# APPENDIX

**Form 399 - ATTACHMENT TO ECONOMIC AND FISCAL IMPACT STATEMENT**

**Photovoltaic Modules (PV Modules) – Universal Waste Management**

This Appendix provides the detailed methodology that the Department of Toxic Substances Control (DTSC) used to calculate the costs that businesses are expected to incur after the regulation for waste photovoltaic modules (PV modules) is adopted. DTSC developed this cost estimate analysis similar to, and when applicable, using information provided in, a recent analysis published by United States Environmental Protection Agency (U.S. EPA), the Regulatory Impact Analysis of U.S. EPA's March 2018 Proposed Rule to Add Aerosol Cans to the Universal Waste Rule. The U.S. EPA analysis and this analysis assess nearly identical regulated activities and impacts of including a hazardous waste under the universal waste program, differed only on waste type and respective impacted businesses. Except where noted, the numbers and references used in this analysis are those developed and used in the U.S. EPA Regulatory Impact Analysis and its references.

## 1. STATEWIDE COSTS/SAVINGS TO COMPLY WITH THE REGULATION

### 1.1 Methodology

DTSC compared the costs by establishing assumptions and parameters that impacted businesses currently incur (or are anticipated to incur as more PV modules become waste) if the regulation were not adopted (baseline) to those of after the regulation is adopted (with regulation), to estimate the total statewide dollar costs that the impacted businesses might incur to comply with the universal waste regulation. DTSC first identified itemized costs for businesses' complying with hazardous waste regulations. PV modules are not currently generated in significant quantities but are expected to increase in the future.

### 1.2 Baseline and With Regulation Parameters

The following parameters were used to define activities in the baseline and with regulation:

| Baseline Parameters | With Regulation Parameters |
|---|---|
| All generators of waste PV modules who have determined that the PV modules are hazardous are subject to full hazardous waste management requirements. Half the total volume of waste PV modules that are generated in California are assumed to be hazardous.[1] | All generators of waste PV modules may elect to manage their PV modules as universal waste. They do not need to make a hazardous waste determination if the modules are managed as universal waste. Half the total volume of waste PV modules that are generated in California are assumed to be hazardous.[1] |

[1] DTSC is aware that not all PV module waste generated are hazardous based on the comments received during the rulemaking process. The regulation only applies to waste PV modules that are determined to be hazardous and does not apply to the modules that are not hazardous. DTSC does not have enough data to accurately predict the percent of PV module waste generated in California that would be considered hazardous. Therefore, DTSC conservatively assumed that half of the total volume of PV module waste generated in California would be hazardous.

| Baseline Parameters | With Regulation Parameters |
|---|---|
| Requirements for hazardous waste generators:<br>Acquire Identification Number<br>Comply with accumulation time limit requirements<br>Comply with hazardous waste label requirements<br>Have emergency procedures/contingency plans<br>Train employees<br>Ship using a manifest and registered transporter<br>Submit a biennial report if RCRA large quantity generator<br>Maintain records for at least 3 years | Requirements for universal waste generators:<br>Do not require an Identification Number before accumulating 5,000 kg of universal waste<br>Comply with longer accumulation time limit requirements<br>Comply with universal waste label requirements<br>Have emergency procedures, but not required to have contingency plans<br>Train employees<br>Transport universal waste using a shipping document in one's own vehicle or by a common carrier as allowed by U.S. Department of Transportation (DOT) and California law; Send universal waste to a universal waste handling facility that collects or recycles universal waste PV modules<br>Submit an annual report and/or a biennial report if RCRA large quantity generator<br>Do not require record maintenance. |
| All generators send their waste PV modules to 8 storage facilities and 2 hazardous waste evenly distributed geographically throughout the state that are authorized to accept PV modules because there are no recycling options available in California as of 2019. Storage facilities dispose of the waste PV modules at the 2 hazardous waste disposal facilities. | All generators send their waste PV modules to 8 universal waste handlers in California that comply with the self-implementing authorization requirements under chapter 23. There are 8 universal waste handlers authorized in California, evenly distributed geographically throughout the state. Handlers perform varying levels of authorized treatment activities. Two-third, five (5), of the handlers perform removal and disassembling activities that do not result in hazardous waste disposal. Waste PV modules are next transported as universal waste to the remaining one-third, three (3), of the handlers that conduct processing treatment activities, 85 percent of which results as hazardous waste residuals which are disposed of at 2 hazardous waste disposal facilities. |

| Baseline Parameters | With Regulation Parameters |
|---|---|
| Storage facility requirements:<br>Obtain Identification Number for each site that generates hazardous waste<br>Comply with requirements for use and management of hazardous waste containers<br>Have emergency procedures and contingency plans in place<br>Train all employees to ensure they are thoroughly familiar with proper waste handling and emergency procedures<br>Ship using only transporters that are registered or permitted by DTSC and comply with U.S. DOT requirements; Use a uniform hazardous waste manifest to accompany hazardous waste from the point of generation to the point of ultimate disposal<br>Maintain records for at least 3 years<br>Submit an annual/biennial report | Universal waste handler requirements:<br>Obtain Identification Number for each site that handles universal waste<br>Store PV modules for no more than one year from the accumulation start date; Document accumulation time; Label universal waste PV modules<br>Conduct authorized treatment<br>Train employees in proper universal waste management including handling, packaging, storing and labeling the waste, and in how to respond to releases<br>Only ship universal waste to a destination facility and comply with applicable U.S. DOT rules; Prepare shipping documents; When sending universal waste outside of the country, comply with regulations addressing universal waste export<br>Keep records of all shipments and receipts of universal waste for 3 years<br>Submit an annual/ biennial report<br>If a universal waste handler of PV modules decides to dispose of the PV modules or any components resulting from the authorized treatment of PV modules, they must manage them as hazardous waste, outlined in the baseline parameters. |

DTSC is aware that not all PV module waste generated are hazardous, as has also been explained by stakeholders. The regulation only applies to waste PV modules that are determined to be hazardous and does not apply to PV modules that are not hazardous. DTSC does not have enough data to accurately predict the percent of PV modules waste generated in California that is hazardous. Therefore, the economic and fiscal impact analysis is based on the assumption that half of the total volume of PV module waste that is generated in California is hazardous.

DTSC expects there will be businesses that become a PV module waste generator for the first time every year. Based on the published statistics by the U.S. Census Bureau, DTSC estimates that newly regulated generators will open at a rate of 1.7 percent of the size of the total number

of businesses each year.[2] Based on this assumption, DTSC estimates that 50 businesses will become newly regulated generators of PV modules each year.

As of 2017, Solar Energy Industries Association, a PV module industry association, indicates that there are approximately 28,906 businesses, such as manufacturers, installers, service providers, nonresidential buildings, and utility companies, in California that may generate, manage, or handle waste PV modules.[3] For this analysis, DTSC assumed that the total number of businesses for the economic impact is 2,947, calculated based on 1.7 percent annual net growth for 5 years. DTSC excludes the businesses with rooftop installations because these businesses are not anticipated to generate waste PV modules for their expected service life of 30 years. DTSC assumed that PV module wastes are generated only by businesses that routinely handle and manage PV modules during production, transportation, installation, and maintenance.

As of 2018, there are no businesses in California with a hazardous waste facility permit to store or treat PV modules. For the purposes of comparison, DTSC assumes that PV module waste generated would be transported from the original waste generator to the disposal facilities through either a hazardous waste storage facility in the baseline or through a universal waste handler with regulation. DTSC assumes in the baseline that at least 8 hazardous waste storage facilities could obtain hazardous waste permit modifications to manage waste PV modules. These storage facilities will dispose of 100 percent of the PV module waste as hazardous waste at the 2 permitted hazardous waste disposal facilities in California.

