the scheme is on the commercial and public lighting sectors as they account for the vast majority of all lighting waste. From July 2013, the scheme will transition to an industry-led and funded voluntary scheme.

2.1.2 FluoroCycle scheme

The scheme is currently administered by Lighting Council Australia with Australian Government funding through a National Environment Protection Council (NEPC) Service Corporation funding agreement. Businesses, government agencies and other organisations can join the scheme and receive recognition for their commitment to recycling mercury. The signatories to the scheme are broken down into two main groups, with further subcategories[1]:

1. **Commercial Users** – A Commercial User is a business or organisation that has committed to recycle all the waste mercury-containing lamps generated by one or more specified sites over which it exercises operational control. In this context, 'site' refers to a building, factory, industrial facility, institution, retail space or location.
2. **Facilitators** – Facilitators have a range of roles in promoting the recycling of waste mercury-containing lamps and the scheme itself. A facilitator belongs to one or more of the following categories
    a. *Collectors*
    b. *Contractors*
    c. *Government*
    d. *Media partners*
    e. *Peak bodies*
    f. *Recycling companies*
    g. *Suppliers*

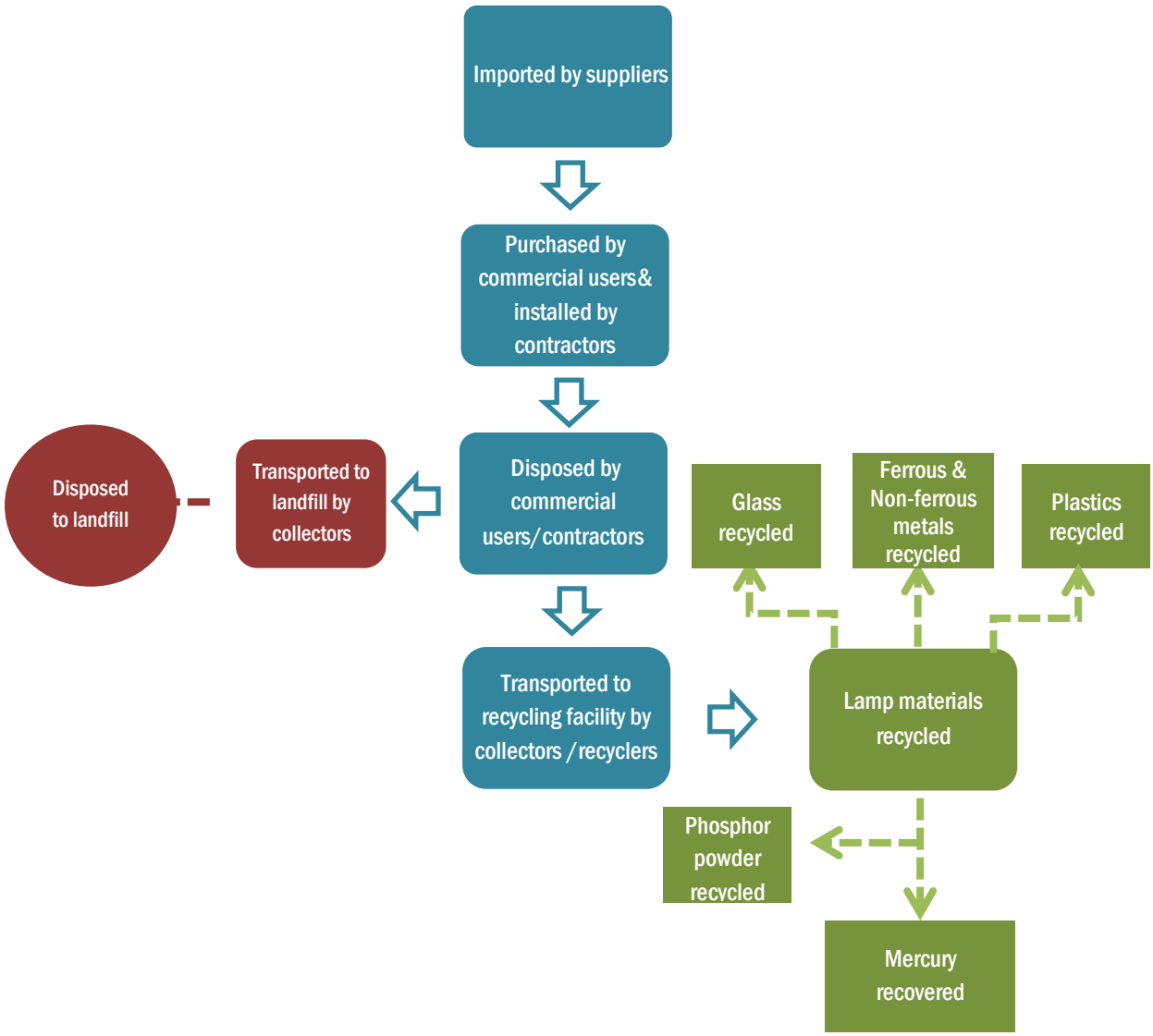
[1] http://www.fluorocycle.org.au/commitments-classifications.php

h. *Trainers*

i. *Advocates*

Organisations may be both Commercial Users and Facilitators.

2.1.3 Mercury-containing lamp commercial supply chain



2.1.4 Data gaps

In order to track performance and calculate recycling rates for mercury-containing lamps, collectors and recyclers are required to provide data on volumes collected and recycled. This has not occurred to the extent required and a lack of robust data collection has meant that the scheme has not been able to validate its outcomes to date.

The Lighting Industry Survey asks members of the Lighting Council to provide quantitative data on the number of mercury-containing lamps imported into Australia by calendar year. This survey provides information on the number of lamps imported by suppliers broken down by lamp type (see Appendix 1). As noted, there is currently limited data available on the number of lamps collected and recycled and the amount of mercury recovered as there is no ongoing data collection process for this.

2.2 Project objectives

Net Balance was engaged to undertake a data collection and analysis project to determine the impact of the FluoroCycle scheme. This project fills an important gap in the knowledge of the market and current rates for recycling of mercury-containing lamps and recovery of mercury.

As outlined in the Request for Quote from the NEPC Service Corporation and confirmed through the course of the engagement, the broad objectives of this project were:

1. To establish an overall recycling rate of mercury-containing lamps and the portion of the recycling rate attributable to FluoroCycle by determining the amount of waste generated and recycled, and mercury recovered, each year.
2. To provide data for the calendar year 2009 to enable a baseline recycling rate to be determined prior to the commencement of FluoroCycle in 2010.
3. To provide data for calendar years 2010 to 2012 to determine the impact of the scheme since its implementation.
4. To provide recommendations to improve the Lighting Industry Survey, including a review of the data collected, to inform future surveys by Lighting Council.

3 Methodology

3.1 Data collection

A targeted data collection process was applied to estimate the mercury recycling rate in the years of 2009 to 2012, attributed to signatories and non-signatories. Box 1 (below) summarises the key level data points required to calculate the recycling rate, and provides an outline of the data sources and structure applied in this study.

Box 1 - Components of the mercury recycling rate each year

$$\text{MERCURY RECYCLING RATE\%} = \frac{\text{MERCURY RECOVERED (1)}}{\text{MERCURY IN ALL DISPOSED LAMPS (2)}}$$

(1) **Mercury recovered:** weight of mercury recovered from lamps; estimated from the mercury content of lamps received by recyclers minus losses from the recovery process.

(2) **Mercury in all disposed lamps:** weight of mercury in all lamps disposed; estimated from the mercury content of lamps modelled for disposal

Further detail on the estimation calculation and assumptions for (1) and (2) are provided in sections 3.3.2 and 3.3.3

The proportion of this overall mercury recycling rate that can be attributed to FluoroCycle signatories is calculated by adding together the mercury recovered (1) from Commercial Users and Collectors, as identified in recycler data.

3.1.1 Data sources and structure

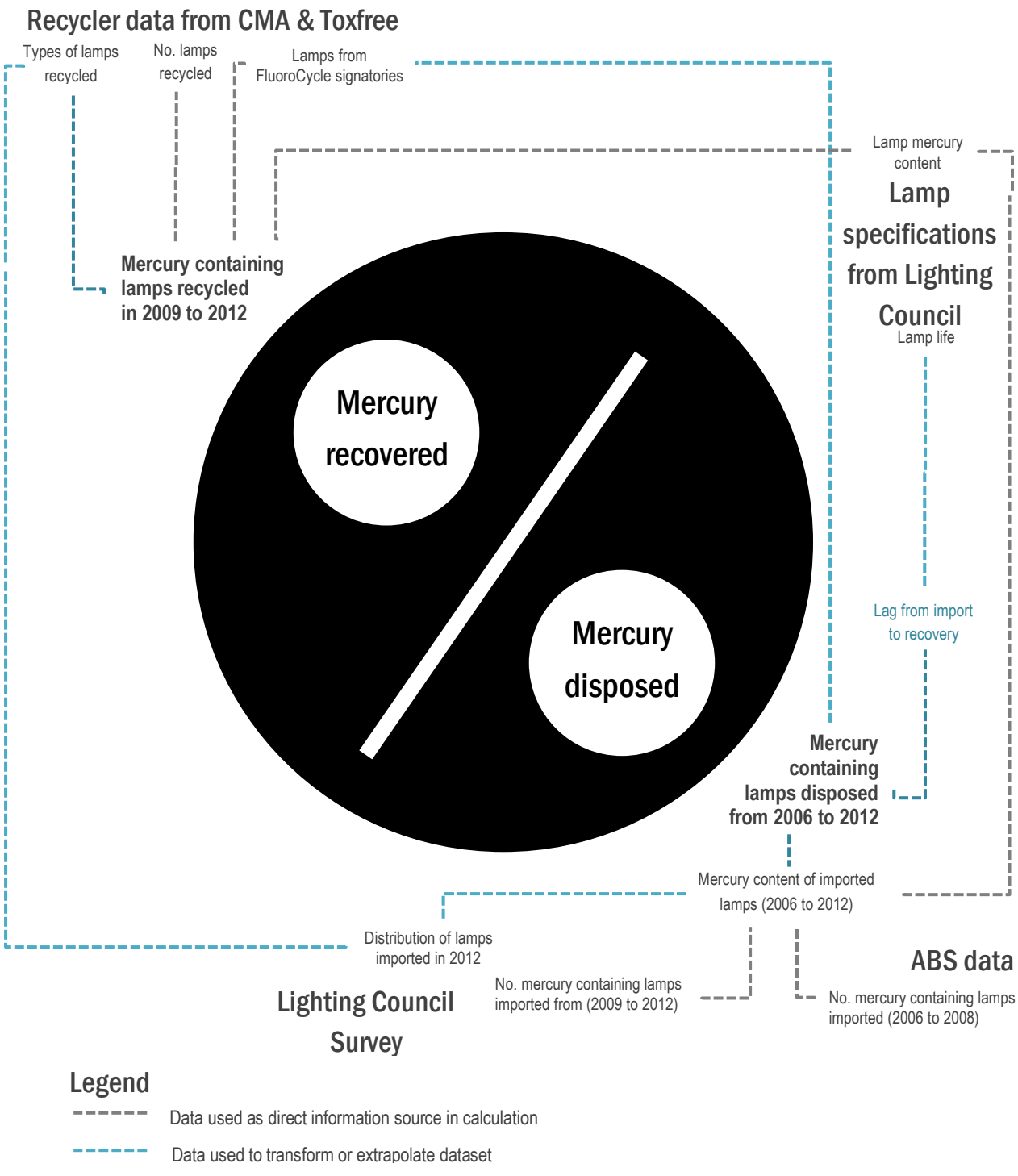
Data collection and engagement focused on two key stakeholder groups:

a. **Mercury lamp recyclers** (**CMA and Toxfree)**: main source of information used to calculate mercury recovered, including:
   - Volumes (no. and weight) of lamps recycled from 2009 to 2012

b. **Lighting Council of Australia:** main source of information used to calculate mercury in disposed lamps, including:
   - number of lamps imported through 2009-12 (Lighting Council survey), together with ABS datasets for prior years (2006-2008)
   - breakdown of imported lamps by type in 2012 (applied as the representative breakdown or distribution of lamp types)
   - lamp specifications including estimated lamp life and mercury content.

Figure 1 below maps how primary data sources are used with key assumptions to calculate mercury recycling rates for 2009 through to 2012.

Figure 1 Mapping of data requirements



3.2 Assessment of data

3.2.1 Data coverage and quality

All data used in the estimation of mercury recycling rate is discussed in Table 1 below.