DTSC also assumes that there will be at least 8 universal waste handlers, replacing the 8 storage facilities assumed in the baseline, that accept hazardous waste PV modules for universal waste management with regulation. This assumption of 8 universal waste handlers is based on a 2017 stakeholder workshop held by DTSC, when electronic waste recyclers expressed interest in potentially expanding their operations to manage waste PV modules. Under the regulation, these universal waste handlers are authorized to accept waste PV modules as a new universal waste stream once they notify DTSC. DTSC assumes that five (5), two-third of these universal waste handlers perform authorized removal and disassembling treatment activities and transport the waste as universal waste to another universal waste handler for further processing. The remaining three (3), one-third, universal waste handlers conduct authorized processing treatment activities that result in 85% of the mass of the PV module becoming treatment residuals that are managed as hazardous waste. Once the universal waste handlers decide to dispose of the PV modules, they become a hazardous waste generator and must manage the waste in accordance with hazardous waste management requirements. At this point, the universal waste regulations no longer apply, and handlers must comply with full hazardous waste regulations for handling and disposal of a hazardous waste in California.

The regulation does not impact the requirements related to the disposal of hazardous waste PV modules; thus, costs associated with transporting waste PV modules using a registered hazardous waste transporter to a hazardous waste landfill remain the same for both the baseline and the with regulation parameters. The volume of hazardous waste received by the disposal facilities with the regulation is estimated to be approximately 85 percent of that in the

[2] https://www.census.gov/data/tables/2015/econ/susb/2015-susb-employment.html, accessed on February 27, 2020.
[3] Source: SEIA/GTM Research U.S. Solar Market Insight.

baseline because at least 15 percent of the waste will be recycled. Additionally, all costs associated with disposal facilities remain the same for both baseline and with regulation.

The assumptions made in this analysis do not include residential installation of solar panels. DTSC assumes that solar installation/repair is beyond an average homeowner's set of skills and therefore would likely be done by a service provider. As a result, any PV module generated would be "co-generated" by the homeowner and the service provider, and thus residential PV module wastes are still already included in the total generated amount.

This analysis assumes residential homes have a service warranty with installers that take back any damaged PV modules before the end of service life, and those wastes are already included in the total generated amount.

### 1.3 Baseline and With Regulation Costs

To estimate baseline costs, DTSC collected information on the unit costs, the costs that each impacted business is expected to incur, to comply with existing hazardous waste management requirements. Unit costs consist of one-time costs, fixed annual costs, and variable costs. Unit costs were applied to potentially impacted businesses, as a generator of waste PV modules or as a storage facility that receives waste PV modules from other businesses to store prior to hazardous waste disposal. Baseline costs were calculated for hazardous waste generators, permitted storage facilities, and permitted disposal facilities.

To estimate costs associated with the regulation for generators and handlers, DTSC gathered information on unit costs relevant to the handling of universal wastes and estimated costs using the same methodology used for baseline costs. Universal waste generators and handlers incur costs in the same categories as those incurred by hazardous waste generators and storage facilities: one-time costs, fixed annual costs, and variable costs. However, the specific cost features and dollar amounts vary between impacted universal waste and hazardous waste businesses. The costs for hazardous waste disposal facilities remain the same as that of the baseline.

**Tables 1 - 3** show the baseline and with regulation costs calculated by estimating one-time, fixed annual, and variable costs for generators, storage facilities or universal waste handlers, and disposal facilities. The difference between the baseline and with regulation for each itemized cost was calculated to show the benefits or added costs associated with the regulation. For the universal waste generators and hazardous waste disposal facilities, no added costs incur and thus resulting benefits with the regulation (**Table 1 and 3**.) For the universal waste handlers, additional costs were observed for regulation familiarization, hazardous waste analysis and characterization, waste transportation, and hazardous waste generator fees. Although there are added costs incurred for specific universal waste activities, the unit and total costs associated with the regulation are still lower than that of the baseline for the universal waste handlers, and thus resulting in the overall benefits for the handlers (**Table 2**.) The sums for the categorized costs, the total unit costs of impacted businesses, and the total costs for the impacted businesses are further projected for the before and with regulation (**Table 1-3**.)

## Table 1. Baseline and With Regulation Costs for Generators

| | BASELINE | WITH REGULATION | | |
|---|---|---|---|---|
| | HW Generator (Costs) ($) | UW Generators (Costs) ($) | UW Generators (Benefits) ($) | UW Generators (Itemized Additional Costs) ($) |
| | One-time Costs ($) | | | |
| Notification of hazardous waste activity | $ 62.00 | $ 62.00 | $ - | $ - |
| Rule familiarization | $ 424.00 | $ 188.00 | $ (236.00) | $ - |
| Closure plan | $ - | $ - | $ - | $ - |
| Contingency plan | $ - | $ - | $ - | $ - |
| **Total One-time costs per business** | **$ 486.00** | **$ 250.00** | **$ (236.00)** | **$ -** |
| | **50** | **50** | **50** | **50** |
| **Total One-time costs for all impacted business** | **$ 24,300.00** | **$ 12,500.00** | **$ (11,800.00)** | **$ -** |
| | Fixed Annual Costs ($) | | | |
| Annual review | $ - | $ - | $ - | $ - |
| Waste recordkeeping | $ 41.00 | $ 41.00 | $ - | $ - |
| Annual reporting | $ 419.00 | $ - | $ (419.00) | $ - |
| Annual employee training | $ 1,341.00 | $ 1,326.00 | $ (15.00) | $ - |
| Manifest training | $ 241.00 | $ - | $ (241.00) | $ - |
| Labeling | $ 74.00 | $ - | $ (74.00) | $ - |
| Facility Permit application preparation (annualized) | $ - | $ - | $ - | $ - |
| Facility Permit application review (annualized) | $ - | $ - | $ - | $ - |
| Financial Assurance for closure (annualized) | $ - | $ - | $ - | $ - |
| Annual Facility Fee | $ - | $ - | $ - | $ - |
| **Total Fixed Annual costs per business** | **$ 2,116.00** | **$ 1,367.00** | **$ (749.00)** | **$ -** |
| **Total Fixed Annual costs for all impacted business** | **$ 6,235,852.00** | **$ 4,028,549.00** | **$ (2,207,303.00)** | **$ -** |

| | Variable Costs ($) | | | |
|---|---|---|---|---|
| Hazardous waste analysis and characterization | $ 1,200.00 | $ - | $ (1,200.00) | $ - |
| Waste shipping recordkeeping | $ 58.00 | $ 3.71 | $ (54.29) | $ - |
| Manifest and land disposal notification | $ 63.00 | $ - | $ (63.00) | $ - |
| Waste transportation | $ 215.00 | $ 143.00 | $ (72.00) | $ - |
| The cost of HW handling/treatment | $ 23,625.00 | $ 23,625.00 | $ - | $ - |
| Haz Waste Generator Fees | $ 230.00 | $ - | $ (230.00) | $ - |
| Fee (Disposal) | $ - | $ - | $ - | $ - |
| **Total Variable costs per business** | **$ 25,391** | **$ 23,772** | **$ (1,619)** | **$ -** |
| | **2,947** | **2,947** | **2,947** | **2,947** |
| **Total Variable costs for all impacted business** | **$ 74,827,277** | **$ 70,055,229** | **$ (4,772,048)** | **$ -** |
| **TOTAL INITIAL COSTS PER BUSINESS** | **$ 486.00** | **$ 250.00** | **$ (236.00)** | **$ -** |
| **TOTAL ANNUAL ONGOING UNIT COSTS PER BUSINESS** | **$ 27,507.00** | **$ 25,138.71** | **$ (2,368.29)** | **$ -** |
| **TOTAL COSTS FOR PER BUSINESS** | **$ 27,993.00** | **$ 25,388.71** | **$ (2,604.29)** | **$ -** |
| **TOTAL INITIAL COSTS FOR ALL BUSINESSES** | **$ 24,300.00** | **$ 12,500.00** | **$ (11,800.00)** | **$ -** |
| **TOTAL ANNUAL ONGOING COSTS FOR ALL BUSINESSES** | **$ 81,063,129.00** | **$ 74,083,778.37** | **$ (6,979,350.63)** | **$ -** |
| **TOTAL COSTS FOR ALL BUSINESSES** | **$ 81,087,429.00** | **$ 74,096,278.37** | **$ (6,991,150.63)** | **$ -** |

## Table 2. Baseline and With Regulation Costs for Storage Facilities or Universal Waste Handlers

| | BASELINE | WITH REGULATION | | | | |
|---|---|---|---|---|---|---|
| | Storage Facilities (SF) (Costs) ($) | UW Handlers (No HW) | UW Handlers/ Processors (HW) | UW Handlers (Costs) ($) | UW Handlers (Benefits) ($) | UW Handlers (Itemized Additional Costs) ($) |
| | One-time Costs ($) | | | | | |
| Notification of hazardous waste activity | $ - | $ - | $ - | $ - | $ - | $ - |
| Rule familiarization | $ - | $ 188.00 | $ 612.00 | $ 347.00 | $ - | $ 347.00 |
| Closure plan | $ 6,712.00 | $ - | $ 984.40 | $ 369.15 | $ (6,342.85) | $ - |
| Contingency plan | $ 731.00 | $ - | $ 731.00 | $ 274.13 | $ (456.88) | $ - |
| **Total One-time costs per business** | **$ 7,443.00** | **$ 188.00** | **$ 2,327.40** | **$ 990.28** | **$ (6,799.73)** | **$ 347.00** |
| | **8** | **5** | **3** | **8** | **8** | **8** |
| **Total One-time costs for all impacted business** | **$ 59,544.00** | **$ 940.00** | **$ 6,982.20** | **$ 7,922.20** | **$ (54,397.80)** | **$ 2,776.00** |
| | Fixed Annual Costs ($) | | | | | |
| Annual review | $ 93.00 | $ 93.00 | $ 93.00 | $ 93.00 | $ - | $ - |
| Waste recordkeeping | $ 41.00 | $ 41.00 | $ 41.00 | $ 41.00 | $ - | $ - |
| Annual reporting | $ 837.00 | $ 837.00 | $ 837.00 | $ 837.00 | $ - | $ - |
| Annual employee training | $ 4,192.00 | $ 1,326.00 | $ 2,667.00 | $ 1,828.88 | $ (2,363.13) | $ - |
| Manifest training | $ 241.00 | $ - | $ 241.00 | $ 90.38 | $ (150.63) | $ - |
| Labeling | $ 74.00 | $ - | $ 74.00 | $ 27.75 | $ (46.25) | $ - |
| Facility Permit application preparation (annualized) | $ 25,000.00 | $ - | $ - | $ - | $ (25,000.00) | $ - |
| Facility Permit application review (annualized) | $ 25,000.00 | $ - | $ - | $ - | $ (25,000.00) | $ - |
| Financial Assurance for closure (annualized) | $ 10,000.00 | $ - | $ 2,000.00 | $ 750.00 | $ (9,250.00) | $ - |
| Annual Facility Fee | $ 11,730.00 | $ - | $ - | $ - | $ (11,730.00) | $ - |
| **Total Fixed Annual costs per business** | **$ 77,208.00** | **$ 2,297.00** | **$ 5,953.00** | **$ 3,668.00** | **$ (73,540.00)** | **$ -** |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Total Fixed Annual costs for all impacted business** | **$ 617,664.00** | **$ 11,485.00** | **$ 17,859.00** | **$ 29,344.00** | **$ (588,320.00)** | **$ -** |
| | **Variable Costs ($)** | | | | | |
| Hazardous waste analysis and characterization | $ - | $ - | $ 4,800.00 | $ 1,800.00 | $ - | $ 1,800.00 |
| Waste shipping recordkeeping | $ 18,096.00 | $ 983.15 | $ 40,948.00 | $ 15,969.97 | $ (2,126.03) | $ - |
| Manifest and land disposal notification | $ 20,436.00 | $ - | $ 46,243.00 | $ 17,341.13 | $ (3,094.88) | $ - |
| Waste transportation | $ 67,080.00 | $ 37,895.00 | $ 151,790.00 | $ 80,605.63 | $ - | $ 13,525.63 |
| The cost of HW handling/treatment | $ 8,714,125.00 | $ - | $19,751,900.00 | $ 7,406,962.50 | $ (1,307,162.50) | $ - |
| Haz Waste Generator Fees | $ - | $ - | $ 92,080.00 | $ 34,530.00 | $ - | $ 34,530.00 |
| Fee (Disposal) | $ - | $ - | $ - | $ - | $ - | $ - |
| **Total Variable costs per business** | **$ 8,819,737** | **$ 38,878** | **$ 20,087,761** | **$ 7,557,209** | **$ (1,312,383)** | **$ 49,856** |
| | **8** | **5** | **3** | **8** | **8** | **8** |
| **Total Variable costs for all impacted business** | **$ 70,557,896** | **$ 194,391** | **$ 60,263,283** | **$ 60,457,674** | **$ (10,499,067)** | **$ 398,845** |
| **TOTAL INITIAL COSTS PER BUSINESS** | **$ 7,443.00** | **$ 188.00** | **$ 2,327.40** | **$ 990.28** | **$ (6,799.73)** | **$ 347.00** |
| **TOTAL ANNUAL ONGOING UNIT COSTS PER BUSINESS** | **$ 8,896,945.00** | **$ 41,175.15** | **$20,093,714.00** | **$ 7,560,877.22** | **$ (1,385,923.41)** | **$ 49,855.63** |
| **TOTAL COSTS FOR PER BUSINESS** | **$ 8,904,388.00** | **$ 41,363.15** | **$20,096,041.40** | **$ 7,561,867.49** | **$(1,392,723.13)** | **$50,202.63** |
| **TOTAL INITIAL COSTS FOR ALL BUSINESSES** | **$ 59,544.00** | **$ 940.00** | **$ 6,982.20** | **$ 7,922.20** | **$ (54,397.80)** | **$ 2,776.00** |
| **TOTAL ANNUAL ONGOING COSTS FOR ALL BUSINESSES** | **$71,175,560.00** | **$ 205,875.75** | **$60,281,142.00** | **$60,487,017.75** | **$(11,087,387.25)** | **$398,845.00** |
| **TOTAL COSTS FOR ALL BUSINESSES** | **$71,235,104.00** | **$ 206,815.75** | **$60,288,124.20** | **$60,494,939.95** | **$(11,141,785.05)** | **$401,621.00** |