Table 1 Summary of Key Data Points

Information	Description of data point	Assessment of data quality
Lamp population data		
Data coverage	Datasets from Lighting Council (survey from 2008 to 2012) and ABS (2006 to 2012) were available. These provided a sufficient history to model the flow of lamps through import to disposal in 2009 to 2012.	Comparison of datasets and observation of trends suggested that each source was consistent, robust and suitable developing a composite time series for modelling.
Depth of available data	2006 to 2011 import data was aggregated to lamp class (i.e. T5, T8, CFL etc.). Detailed Lighting Council survey data for 2012 provided further breakdown by lamp type (i.e. T5 14W, T5 28w etc.).	Detailed breakdown data provided good evidence and basis for mapping the market share of each lamp type.
Recycler data		
Data coverage	All mercury-containing lamp recycling is done by either CMA or Toxfree, implying that a full dataset on lamp recovery was available from these stakeholders.	Strong coverage, however subject to availability of disaggregated datasets and recovery of other mercury containing materials.
Primary data availability	CMA (with mercury recovery facility) has paper based system for recording batches for distilling prior to weighing the mass of mercury recovered after processing.	It would be too labour intensive to go through four years of paper records, noting that these records may not provide all the information required to directly relate them to lamp recycling.
Depth of available data	1. CMA provided a breakdown of lamps recycled by aggregated type, year and attributed to signatories and non-signatories. Minor data processing required to further disaggregate lamp types and calculate mercury recovery. 2. Toxfree provided aggregated data over 5 years by customer, however with unidentified quantities and lamp types. Large data transformation and high level assumptions required.	Estimation of CMA component is robust. The level of aggregation of Toxfree implies that extrapolation in line with CMA data structure is most appropriate This implies that the CMA data is used as representative sample to which high level Toxfree data can be mapped.
Other		
Lamp specification	Lighting Council provided indicative lamp life and estimated mercury content by lamp type.	Highly reputable and detailed data (i.e. by lamp type)) provides a reliable and consistent data source.

3.2.2 Data quality

In order to ensure that data collected for the scheme is robust, existing data has been assessed for quality.

As used in the National Waste Data System Requirements Study[2], we have used the following principles; transparency comparability, accuracy, completeness, clarity and timeliness; to assess data collected as part of this project. The principles used are outlined and defined as follows:

- **Transparency**: Data is documented and verifiable
- **Comparability**: Data is produced by same methodologies and can be compared across jurisdictions, and between reporting periods
- **Accuracy**: Uncertainty in data values is minimized, and where estimates were made, an appropriate method is used and clearly communicated
- **Completeness**: All source data within signatory boundaries is identified and accounted for
- **Clarity:** Information is understandable and accessible
- **Timeliness**: Reporting is occurring on a regular schedule and within a suitable timeframe

Table 2 Quality Assessment of Input Data

Input Data Source	Transparency	Comparability	Accuracy	Completeness	Clarity	Timeliness
Lamp Population Data	Robust	Robust	Robust	Satisfactory	Robust	N/A
Recycler Data	Questionable	Questionable	Questionable	Questionable	Questionable	
Lamp Specification	Robust	Robust	Satisfactory	Robust	Robust	

It is clear from Table 2 that data from recyclers is where most work needs to be undertaken into the future to get a more accurate estimation of the recycling rate attributable to FluoroCycle, noting that there are still a number of areas where both Commercial Users and Collector signatories can assist the recyclers especially in the description (source, type) of lamps sent for recycling.

[2] http://www.environment.gov.au/settlements/waste/publications/pubs/nwds.pdf

3.2.3 *Data gaps and key issues*

The following data gaps and issues were identified during data collection and calculation of estimated mercury recycling rate:

- Recording of weight of recovered mercury (i.e. end of process) by recyclers was unavailable and required estimation based on the number and type of lamp split. This parameter is difficult to measure as the mercury recovery equipment also processes mercury from other sources, not just lamps.
- Data on lamps recycled by signatories is very difficult to obtain from recyclers as Commercial User signatories may get their lamps collected by non-signatory collectors who then deliver the lamps to recyclers. Lamps delivered to recyclers by signatory collectors may come from both signatory and non-signatory organisations.
- Lamps are sent to recyclers in a number of forms which include drums of pre-crushed waste and recycler-provided boxes and containers. Some deliveries are mixed lamps from both commercial and residential sources. In some cases tubes are returned with the cardboard lamp packaging. This means that allocating lamp type and weight can be very difficult for the recyclers.
- Detailed identification of lamp type over time: the conversion of number of lamps to mercury is most effective where datasets for import and recycling are disaggregated to the most granular level of lamp type (e.g. no. of T5 14w lamps).

3.3 Assumptions and limitations

3.3.1 *Global assumptions*

- **Baseline year**: the calendar year 2009 is adopted as baseline year. This year was determined by data availability (i.e. CMA recycling data was only available from this year forward). FluoroCycle began in July 2010.
- **Lamp mercury content**: to ensure the most robust and consistent estimation of mercury mass both recovered (1) and disposed (2), the average mercury content for each lamp type is applied to imported and recycled lamp data sets (see Appendix 1 for further detail).
- **Distribution of lamp types**: Varying levels of aggregation were detected in datasets to describe the distribution of lamp types[3]. Where required, all the distribution of lamps by type has been made by applying the most current and detailed available breakdown (provided by Lighting Council for 2012).

[3] For example, Lighting Council survey data of imported lamps

The application and source of these and other key assumptions are tabulated below.

Table 3 Lamp number to mercury recovery assumptions

Item		Use	Assumption	Source
a.	**Mercury content by lamp type**	Used to convert mass of lamps to mass of mercury	Various by lamp: see Appendix A	Lighting Council estimate
b.	**Mass by lamp type**	Used to convert no. lamps to mass	Various by lamp: see Appendix A	Lighting Council estimate
c.	**Average life by lamp**	Used to estimate the lag between a lamp being imported and disposed.	Various life by lamp: see Appendix A - All imported lamps are assumed to be sold and installed on an average of 6 months later. - Disposal occurs at the end of modelled lamp life.	Lighting Council estimate for lamp life and Net Balance modelling of lag from import to disposal
d.	**Time from import to installation**			
e.	**Exclusion of CFL integrated ballast lamps**	Adjustment to lamp and mercury calculation to exclude CFL integrated ballast lamps	Lighting Council members advised that 98 per cent of lamps would be for domestic use. To best model the recycling rate for commercial and public lighting sectors, CFL integrated ballast lamps have been excluded from the calculation.	Various
f.	**Recycling loss rate**	Used to model losses in recovery	100% of each lamps mercury content is recovered in the recovery process	CMA

3.3.2 Estimation of mercury content recovered (1)

An estimation of mercury recovered was required to overcome the absence of primary data (i.e. direct weighing of mercury recovered). The structure of estimation methodology adopted responded to the level of data provided by both recyclers.