## Table 3. Baseline and With Regulation Costs for Disposal Facilities

| | BASELINE | WITH REGULATION | | |
|---|---|---|---|---|
| | HW Disposal Facilities (DF) (Costs) ($) | HW Disposal Facilities (DF) (Costs) ($) | HW Disposal Facilities (Benefits) ($) | HW Disposal Facilities (Itemized Additional Costs) ($) |
| | One-time Costs ($) | | | |
| Notification of hazardous waste activity | $ - | $ - | $ - | $ - |
| Rule familiarization | $ - | $ - | $ - | $ - |
| Closure plan | $ 6,712.00 | $ 6,712.00 | $ - | $ - |
| Contingency plan | $ 731.00 | $ 731.00 | $ - | $ - |
| **Total One-time costs per business** | **$ 7,443.00** | **$ 7,443.00** | **$ -** | **$ -** |
| | **2** | **2** | **2** | **2** |
| **Total One-time costs for all impacted business** | **$ 14,886.00** | **$ 14,886.00** | **$ -** | **$ -** |
| | Fixed Annual Costs ($) | | | |
| Annual review | $ 93.00 | $ 93.00 | $ - | $ - |
| Waste recordkeeping | $ 41.00 | $ 41.00 | $ - | $ - |
| Annual reporting | $ 837.00 | $ 837.00 | $ - | $ - |
| Annual employee training | $ 4,192.00 | $ 4,192.00 | $ - | $ - |
| Manifest training | $ 241.00 | $ 241.00 | $ - | $ - |
| Labeling | $ 74.00 | $ 74.00 | $ - | $ - |
| Facility Permit application preparation (annualized) | $ 25,000.00 | $ 25,000.00 | $ - | $ - |
| Facility Permit application review (annualized) | $ 25,000.00 | $ 25,000.00 | $ - | $ - |
| Financial Assurance for closure (annualized) | $ 10,000.00 | $ 10,000.00 | $ - | $ - |
| Annual Facility Fee | $ 330,970.00 | $ 330,970.00 | $ - | $ - |
| **Total Fixed Annual costs per business** | **$ 396,448.00** | **$ 396,448.00** | **$ -** | **$ -** |

| | | | | |
|---|---|---|---|---|
| **Total Fixed Annual costs for all impacted business** | **$ 792,896.00** | **$ 792,896.00** | **$ -** | **$ -** |
| | **Variable Costs ($)** | | | |
| Hazardous waste analysis and characterization | $ - | $ - | $ - | $ - |
| Waste shipping recordkeeping | $ - | $ - | $ - | $ - |
| Manifest and land disposal notification | $ - | $ - | $ - | $ - |
| Waste transportation | $ - | $ - | $ - | $ - |
| The cost of HW handling/treatment | $ - | $ - | $ - | $ - |
| Haz Waste Generator Fees | $ - | $ - | $ - | $ - |
| Fee (Disposal) | $ 806,479.82 | $ 685,536.19 | $ (120,943.63) | $ - |
| **Total Variable costs per business** | **$ 806,480** | **$ 685,536** | **$ (120,944)** | **$ -** |
| | **2** | **2** | **2** | **2** |
| **Total Variable costs for all impacted business** | **$ 1,612,960** | **$ 1,371,072** | **$ (241,887)** | **$ -** |
| **TOTAL INITIAL COSTS PER BUSINESS** | **$ 7,443.00** | **$ 7,443.00** | **$ -** | **$ -** |
| **TOTAL ANNUAL ONGOING UNIT COSTS PER BUSINESS** | **$ 1,202,927.82** | **$ 1,081,984.19** | **$ (120,943.63)** | **$ -** |
| **TOTAL COSTS FOR PER BUSINESS** | **$ 1,210,370.82** | **$ 1,089,427.19** | **$ (120,943.63)** | **$ -** |
| **TOTAL INITIAL COSTS FOR ALL BUSINESSES** | **$ 14,886.00** | **$ 14,886.00** | **$ -** | **$ -** |
| **TOTAL ANNUAL ONGOING COSTS FOR ALL BUSINESSES** | **$ 2,405,855.64** | **$ 2,163,968.38** | **$ (241,887.26)** | **$ -** |
| **TOTAL COSTS FOR ALL BUSINESSES** | **$ 2,420,741.64** | **$ 2,178,854.38** | **$ (241,887.26)** | **$ -** |

## Table 4. Costs Comparison between the Baseline and With Regulation

| | BASELINE | WITH REGULATION | | |
|---|---|---|---|---|
| | **Total Costs ($)** | **Total Costs ($)** | **Total Benefits ($)** | **Itemized Additional Costs ($)** |
| | **One-time Costs ($)** | | | |
| Notification of hazardous waste activity | $ 62.00 | $ 62.00 | $ - | $ - |
| Rule familiarization | $ 424.00 | $ 535.00 | $ (236.00) | $ 347.00 |
| Closure plan | $ 13,424.00 | $ 7,081.15 | $ (6,342.85) | $ - |
| Contingency plan | $ 1,462.00 | $ 1,005.13 | $ (456.88) | $ - |
| **Total One-time costs per business** | **$ 15,372.00** | **$ 8,683.28** | **$ (7,035.73)** | **$ 347.00** |
| **Total One-time costs for all impacted business** | **$ 98,730.00** | **$ 35,308.20** | **$ (66,197.80)** | **$ 2,776.00** |
| | **Fixed Annual Costs ($)** | | | |
| Annual review | $ 186.00 | $ 186.00 | $ - | $ - |
| Waste recordkeeping | $ 123.00 | $ 123.00 | $ - | $ - |
| Annual reporting | $ 2,093.00 | $ 1,674.00 | $ (419.00) | $ - |
| Annual employee training | $ 9,725.00 | $ 7,346.88 | $ (2,378.13) | $ - |
| Manifest training | $ 723.00 | $ 331.38 | $ (391.63) | $ - |
| Labeling | $ 222.00 | $ 101.75 | $ (120.25) | $ - |
| Facility Permit application preparation (annualized) | $ 50,000.00 | $ 25,000.00 | $ (25,000.00) | $ - |
| Facility Permit application review (annualized) | $ 50,000.00 | $ 25,000.00 | $ (25,000.00) | $ - |
| Financial Assurance for closure (annualized) | $ 20,000.00 | $ 10,750.00 | $ (9,250.00) | $ - |
| Annual Facility Fee | $ 342,700.00 | $ 330,970.00 | $ (11,730.00) | $ - |
| **Total Fixed Annual costs per business** | **$ 475,772.00** | **$ 401,483.00** | **$ (74,289.00)** | **$ -** |
| **Total Fixed Annual costs for all impacted business** | **$ 7,646,412.00** | **$ 4,850,789.00** | **$(2,795,623.00)** | **$ -** |

| | Variable Costs ($) | | | |
|---|---|---|---|---|
| Hazardous waste analysis and characterization | $ 1,200.00 | $ 1,800.00 | $ (1,200.00) | $ 1,800.00 |
| Waste shipping recordkeeping | $ 18,154.00 | $ 15,973.68 | $ (2,180.32) | $ - |
| Manifest and land disposal notification | $ 20,499.00 | $ 17,341.13 | $ (3,157.88) | $ - |
| Waste transportation | $ 67,295.00 | $ 80,748.63 | $ (72.00) | $ 13,525.63 |
| The cost of HW handling/treatment | $ 8,737,750.00 | $ 7,430,587.50 | $ (1,307,162.50) | $ - |
| Haz Waste Generator Fees | $ 230.00 | $ 34,530.00 | $ (230.00) | $ 34,530.00 |
| Fee (Disposal) | $ 806,479.82 | $ 685,536.19 | $ (120,943.63) | $ - |
| **Total Variable costs per business** | **$ 9,651,607.82** | **$ 8,266,517.12** | **$ (1,434,946.33)** | **$ 49,855.63** |
| **Total Variable costs for all impacted business** | **$ 146,998,132.64** | **$ 131,883,975.50** | **$ (15,513,002.14)** | **$ 398,845.00** |
| **TOTAL INITIAL COSTS PER BUSINESS** | **$ 15,372.00** | **$ 8,683.28** | **$ (7,035.73)** | **$ 347.00** |
| **TOTAL ANNUAL ONGOING UNIT COSTS PER BUSINESS** | **$ 10,127,379.82** | **$ 8,668,000.12** | **$ (1,509,235.33)** | **$ 49,855.63** |
| **TOTAL COSTS FOR PER BUSINESS** | **$ 10,142,751.82** | **$ 8,676,683.39** | **$ (1,516,271.05)** | **$ 50,202.63** |
| **TOTAL INITIAL COSTS FOR ALL BUSINESSES** | **$ 98,730.00** | **$ 35,308.20** | **$ (66,197.80)** | **$ 2,776.00** |
| **TOTAL ANNUAL ONGOING COSTS FOR ALL BUSINESSES** | **$154,644,544.64** | **$ 136,734,764.50** | **$ (18,308,625.14)** | **$ 398,845.00** |
| **TOTAL COSTS FOR ALL BUSINESSES** | **$ 154,743,274.64** | **$ 136,770,072.70** | **$ (18,374,822.94)** | **$ 401,621.00** |

**Table 4** compares the itemized, unit, and total costs for all businesses under the baseline and with regulation. The overall unit and total costs with regelation are lower although universal waste handlers incur additional itemized costs for regulation familiarization, hazardous waste analysis and characterization, waste transportation, and hazardous waste generator fees. The benefits and added costs with regulation were calculated to be $18,374,823 and $401,621, resulting in the net benefits of $17,973,203.

**Table 5** is a summary of estimated cost comparison for one-time costs, fixed costs, and variable costs for generators, storage facilities or universal waste handlers, and disposal facilities for the baseline and with regulation. The total costs estimated for generators and universal waste handlers with regulation is lower than that of the baseline. The total costs for disposal facilities with regulation is also lowered since only 85 percent of the waste is assumed to be disposed of as hazardous waste. Overall, DTSC estimated a total cost savings of $17,973,203 under the regulation.

## Table 5. Comparison of Costs or Savings Before and After Regulation

| COST CATEGORY | BASELINE | | | WITH REGULATION | | | COSTS SAVINGS (Benefits) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Generators | Storage Facilities | Disposal Facilities | Generators | Handlers | Disposal Facilities | Generators | Storage Facilities / Handlers | Disposal Facilities |
| One-time Costs ($) | $ 24,300 | $ 59,544 | $ 14,886 | $ 12,500 | $ 7,922 | $ 14,886 | $ (11,800) | $ (51,622) | $ - |
| Fixed Annual Costs ($) | $6,235,852 | $ 617,664 | $ 792,896 | $ 4,028,549 | $ 29,344 | $ 792,896 | $(2,207,303) | $ (588,320) | $ - |
| Variable Costs ($) | $74,827,277 | $70,557,896 | $1,612,960 | $70,055,229 | $60,457,674 | $1,371,072 | $(4,772,048) | $ (10,100,222) | $ (241,888) |
| Total Costs ($) | $81,087,429 | $71,235,104 | $2,420,742 | $74,096,278 | $60,494,940 | $2,178,854 | $(6,991,151) | $ (10,740,164) | $ (241,888) |
| Total Costs (Generators, Storage Facilities /Handlers, and Disposal Facilities) | $ 154,743,275 | | | $ 136,770,072 | | | $ 17,973,203 | | |

### 1.3.1 Baseline One-Time Costs

One-time costs in the baseline apply to generators that generate, storage facilities that store, and disposal facilities that accept waste PV modules for hazardous waste disposal for the first time. For the first-time generators, one-time costs include notifying DTSC of hazardous waste activities and becoming familiar with hazardous waste regulations (see **Table 1 - 3**). For both storage and disposal facilities, one-time costs include creating a closure plan and a contingency plan, since these facilities will be accepting waste PV modules as a new waste stream. These one-time costs were already incurred by impacted businesses that generate other hazardous wastes.

This analysis assumes that new hazardous waste generators will open at a rate equal to 1.7 percent annually. This is the average of the total number of new businesses in California and average number of new waste management and remediation services business in California.[4] The total number of businesses used to estimate the economic impact is 2,947, at 1.7 percent annual increase. Therefore, this analysis estimates that there will be 50 newly regulated businesses each year that incur the one-time costs specified above[5] (see **Table 1 - 3**). DTSC assumed that there are 8 storage facilities that will manage hazardous waste PV modules by storing them prior to disposal, and 2 disposal facilities that accept hazardous waste PV modules for disposal, as described earlier.

[4] https://www.census.gov/data/tables/2015/econ/susb/2015-susb-employment.html, accessed on February 27, 2020.

[5] If the number of newly regulated businesses increase, it is likely that estimated cost savings will exceed the estimates calculated in this analysis.

### 1.3.2 With Regulation One-time Costs

The requirements for newly regulated businesses that are universal waste generators are less stringent than those of hazardous waste generators. Both universal waste generators and handlers need time to become familiar with the regulations. Universal waste handlers that perform processing activities are required to familiarize both universal and hazardous waste regulations. Universal waste generators are still required to notify DTSC of the hazardous waste activities. For universal waste handlers that manage PV modules as a new universal waste stream, they do not require a closure plan or have a contingency plan in place if the handlers only conduct removal and disassembling treatment activities. Universal waste handlers that conduct processing treatment activities are required to create a closure plan and have a contingency plan in place. The one-time costs for the disposal facilities that accept PV modules as a new hazardous waste stream remains the same as that of the baseline. The total one-time costs for PV module generators, handlers, and disposal facilities are as shown in **Table 1 - 3**.

### 1.3.3 Baseline Fixed Annual Costs

Fixed annual costs are costs that are consistently experienced each year by impacted businesses. This category also includes costs that are incurred every other year (e.g., biennial reporting costs) that have been annualized to reflect a consistent value. Fixed annual costs do not vary based on the quantity of hazardous waste generated.[6]

Hazardous waste generators, and storage and disposal facilities incur varying degrees of fixed annual costs in the baseline. Fixed annual costs of compliance with the regulations for hazardous waste generators include recordkeeping, reporting, annual employee training, manifest training, and hazardous waste labeling (see **Table 1**.) Fixed annual costs of compliance of storage and disposal facilities are more extensive. They include annual review of hazardous waste regulations, recordkeeping, reporting, annual employee training, manifest training, hazardous waste labeling, costs to prepare and review the facility permit applications (annualized), and financial assurance for closure (annualized). Facility permits are required to be renewed every ten years, which are also captured in the fixed annual costs (see **Table 2 - 3)**.

### 1.3.4 With Regulation Fixed Annual Costs

DTSC expects that training requirements will be less for all impacted businesses under the regulation. With the regulation, regulated businesses that only generate PV modules incur two fixed annual costs associated with recordkeeping and employee safety training (see **Table 1**).

Under the regulation, fixed annual costs for all universal waste handlers include an annual review of the relevant regulations, recordkeeping, reporting, and personnel safety training. DTSC assumes that one-third of the universal waste handlers conduct processing treatment activities that generate PV module waste residuals disposed of as hazardous waste. These universal waste handlers incur costs for manifest training and hazardous waste labeling. They are also required to have in place financial assurance for facility closure. If the universal waste handlers decide to dispose of the PV modules as hazardous waste, they become hazardous waste generators and incur costs that any hazardous waste generator incurs when disposing

[6] Biennial reporting costs are dependent on the number of waste streams generated by a business. However, if the number of waste streams generated by a business remains constant over time, its biennial reporting costs will also remain constant.

hazardous waste. These costs are already incurred by universal waste handlers that manage other hazardous waste residuals (see **Table 2**.)