- **CMA**: provided volume of lamps recycled (by type) was converted to recoverable mercury using the lamp specifications (outlined above). CMA provided data by FluoroCycle Signatory/non-signatory to allow calculations of attribution to FluoroCycle. CMA did a sense check on data provided against their estimate of the mercury recovery weights and believe this to be ± 30 per cent.
- **Toxfree**: provided aggregated data that was transformed (to estimate total no. of lamps) and mapped using the distribution of lamps and lamp specifications (outlined above). Toxfree provided data by client that was mapped to FluoroCycle signatory/non-signatory.

The above data transformations were used to model the number of relevant mercury containing lamps being recycled, and their mercury content (by applying the methodology outlined in Table 3). The mercury in lamps from signatories (both commercial users and collectors), was then attributed

using the mapping provided by each recycler. This attribution enabled the calculation of overall recycling rates for 2009 – 2012. The data provided by both recyclers did not account for the fact that commercial users and collectors became signatories at varying points between 2010 and 2012. This insufficient granularity precluded an accurate breakdown of the overall recycling rates by signatory and non-signatory for 2010 and 2011. As such, recycling rates attributed to FluoroCycle signatories are only presented for 2012.

3.3.3 Estimation of mercury disposed (2)

Estimation of mercury disposed in each year was based on modelling the flow of lamps through their lifecycle of import > installation > use > collection and mercury recovery. For each imported lamp, a modelled lamp life[4] was combined with an estimated time from import to installation to determine when in the future that lamp would be disposed.

Modelling this historical inventory provided a robust measure of the number of lamps by type disposed in 2009 to 2012[5].Mercury content specifications for each lamp type were then applied to estimate the theoretical mass of mercury disposed.

3.4 Market profile

3.4.1 Lighting Council Lighting Industry Survey

Lighting Council Australia has a membership of 92 organisations and its Lighting Industry Survey is administered to all members who import lamps. These lamp importers represent the vast majority of the mercury-containing lamp market in Australia (Lighting Council, pers comms).

A more detailed breakdown of their coverage, based on discussions with representatives from Lighting Council Australia, OSRAM and Legrand is provided below for the various lamp types.

- All street lighting (mostly mercury vapour lamps) is covered by the survey as all the 11 public lighting utilities in Australia are covered by the 13 suppliers surveyed.
- Approximately 85-90% of CFLs would be represented by the 13 suppliers.
- Approximately 95% of all other lamp types, i.e. Fluorescent tubes, HID metal halide, HID sodium, mercury-containing UV.

This information formed part of the assumptions and factoring used to calculate the recycling rates.

[4] Based on specified lamp life and reasonable usage pattern

[5] To accommodate instances of lamps disposed of between 2009 and 2012 that were installed prior to 2006, the model of lamp stock extrapolated prior to 2006 using a seven year moving average. A moving average was considered suitable as the seven years of available data showed relatively robust volumes and no obvious trend.

3.4.2 *Mercury-containing lamps import and sales volumes*

- Lighting Council member survey represents lamps imported and it is not clear how many lamps imported are replacement lamps for existing fittings versus 'new' lamps for new fittings. Discussions with Lighting Council and key importers indicated a 2% annual growth rate in lamp fittings[6].
- State government schemes may also be having an impact on replacement of old lighting but the net impact of these schemes was not able to be determined. The schemes include the QLD Solar and Energy Efficiency program between 2008-2011 which, among other measures, replaced mercury-containing lamps in 1,200 schools around the state; the Victorian Energy Efficiency Target (VEET), which only added business customers at the end of 2011; and the NSW Energy Savings Scheme (ESS), which commenced in 2009 but has only more recently accelerated in terms of recycled lighting (Department of Sustainability, Environment, Water, Population and Communities, pers. comm).

[6] This assumption has been applied in cross checking the calculation of mercury disposed by year (in section 3.3.3). Moreover, the comparative modelling of 98% of imported lamps in year X as a proxy for disposal in year X was conducted. Results showed that the overall recycling rate determined using the methodology outlined in section 3 and reported in section 4 remained robust over the 2010-12 period.

4 Findings – FluoroCycle scheme recycling rates

4.1 Summary of findings

Estimated recycling rates and supporting mercury recovery data are visualised below and discussed in the following sections.