The costs for personnel safety training for universal waste handlers is lower than that of storage facilities, but the costs of the annual review of relevant regulations, recordkeeping, and reporting are anticipated to be similar. Also, universal waste handlers conducting authorized processing treatment activities generate hazardous wastes and are required to use hazardous waste labels and ship the wastes using hazardous waste manifests. The labeling and manifest training costs were assumed to be the same as that of storage and disposal facilities costs (see **Table 2**).

Universal waste handlers conducting processing authorized treatment need to establish and maintain a financial assurance instrument to pay for closure costs. Based on the financial assurance instruments for electronic waste (e-waste) recyclers, a similar universal waste stream, DTSC estimates the annualized cost of financial assurance for closure for PV module processing handlers is $2,000 (see **Table 2**).

For the total fixed annual costs, the number of estimated impacted businesses is multiplied by the sum of all fixed annual costs anticipated under the regulation. For generators, this analysis estimates total fixed annual costs of $1,367 per business. These costs were applied to the 2,947 PV module generators. For the universal waste handlers, this analysis estimates the average total fixed annual costs of $3,668 per handler. These costs were applied to the 8 new anticipated universal waste handlers (see **Table 1 - 2**).

The fixed annual costs for the 2 disposal facilities are the same for both baseline and with regulation (see **Table 3**).

### 1.3.5 Baseline Variable Costs

Variable costs include costs that are experienced throughout the year and vary based on the quantity of hazardous waste generated, the quantity of hazardous wastes shipped, and the number of hazardous waste shipments made by each impacted business.[7] Variable costs are different among generators, storage facilities, and disposal facilities. The costs may include: (1) costs of analyzing and characterizing the regulated hazardous waste for each shipment; (2) costs for shipping and recordkeeping; (3) costs for properly filling out a manifest and land disposal restriction notification for each shipment; (4) costs for shipping waste: hazardous waste using a certified hazardous waste transporter or universal waste without a manifest; (5) the cost of hazardous waste recycling or disposal; (6) cost of any fees for hazardous waste generation; and (7) fees for the disposal of hazardous wastes.

Variable costs are projected based on the expected number of hazardous waste PV modules generated in the future to estimate an annual quantity, and thus the expected number of shipments for each impacted business (see **Section 3**). Estimated variable costs are then multiplied by the number of businesses (2,947 generators, 8 storage facilities, or 2 disposal facilities) to obtain the total variable costs (see **Table 1 - 3**).

### 1.3.6 With Regulation Variable Costs

Variable costs parameters used in the baseline also apply under the regulation. Variable costs are lower for universal waste generators under the regulation. Universal waste generators are

[7] The number of hazardous waste shipments made by each business is dependent on the amount of hazardous waste PV modules they generate.

required to complete basic recordkeeping, at an estimated cost of approximately $4 per shipment, compared to approximately $58 per shipment for hazardous waste recordkeeping. Additionally, regulated businesses that ship only universal wastes to another universal waste handler do not need to use a registered hazardous waste transporter, further reducing the shipping costs. DTSC assumes that one-third of the handlers that conduct authorized processing treatment activities incur hazardous waste transportation costs, in which 85% of the PV module treatment residual waste is shipped as hazardous waste. The costs for hazardous waste shipments is $215 per shipment. This analysis assumes that universal waste shipments cost $143 per shipment.[8] This analysis also assumes the same average truck capacity (16 tons) and average travel distance (125 miles) for universal waste shipments as used for hazardous waste shipments.

DTSC multiplied the total number of estimated impacted businesses by the sum of all variable costs anticipated for the relevant business category. For universal waste generators, this analysis estimates variable costs of $23,772 per business per year applied to the 2,947 PV module generators. For universal waste handlers, this analysis estimates total variable costs of $7,557,209 per business, an average variable costs which applied to the 8 anticipated universal waste handlers (see **Table 1 - 2**).

Disposal facilities collect disposal fees (paid by those sending hazardous waste for land disposal) for hazardous waste PV modules and treatment residuals that are disposed of at their facilities. The disposal fees with regulation is lower because only 85 percent of the waste is disposed of as hazardous waste under the regulation (see **Table 3**.)

## 1.4 Net Cost Impacts

The regulation does not establish any significant new costs. It removes certain cost features from regulated businesses, mainly generators, and replaces other cost features with less expensive alternatives. As a result, DTSC expects the regulation to result in a net cost savings. DTSC estimated annual cost savings by calculating the difference between the baseline total costs and the post-regulation total costs. The results are presented in **Tables 4 - 5**.

This analysis estimates cost savings of $6,991,151 for PV module generators and $10,740,164 for universal waste handlers of PV modules per year, as shown in **Table 6**. Most notable in this analysis is that because there is currently no recycling market for PV module glass in California, the variable costs under both the baseline and with regulation are similar. The hazardous waste disposal costs associated with the 2 hazardous waste disposal facilities is lower with regulation because only 85 percent of the PV module hazardous waste is disposed of as hazardous waste under the regulation. There is a shift in generator fee liability from the PV module generators in the baseline to the universal waste handlers with the regulation. DTSC anticipates that the rates universal waste handlers will charge to handle PV modules will be adjusted to account for all variable costs, and those costs will be passed to the PV module generators.

[8] Based on the data presented on page 21 in Regulatory Impact Analysis of U.S. EPA's March 2018 Proposed Rule to Add Aerosol Cans to the Universal Waste Rule and references therein.

**Table 6. Costs Savings for Generators and Handlers With Regulation**

| COST CATEGORY | GENERATORS | | STORAGE FACILITIES / HANDLERS | |
|---|---|---|---|---|
| | Cost Savings | Percent Change from Baseline (%) | Cost Savings | Percent Change from Baseline (%) |
| One-Time Cost Savings | $ (11,800.00) | $ 48.56 | $ (51,622.00) | $ 86.70 |
| Fixed Annual Cost Savings | $ (2,207,303.00) | $ 35.40 | $ (588,320.00) | $ 95.25 |
| Variable Cost Savings | $ (4,772,048.00) | $ 6.38 | $ (10,100,222.00) | $ 14.31 |
| Total Cost Savings | $ (6,991,151.00) | $ 8.62 | $ (10,740,164.00) | $ 15.08 |

## 2. FUTURE WASTE PV QUANTITY PROJECTIONS

Quantities of waste PV modules expected in the future were calculated using the estimated cumulative waste quantities of PV panels currently generated in the United States (U.S.).[9] In the June 2016 publication by The International Renewable Energy Agency (IRENA), titled "*End of Life Management: Solar Photovoltaic Panels,"*[10] the author(s) presented a methodology to estimate cumulative PV module waste quantities expected to be produced over time for the entire U.S. The results of this estimation are shown in **Table 7** below.

**Table 7. Estimated Cumulative Waste Quantities (in tons) of PV modules for the U.S.**

| Year | 2016 | 2020 | 2030 | 2040 |
|---|---|---|---|---|
| Total waste PV modules[1] in the U.S. (tons) | 30,500 | 98,000 | 1,170,000 | 5,700,000 |
| 1 Total waste includes regular loss, waste at the end of service life, and early loss, waste before service life is reached. | | | | |

The cumulative PV module waste quantity (in tons), estimated to be generated by California businesses from 2018 to 2022, was calculated based on the data in **Table 7**. It is assumed that

[9] In the regulation, PV panels are referred to as PV modules.
[10] http://www.irena.org/publications/2016/Jun/End-of-life-management-Solar-Photovoltaic-Panels, accessed on February 27, 2020.

nearly half of all solar electricity generating capacity in the U.S. currently is located in California.[11]

A second assumption was made that year-to-year changes between quantities of waste generated were linear with a proportional increase following each year. With this assumption, estimated total PV module waste quantities for the years 2018 to 2022 were tabulated (see **Table 8**).

A third assumption made is for the volume of PV module waste that is determined to be hazardous. DTSC is aware that not all PV module wastes generated are hazardous, as has also been asserted by stakeholders. The regulation only applies to waste PV modules that are hazardous and does not apply to the modules that do not exhibit the hazardous waste characteristic of toxicity. DTSC cannot accurately predict the percent of PV modules waste generated in California that will be hazardous. Therefore, in this economic and fiscal impact analysis, DTSC assumes that only half of the total PV module waste that is generated in California is hazardous, and the economic and fiscal impact analysis is calculated based on the half of the total quantity of PV module waste that is projected to be generated (see **Table 8)**.

**Table 8. Estimated Waste Quantities (in tons) of PV Modules for California**

| Year | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|
| **PV module waste in California (tons)** | 32,126 | 40,564 | 49,000 | 108,556 | 168,112 |
| **Half of the total PV module waste in California (tons)** | 16,063 | 20,282 | 24,500 | 54,278 | 84,056 |

Hazardous waste manifest data in the Hazardous Waste Tracking System (HWTS) could not be used to verify these estimates. Hazardous waste PV modules, which are required to be transported using hazardous waste manifests, do not have a unique waste code associated with this waste and cannot be tracked using the HWTS.

## 3. UNIT COST INFORMATION

Several unit costs outlined in this analysis are calculated based on the labor costs as shown in **Table 9** based on the data provided in U.S. EPA's Regulatory Impact Analysis for Aerosol Cans. Estimates of one-time costs per business, supplementing the unit costs relevant to existing regulated businesses, are calculated assuming that the regulation also affects the one-

[11] The 5 Big Questions About Solar After Trump's Tariffs - GV Wire." *GV Wire. 2018-01-25* and https://www.seia.org/research-resources/solar-market-insight-report-2018-q2

time costs incurred by new generators of hazardous waste PV modules (e.g., the cost of establishing a contingency plan).[12]

**Table 9. Hourly Labor Costs**

| Labor Category | Median Hourly Wage Rate[1] | Labor Loading Multipliers | | Median Loaded Hourly Labor Cost[1,2,3] |
|---|---|---|---|---|
| | | Benefits[2] | Overhead[3] | |
| Managers | $54.76 | 1.533 | 1.336 | $113.78 |
| Technicians | $23.69 | | | $49.22 |
| Software Developers and Programmers | $46.07 | | | $95.72 |
| Office Clerks, General | $17.86 | | | $37.11 |
| Lawyers | $77.36 | | | $160.74 |

Source:
1. Bureau of Labor Statistics, National Occupational Employment and Wage Estimates, May 2016, accessed at https://www.bls.gov/oes/current/oes_nat.htm on August 25, 2017.
2. Fringe benefit cost factor calculated from Bureau of Labor Statistics, Employer Costs for Worker Compensation, released June 9, 2017. Table 10: Employer Costs per Hour Worked for Employee Compensation and Costs as a Percent of Total Compensation: Private Workers, by Industry Group, March 2017.
3. Overhead loading factor calculated from Remedial Action Cost Engineering and Requirements (RACER) cost estimating software 2005 defaults.

## 3.1 Impacted Businesses

### 3.1.1 Generators

DTSC limited its analysis to only those businesses that routinely handle PV modules and most likely manage waste PV modules during production, transportation, installation, and maintenance. Based on this assumption, the total number of impacted businesses DTSC estimates is 2,947.

### 3.1.2 Newly Regulated Generators

Several one-time costs are incurred when a business first becomes a hazardous waste generator. Based on the published statistics, DTSC estimated that newly regulated generators will open at a rate of 1.7% of the size of the total number of businesses each year,[13] replacing existing businesses that choose to no longer operate (and therefore no longer generate or handle PV modules). Based on this assumption, DTSC estimates that 50 businesses will become newly regulated generators of PV modules each year.

### 3.1.3 Storage Facilities/Disposal Facilities/Universal Waste Handlers/Recyclers

As of 2018, there are no PV module recyclers in California that treat hazardous waste PV modules. For the baseline, DTSC assumed that there are 8 storage facilities to store and manage hazardous waste PV modules prior to disposal. Storage facilities only accept and do

[12] Because these are sunk costs for existing businesses, this analysis does not include these costs.
[13] https://www.census.gov/ces/dataproducts/bds/data_firm.html, accessed on February 27, 2020.

not treat hazardous waste PV modules. Therefore, 100% of the hazardous waste PV modules will be disposed of. For the regulation, DTSC assumed that there will be at least 8 universal waste handlers that manage universal waste PV modules, based on the interest expressed by e-waste handlers at a workshop held by DTSC in 2017. Universal waste handlers are authorized to conduct varying levels of authorized treatment activities: removal, disassembling, and processing. In this analysis, DTSC assumes that five (5), two-third of the handlers conduct removal and disassembling treatment activities send the PV module waste as universal waste to three (3), the remaining one-third of the universal waste handlers for further processing treatment. After the processing treatment activities, 15% of the total tons of universal waste PV modules are recycled. The remaining 85% of the total PV module universal waste handled by universal waste handlers is shipped as hazardous waste residuals to the 2 permitted disposal facilities in California.

## 3.2 One-Time Costs

One-time cost items that are assumed to occur when a business becomes subject to the regulations for the first time are as follows.

### 3.2.1 Notification[14] - Baseline and With Regulation

This estimates notification costs under the baseline for new generators and under the regulation for all regulated businesses that become large quantity generators. Small Quantity Generators are not required to notify under the universal wastes rule. The notification cost for generators is $62 per business: 0.08 hours of managerial time, 0.93 hours of technician time, 0.08 hours of administrative time, and approximated $3.85 for operation and maintenance.

For storage facilities, disposal facilities, and universal waste handlers, these costs are incorporated in the costs to prepare and review the facility permit application.

### 3.2.2 Regulation Familiarization - Baseline and With Regulation

Newly regulated businesses that become subject to regulation are assumed to incur costs to familiarize themselves with the universal waste and other hazardous waste regulations. The amount of personnel time for regulation familiarization depends, in part, on whether legal counsel is involved and how thorough regulated businesses are in their review.

The analysis assumes that storage and disposal facilities' costs include legal counselling and generators costs do not include legal counselling. The personnel hours for these costs were obtained from the U.S. EPA Regulatory Impact Analysis for the addition of mercury containing equipment to the universal waste system.[15]

The estimated regulation familiarization costs for hazardous waste generators under the baseline are $424 per business per year. For storage and disposal facilities, familiarization costs are incorporated into the costs to prepare and review the facility permit application.

Under the regulation, the universal waste system for businesses that exclusively generate hazardous waste PV modules is less complicated than full hazardous waste requirements; thus,

[14] Notification costs based on hours estimates and operations and maintenance costs from U.S. EPA, Supporting Statement for EPA Information Collection Request Number 0976.18 "2017 Hazardous Waste Report, Notification of Regulated Waste Activity, and Part A Hazardous Waste Permit Application and Modification," December 2016.