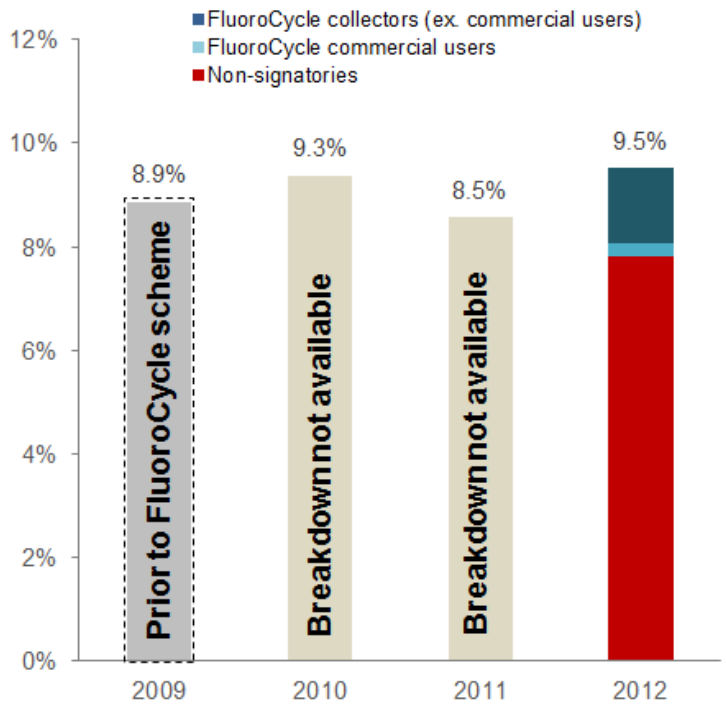


Figure 2 Estimated mercury recycling rate

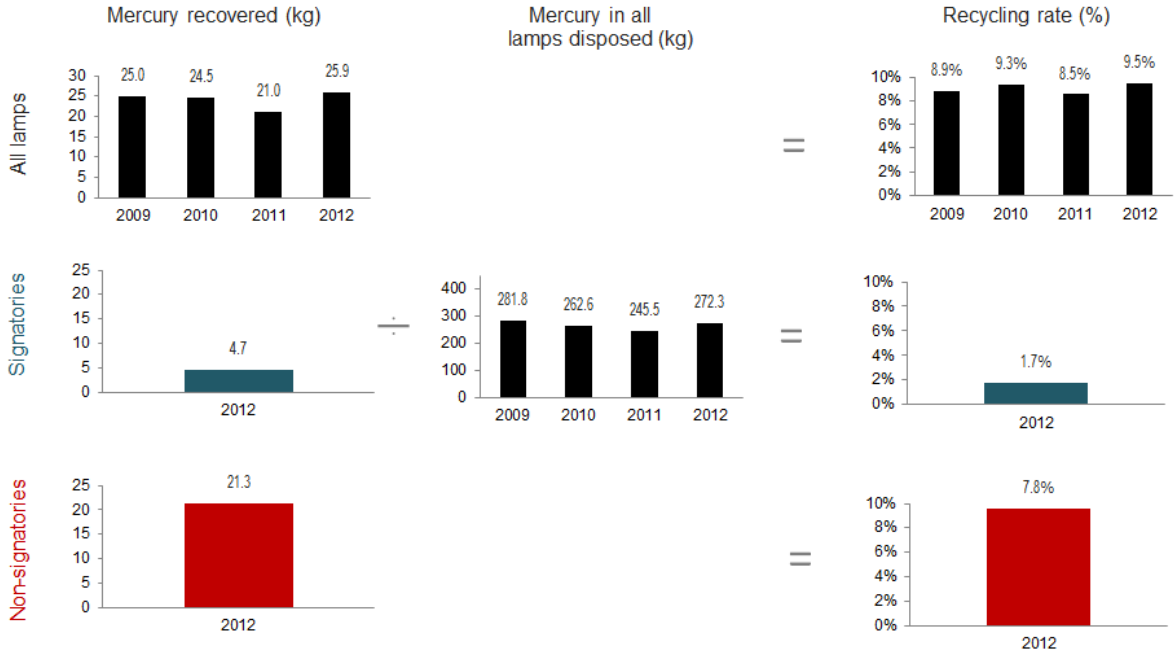


Figure 3 Estimated mercury disposal and recovery

4.2 Discussion of baseline and current recycling rates

The baseline lamp mercury recycling rate calculated for 2009 is 8.9%. This represents the recovery of 25kg of mercury from mercury containing lamps disposed in 2009.

The calculation of recycling rates for subsequent years shows that recycling rates have remained fairly stable with a dip (to 8.5%) in 2011 and immediate increase (to 9.5%) in 2012. This rebound is reflected in the volume of absolute mercury recovered (with a low of 21kg in 2011 retuning to a high of 26kg in 2012), suggesting that no significant trend in mercury recovery is observable over the 4 year period analysed.

Based on discussions with both recyclers they thought that the numbers of lamps they received for recycling had gradually increased over the period. This perceived trend is not reflected in the data. Any trend may have been offset by short term spikes in lamp recycling due mostly to the government related incentives to replace older types of mercury-containing lamps with more efficient lighting.

Calculations of total waste and mercury to landfill over the 2009 – 2012 period were also made for lamps targeted by FluoroCycle. This analysis showed that an average of 241kg per year of mercury was landfilled through these mercury containing lamps, with the nominal weight of these lamps accounting for approximately 3,790 tonnes of waste to landfill each year. The analysis also showed

that an average of 625 tonnes of lamp waste was diverted annually from landfill for recycling between 2009 – 2012.

4.3 FluoroCycle recycling rates

Given that an accurate breakdown of data by FluoroCycle signatories and non-signatories was not possible for 2010 and 2011, no trend could be observed or analysed for recycling rates attributable to FluoroCycle.

In 2012, the recycling rate of all relevant mercury containing lamps attributable to FluoroCycle signatories was 1.7%. Mercury recovered from identified signatories therefore represents approximately 18% of all recovered mercury (i.e. the proportion of recycling of signatories to the total mercury recycling rate).

Further analysis of recycler data showed that the majority of lamps sent to recycling from identified signatories came through collectors that were signatories. It was not possible, however, to clearly identify lamps recycled when a third party collector is used by a signatory or non-signatory who themselves may or may not be FluoroCycle signatories.

4.4 Discussion of attribution of recycling to FluoroCycle

Analysis of recycler data identified 35 commercial user signatories which had sent lamps to recycling over the 2009-12 period. This represents 60% of all current signatories (i.e. 58 identified). These signatories are direct customers of the recyclers and do not include commercial users that use third-party collectors. As noted, most of the lamps received by recyclers were brought by signatory Collectors on behalf of both signatory and non-signatory Commercial Users. The total lamp volumes, mass and subsequently mercury recovered, for both signatory Commercial Users and Collectors were attributed to FluoroCycle. There were approximately 40% of Commercial Users who were signatories but not identified in the data for this analysis and so an assumption was made that they were using non-signatory Collectors. As such, their recycling volumes would be captured under the 'Non-signatory' data. This may not be the case, however, as they may be using signatory Collectors and have not been correctly identified. It was not possible to confirm this either way during the course of this project but understanding the fate of the mercury-containing lamps sent for recycling by the 40% of signatories not identified in this analysis would greatly refine the breakdown of signatory vs. non-signatory recycling rates.

4.5 Recycling of non-mercury components of lighting

Although the FluoroCycle scheme is primarily focused on limiting the amount of mercury going to landfill, there are several other components in lighting that can be and are recovered during the recycling process, including glass, plastics, ferrous and non-ferrous metals (e.g. aluminium) and phosphor powder.

4.5.1 Glass and plastics

Glass and plastic materials comprise close to 90% of the total lamp weight. During the engagement with the recyclers, it was determined that the glass and plastics can be recycled and transported to a third party. There is no payment for this service and the recycled materials are provided at no charge to the third party. The recyclers indicated that they would prefer this to become a revenue stream but currently there is no imperative for third parties to pay for this (i.e. no designated market force).

4.5.2 Ferrous and non-ferrous metals

All metals that are extracted and recovered during the recycling process are either consolidated on-site as part of the broader business or on-sold to other recyclers. Processing of metals is a standard aspect of the recyclers' operations and dealing with the metal components of lighting does not pose an issue.

4.5.3 Phosphor powder

The final stage of the mercury-containing lamp recycling process involves processing the phosphor powder content. Batch distillers are used to distil the mercury in vapour form but powder containing rare earth elements and other materials remains as an output of the process. Historically this has posed an issue for the recyclers as there are insufficient quantities produced to generate any regular revenue and the powder has been stored over time.

The recyclers are currently working with the lighting industry to export this material for re-use in fluorescent lighting. Currently the total mass of this component is restricting the value of this resource for reuse. Growth in the tonnage of lamps coming to recyclers will assist in the future development of this market for phosphor powder.

5 Conclusions and Recommendations

Based on data provided for this project by the Lighting Council and the two recycling organisations the estimated recycling rate attributable to FluoroCycle was 1.7% for the 2012 calendar year, with no data available to accurately determine the rates for the first two years that the scheme was operating. There is a high amount of confidence in the amount of imported lamps each year based on the Lighting Council survey and discussions with key importers. Unfortunately the data on recycling does have limitations mainly due to the way that both the tubes are delivered (multiple forms that may include old packaging) to the recyclers and how the recycling of mercury is recorded internally by these recyclers (mainly paper based).

Recommendations to improve the Lighting Industry Survey, including a review of the data collected, to inform future surveys by Lighting Council include:

- Lighting Council work with the recyclers on the Data Collection Templates (see Appendix 3), and how these can be incorporated into their business recording system. This will provide more defined information to support improvements in future calculations of scheme recycling rates. This also will require clearer information to be provided by signatories when lamps are delivered to recyclers.
- Lighting Council work with recyclers to establish pathways for measuring the actual mass of mercury recovered from mercury-containing lamps, as opposed to other mercury-containing items.
- Lighting Council was able to determine a market share breakdown of different lamp types by wattages within categories (i.e. CFLs, tubes, mercury vapour) by speaking with one supplier for CY 2012. We recommend that this breakdown be refined and updated by engaging with several suppliers.
- A pilot could be conducted to test the accuracy of the reported mercury content in particular lamps.

6 Limitations

Net Balance Management Group Pty Ltd (Net Balance) has prepared this report in accordance with the usual care and thoroughness of the consulting profession. This report has been prepared for use by the National Environment Protection Council, the Department of Sustainability, Environment, Water, Population and Communities, and only those third parties who have been authorised in writing by Net Balance.

The Report is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the project brief. The methodology adopted and sources of information used by Net Balance are outlined in this report.

Please note that all results have been reported as recorded. Any percentages that do not add up to exactly one hundred percent are the result of rounding errors.

This report was prepared between June and August 2013 and is based on the conditions encountered and information reviewed at the time of preparation. Net Balance disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Appendix 1 – Lamp specification and modelling assumptions

Lamp	Average life span hrs (modelled usage pattern)	Lamp % of lamp type market (2012)	Estimated mercury content (mg)	Average daily usage (hrs per day)	Modelled average lamp life (years)	Estimated import to installation & disposal to processing time (years)	Modelled lag from import to recovery (whole no. years)
T5 14W	24000	15%	5	18.0	3.7	0.5	4.0
T5 28W	24000	80%	5	18.0	3.7	0.5	4.0
T5 35W	24000	5%	5	18.0	3.7	0.5	4.0
T8 18W	16000	15%	5	18.0	2.4	0.5	2.0
T8 36W	16000	75%	5	18.0	2.4	0.5	2.0
T8 58W	16000	10%	5	18.0	2.4	0.5	2.0
Fluorescent CFL (integrated ballast) 59W	6000	100%	N/A	6.0	2.7	0.5	3.0
Fluorescent CFL (non integrated) 60W	12000	100%	5	6.0	5.5	0.5	5.0
Fluorescent (others) 61W	12000	100%	5	6.0	5.5	0.5	5.0
Mercury Vapour 50W	16000	5%	12	12.0	3.7	0.5	4.0
Mercury Vapour 80W	16000	20%	15	12.0	3.7	0.5	4.0
Mercury Vapour 125W	16000	5%	22	12.0	3.7	0.5	4.0
Mercury Vapour 250W	16000	15%	40	12.0	3.7	0.5	4.0
Mercury Vapour 400W	16000	50%	70	12.0	3.7	0.5	4.0
Mercury Vapour 1000W	16000	5%	80	12.0	3.7	0.5	4.0
Low Wattage elliptical Metal halide 70W	12000	2%	12	15.0	2.2	0.5	2.0
Low Wattage elliptical Metal halide 150W	12000	2%	13	15.0	2.2	0.5	2.0
Low Wattage Double ended Metal Halide 70W	12000	25%	12	15.0	2.2	0.5	2.0
Low Wattage Double ended Metal Halide 150W	12000	10%	13	15.0	2.2	0.5	2.0
Elliptical Metal Halide 250W	12000	10%	35	15.0	2.2	0.5	2.0
Elliptical Metal Halide 400W	12000	35%	65	15.0	2.2	0.5	2.0
Elliptical Metal Halide 1000W	12000	5%	150	15.0	2.2	0.5	2.0
Tubular Metal Halide 250W	12000	2%	35	15.0	2.2	0.5	2.0
Tubular Metal Halide 400W	12000	2%	40	15.0	2.2	0.5	2.0
Tubular Metal Halide 1000W	12000	1%	75	15.0	2.2	0.5	2.0
Tubular Metal Halide 2000W	12000	1%	160	15.0	2.2	0.5	2.0
Double Ended High wattage Metal Halide 1500W	12000	2%	160	15.0	2.2	0.5	2.0
Double Ended High wattage Metal Halide 2000W	12000	3%	180	15.0	2.2	0.5	2.0
High Pressure Sodium 70W	20000	3%	12	15.0	3.7	0.5	4.0
High Pressure Sodium 150W	20000	8%	20	16.0	3.4	0.5	3.0
High Pressure Sodium 250W	20000	11%	22	17.0	3.2	0.5	3.0
High Pressure Sodium 400W	20000	78%	40	18.0	3.0	0.5	3.0
HID - ARC	20000	100%	70	12.0	4.6	0.5	5.0
UV	20000	100%	N/A	12.0	4.6	0.5	5.0
OTHERS	20000	100%	N/A	12.0	4.6	0.5	5.0

Information provided by Lighting Council of Australia

Modelling assumptions from Net Balance (see main body)

Appendix 2 – Stakeholders consulted

The following table lists stakeholders that were consulted through the course of this project.

Organisation	Purpose
Lighting Council Australia	▪ Provision and explanation of the member survey results ▪ Peak body perspective
Lighting Council Australia	▪ Provision of FluoroCycle scheme information ▪ Peak body perspective
CMA Eco Cycle	▪ Hosting on-site visit to CMA Eco Cycle facility ▪ Provision of data on lamps recycled and mercury recovered ▪ Recyclers' perspective
Toxfree Australia	▪ Hosting on-site visit to Toxfree facility ▪ Provision of data on lamps recycled ▪ Recyclers' perspective
Legrand	▪ Lighting industry perspective
OSRAM	▪ Lighting industry perspective
SITA Australia	▪ Provision of data on lamps collected ▪ Collectors' perspective
KP Lighting	▪ Contractors' perspective

Appendix 3 – Data collection template

The template below was used to collect data from recyclers for this report.

SIGNATORIES (Commercial users)										
	CY 2008		CY 2009		CY 2010		CY 2011		CY 2012	
LAMP TYPE	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)
Fluoro Tubes (total)										
Fluorescent T8										
Fluorescent T5										
Fluoro Globes (total)										
Fluorescent CFL										
Fluorescent (others)										
Other Globes (total)										
HID Mercury Vapour										
HID Metal Halide										
HID High Pressure Sodium										
HID - ARC										
UV										
Others (total) - Please specify below										
TOTAL										

	CY 2008	CY 2009	CY 2010	CY 2011	CY 2012
MERCURY RECOVERED (kg)					

SIGNATORIES (Facilitators)										
	CY 2008		CY 2009		CY 2010		CY 2011		CY 2012	
LAMP TYPE	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)
Fluoro Tubes (total)										
Fluorescent T8										
Fluorescent T5										
Fluoro Globes (total)										
Fluorescent CFL										
Fluorescent (others)										
Other Globes (total)										
HID Mercury Vapour										
HID Metal Halide										
HID High Pressure Sodium										
HID - ARC										
UV										
Others (total) - Please specify below										
TOTAL										

	CY 2008	CY 2009	CY 2010	CY 2011	CY 2012
MERCURY RECOVERED (kg)					

NON - SIGNATORIES										
	CY 2008		CY 2009		CY 2010		CY 2011		CY 2012	
LAMP TYPE	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)	Number	Weight (kg)
Fluoro Tubes (total)										
Fluorescent T8										
Fluorescent T5										
Fluoro Globes (total)										
Fluorescent CFL										
Fluorescent (others)										
Other Globes (total)										
HID Mercury Vapour										
HID Metal Halide										
HID High Pressure Sodium										
HID - ARC										
UV										
Others (total) - Please specify below										
Incadescent GLS Globes (no mercury)										
Halogen/Dichroic Downlights (no mercury)										
TOTAL										

	CY 2008	CY 2009	CY 2010	CY 2011	CY 2012
MERCURY RECOVERED (kg)					

Appendix 4 – Calculations and raw data

All the raw data, assumptions and calculations have been provided in a separate Excel spread sheet. Key figures are reproduced below.

LAMP TYPE	WEIGHT OF LAMPS TO LANDFILL (t)				WEIGHT OF LAMPS TO LANDFILL (t)				WEIGHT OF LAMPS RECYCLED (t)			
	2009	2010	2011	2012	2009	2010	2011	2012	2009	2010	2011	2012
T5 14W	28	19	28	24	24	14	24	17	4	5	4	6
T5 28W	326.0	218.2	323.0	272.0	280.5	161.8	275.7	198.9	45.5	56.4	47.3	73.1
T5 35W	25.1	16.8	24.8	20.9	21.6	12.4	21.2	15.3	3.5	4.3	3.6	5.6
T8 18W	283.5	238.7	222.1	278.1	251.6	199.9	186.3	235.5	31.9	38.9	35.8	42.6
T8 36W	2,834.5	2,387.4	2,221.0	2,780.9	2,515.6	1,998.7	1,862.8	2,354.7	318.9	388.6	358.2	426.2
T8 58W	453.5	382.0	355.4	444.9	402.5	319.8	298.0	376.8	51.0	62.2	57.3	68.2
Fluorescent CFL (non integrated ballast)	237.3	232.1	186.9	276.6	227.9	223.9	180.6	271.2	9.4	8.1	6.3	5.5
Fluorescent (others)	42.0	41.8	34.3	50.7	40.2	40.4	33.3	49.6	1.8	1.4	1.0	1.1
Mercury Vapour 50W	1.3	1.4	1.4	1.4	1.2	1.3	1.3	1.3	0.1	0.1	0.0	0.1
Mercury Vapour 80W	6.2	6.7	6.6	6.5	5.8	6.3	6.4	6.1	0.5	0.3	0.2	0.4
Mercury Vapour 125W	2.1	2.2	2.2	2.1	1.9	2.1	2.1	2.0	0.2	0.1	0.1	0.1
Mercury Vapour 250W	11.9	12.7	12.6	12.4	11.0	12.0	12.1	11.6	0.9	0.7	0.5	0.8
Mercury Vapour 400W	57.0	60.7	60.2	59.5	52.6	57.6	58.1	55.6	4.5	3.1	2.2	3.9
Mercury Vapour 1000W	14.9	15.8	15.7	15.5	13.7	15.0	15.2	14.5	1.2	0.8	0.6	1.0
Low Wattage elliptical Metal halide 70W	2.3	2.3	2.1	2.1	2.2	2.2	2.0	2.0	0.2	0.1	0.1	0.1
Low Wattage elliptical Metal halide 150W	4.2	4.1	3.7	3.8	3.9	3.9	3.6	3.7	0.3	0.2	0.2	0.1
Low Wattage Double ended Metal Halide 70W	9.7	9.6	8.6	8.9	9.0	9.1	8.2	8.5	0.7	0.5	0.4	0.3
Low Wattage Double ended Metal Halide 150W	5.6	5.5	4.9	5.1	5.2	5.2	4.7	4.9	0.4	0.3	0.2	0.2

Elliptical Metal Halide 250W	28.7	28.4	25.5	26.2	26.6	26.9	24.3	25.2	2.0	1.4	1.1	1.0
Elliptical Metal Halide 400W	184.6	182.4	164.0	168.5	171.4	173.2	156.7	162.2	13.2	9.3	7.3	6.4
Elliptical Metal Halide 1000W	35.6	35.2	31.6	32.5	33.1	33.4	30.2	31.3	2.5	1.8	1.4	1.2
Tubular Metal Halide 250W	7.0	7.0	6.2	6.4	6.5	6.6	6.0	6.2	0.5	0.4	0.3	0.2
Tubular Metal Halide 400W	7.0	7.0	6.2	6.4	6.5	6.6	6.0	6.2	0.5	0.4	0.3	0.2
Tubular Metal Halide 1000W	11.1	11.0	9.9	10.1	10.3	10.4	9.4	9.8	0.8	0.6	0.4	0.4
Tubular Metal Halide 2000W	11.1	11.0	9.9	10.1	10.3	10.4	9.4	9.8	0.8	0.6	0.4	0.4
Double Ended High wattage Metal Halide 1500W	22.2	21.9	19.7	20.3	20.6	20.8	18.9	19.5	1.6	1.1	0.9	0.8
Double Ended High wattage Metal Halide 2000W	25.0	24.7	22.2	22.8	23.2	23.4	21.2	21.9	1.8	1.3	1.0	0.9
High Pressure Sodium 70W	1.2	1.2	1.2	1.1	1.1	1.1	1.1	1.1	0.1	0.1	0.1	0.1
High Pressure Sodium 150W	7.4	7.3	7.3	7.6	6.8	6.8	6.9	7.1	0.6	0.5	0.4	0.5
High Pressure Sodium 250W	10.2	10.1	10.0	10.4	9.3	9.4	9.5	9.7	0.8	0.7	0.5	0.7
High Pressure Sodium 400W	82.5	81.8	80.9	84.5	75.7	76.2	76.7	78.7	6.8	5.6	4.2	5.8
TOTAL	**4,847**	**4,132**	**3,943**	**4,726**	**4,272**	**3,491**	**3,372**	**4,018**	**575**	**641**	**572**	**708**

LAMP TYPE	MERCURY IN LAMPS DISPOSED (kg)				MERCURY IN LAMPS TO LANDFILL (kg)				MERCURY IN LAMPS RECYCLED (kg)			
	2009	2010	2011	2012	2009	2010	2011	2012	2009	2010	2011	2012
T5 14W	2.4	1.6	2.3	2.0	2.0	1.2	2.0	1.4	0.33	0.41	0.34	0.53
T5 28W	12.5	8.4	12.4	10.5	10.8	6.2	10.6	7.7	1.75	2.18	1.82	2.81
T5 35W	0.8	0.5	0.8	0.7	0.7	0.4	0.7	0.5	0.11	0.14	0.11	0.18
T8 18W	14.2	11.9	11.1	13.9	12.6	10.0	9.3	11.8	1.60	1.95	1.79	2.13
T8 36W	70.9	59.7	55.5	69.5	62.9	50.0	46.6	58.9	7.98	9.74	8.97	10.65
T8 58W	9.4	8.0	7.4	9.3	8.4	6.7	6.2	7.8	1.06	1.30	1.20	1.42
Fluorescent CFL (non integrated ballast)	17.0	16.6	13.4	19.8	16.3	16.0	12.9	19.4	0.67	0.57	0.44	0.39
Fluorescent (others)	3.5	3.5	2.9	4.2	3.4	3.4	2.8	4.1	0.15	0.11	0.08	0.10

Mercury Vapour 50W	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.02	0.02	0.01	0.02
Mercury Vapour 80W	1.5	1.6	1.6	1.6	1.4	1.5	1.5	1.5	0.12	0.08	0.06	0.10
Mercury Vapour 125W	0.5	0.6	0.6	0.6	0.5	0.6	0.6	0.5	0.04	0.03	0.02	0.04
Mercury Vapour 250W	3.0	3.2	3.1	3.1	2.7	3.0	3.0	2.9	0.23	0.16	0.11	0.20
Mercury Vapour 400W	17.4	18.5	18.3	18.1	16.0	17.5	17.7	16.9	1.35	0.94	0.65	1.19
Mercury Vapour 1000W	2.0	2.1	2.1	2.1	1.8	2.0	2.0	1.9	0.15	0.11	0.07	0.14
Low Wattage elliptical Metal halide 70W	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.03	0.02	0.02	0.02
Low Wattage elliptical Metal halide 150W	0.5	0.5	0.4	0.4	0.4	0.5	0.4	0.4	0.03	0.02	0.02	0.02
Low Wattage Double ended Metal Halide 70W	5.6	5.5	4.9	5.1	5.2	5.2	4.7	4.9	0.40	0.28	0.22	0.19
Low Wattage Double ended Metal Halide 150W	2.4	2.4	2.1	2.2	2.2	2.3	2.0	2.1	0.17	0.12	0.09	0.08
Elliptical Metal Halide 250W	6.5	6.4	5.8	5.9	6.0	6.1	5.5	5.7	0.46	0.32	0.25	0.22
Elliptical Metal Halide 400W	42.1	41.6	37.4	38.4	39.1	39.5	35.7	37.0	3.00	2.09	1.64	1.45
Elliptical Metal Halide 1000W	13.9	13.7	12.3	12.7	12.9	13.0	11.8	12.2	0.99	0.69	0.54	0.48
Tubular Metal Halide 250W	1.3	1.3	1.2	1.2	1.2	1.2	1.1	1.1	0.09	0.06	0.05	0.04
Tubular Metal Halide 400W	1.5	1.5	1.3	1.4	1.4	1.4	1.3	1.3	0.11	0.07	0.06	0.05
Tubular Metal Halide 1000W	1.4	1.4	1.2	1.3	1.3	1.3	1.2	1.2	0.10	0.07	0.05	0.05
Tubular Metal Halide 2000W	3.0	2.9	2.6	2.7	2.7	2.8	2.5	2.6	0.21	0.15	0.12	0.10
Double Ended High wattage Metal Halide 1500W	5.9	5.9	5.3	5.4	5.5	5.6	5.0	5.2	0.42	0.29	0.23	0.20
Double Ended High wattage Metal Halide 2000W	10.0	9.9	8.9	9.1	9.3	9.4	8.5	8.8	0.71	0.50	0.39	0.34
High Pressure Sodium 70W	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.02	0.01	0.01	0.02
High Pressure Sodium 150W	1.0	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.08	0.06	0.05	0.07
High Pressure Sodium 250W	1.4	1.4	1.4	1.5	1.3	1.3	1.3	1.4	0.12	0.10	0.07	0.10
High Pressure Sodium 400W	18.6	18.5	18.3	19.1	17.1	17.2	17.3	17.8	1.53	1.24	0.93	1.31
HID - ARC	10.9	11.9	9.0	8.9	17.1	17.2	17.3	17.8	0.94	0.71	0.55	1.29
TOTAL	**281.8**	**262.6**	**245.5**	**272.3**	**247**	**227**	**216**	**239**	**25.0**	**24.5**	**21.0**	**25.9**