[15] U.S. EPA, Economic Analysis of Including Mercury Containing Equipment in the Universal Waste System: Final Rule. February 15, 2002 (revised May 9, 2005).

regulation familiarization costs are assumed to be less. Based on the data used in U.S. EPA regulatory impact analyses for other universal wastes,[16] DTSC estimates regulation familiarization costs of $188 for businesses generating hazardous waste PV modules and universal waste handlers that conduct removal and disassembling activities. Universal waste handlers that conduct processing treatment activities generate waste residuals as hazardous waste which is disposed of as hazardous wastes. These handlers incur rule familiarization costs for both hazardous waste and universal waste regulations. The average costs for rule familiarization for all universal waste handlers is estimated at $277.

### 3.2.3 Development of a Closure Plan[17] – Baseline and With Regulation

This analysis assumes in the baseline that storage and disposal facilities subject to hazardous waste regulation incur costs to develop a closure plan, specifically for a new waste stream such as PV modules, in the baseline. **Table 10** includes costs associated with the development of a closure plan: writing descriptions, estimating costs, and creating a closure schedule. These costs are estimated to be $6,712 per disposal facility. A closure plan only needs to be established for three (3) universal waste handlers that conduct processing treatment activities under the regulation, but at a lesser cost of $984, compared to the cost of full hazardous waste management. Therefore, the costs of closure plan averaged for eight (8) universal waste handlers is estimated to be $369 per handler.

[16] Based on the data presented on page 35 in Regulatory Impact Analysis of U.S. EPA's March 2018 Proposed Rule to Add Aerosol Cans to the Universal Waste Rule and references therein.
[17] U.S. EPA, Supporting Statement for EPA Information Collection Request Number ICR 1573.14 "Part B Permit Application, Permit Modifications, and Special Permits," March 2016.

**Table 10. Closure Plan Costs for a Disposal Facility under a Full Hazardous Waste Regulation**

| Activity | Managerial Time (hours) | Technician Time (hours) | Administrative Time (hours) | Operation and Maintenance Costs | Total Costs |
|---|---|---|---|---|---|
| Write descriptions of necessary closure activity | 2 | 16 | 2 | $5000 | $6,089* |
| Estimate final closure | 1 | 8 | 1 | $0 | $545* |
| Write the closure schedule | 0.25 | 1 | 0 | $0 | $78 |
| | | | | Total Closure Plan Cost per Generator | $6,712* |

Source:
U.S. EPA, Supporting Statement for EPA Information Collection Request Number ICR 1573.14 "Part B Permit Application, Permit Modifications, and Special Permits," March 2016.
* The costs were calculated based on the personnel time spent and median hourly wage rate provided in **Table 6** and are different from the values reported in the U.S. EPA Impact Analysis for Aerosol Cans.

### 3.2.4 Contingency Planning[18] – Baseline and With Regulation

In the baseline, storage and disposal facilities incur costs for development of a contingency plan for a new waste stream, PV modules. **Table 11** shows a breakdown of the activities for contingency planning: data collection, documentation input from authorities, plan drafting and submission to relevant emergency centers. The total cost estimate is $731 per plan.

Under the regulation, the three (3) universal waste handlers of PV modules that conduct processing treatment activities as a new waste stream also incur similar costs under the regulation. No contingency planning is required for five (5) universal waste handlers that conduct only removal and disassembling activities. Therefore, the costs of contingency planning averaged for eight (8) universal waste handlers is estimated to be $274 per handler.

[18] U.S. EPA, Supporting Statement for EPA Information Collection Request Number ICR 0820.14 Hazardous Waste Generator Standards, September 2014.

**Table 11. Contingency Planning Costs**

| Activity | Technician Time (hours) | Administrative Time (hours) | Operation and Maintenance Costs | Total Cost |
|---|---|---|---|---|
| Collection of data | 3.35 | 1.65 | $0 | $226 |
| Document whether authorities decline arrangement | 0 | 0.5 | $0 | $19 |
| Write contingency plan | 7.5 | 2.5 | $0 | $462 |
| Submit plan to relevant emergency centers | 0 | 0.5 | $5.73 | $24 |
| **Total Contingency Planning Cost per business** | | | | $731 |

Source:
U.S. EPA, Supporting Statement for EPA Information Collection Request Number ICR 0820.14 Hazardous Waste Generator Standards, September 2014.

## 3.3 Fixed Annual Costs

Fixed annual costs include costs that remain unchanged from year to year.

### 3.3.1 Annual Review of Regulations – Baseline and With Regulation

DTSC assumed that storage facilities, disposal facilities, and universal waste handlers conduct an annual review of the regulations, but generators of waste PV modules do not. **Table 12** shows a limited amount of legal, managerial, and technician time estimated for the annual review.

**Table 12. Costs for Annual Review of Regulations for Baseline and With Regulation**

| Type of Business | Legal Time (hours) | Managerial Time (hours) | Technician Time (hours) | Total Cost |
|---|---|---|---|---|
| Storage Facilities / Disposal Facilities / Handlers | 0.25 | 0.15 | 0.5 | $60.87 |

Source:
U.S. EPA, Supporting Statement for EPA Information Collection Request Number ICR 0820.14 Hazardous Waste Generator Standards, September 2014.

### 3.3.2 Recordkeeping[19]– Baseline and With Regulation

Under hazardous waste and universal waste regulations, all businesses are required to maintain records of waste management activities for three years from the date the last waste was sent off-site and must provide information as requested by DTSC or Certified Unified Program Agencies (CUPA) inspectors. These activities involve 0.25 hours of managerial time, 0.2 hours of a technician's time, and $2.50 to $3.00 for operation and maintenance costs. These costs total to approximately $41 per business.

### 3.3.3 Annual/Biennial Reporting – Baseline and With Regulation

RCRA large quantity generators must submit biennial reports of hazardous waste generation activities to DTSC. The costs to prepare a biennial report include time to read instructions, complete the site ID form, gather information, prepare a generation and management form, submit the report to DTSC, and maintain a copy of the report for three years. **Table 13** summarizes the personnel time to complete these activities and associated costs per generator, approximated to be $837, annualized in this analysis to $419. PV module generators under the regulation are not required to submit a similar biennial report.

In California under current regulations, storage and disposal facilities are required to submit an annual report. DTSC estimates that each year, these facilities will incur costs similar to those estimated in **Table 13**, $837 per business per year.

Under the regulation, universal waste handlers that conduct authorized treatment are required to submit an annual report. For purposes of this analysis, the annual reporting costs are assumed to be the same as for a disposal facility's annual report, $837 per business per year.

[19] Recordkeeping cost estimate based on information in U.S. EPA, Supporting Statement for EPA Information Collection Request Number ICR 0820.14 Hazardous Waste Generator Standards, September 2014.

**Table 13. Costs of Biennial Reporting**

| Activity | Manager Time (hours) | Technician Time (hours) | Administrative Time (hours) | Labor Cost | Operation and Maintenance Cost | Total Cost |
|---|---|---|---|---|---|---|
| Read instructions | 1.08 | 1.68 | 0 | $205.57 | $0 | $205.57 |
| Gather information and prepare form GM[2] | 0.13 | 0.15 | 0.04 | $23.66 per form | $0 | $462.86[1] |
| Gather and prepare information for Site ID form | 0.08 | 0.6 | 0.16 | $44.57 | $0 | $44.57 |
| Submit report | 0.82 | 0.32 | 0.2 | $116.47 | $6.57 | $123.05 |
| Maintain a copy of form for three years | 0 | 0.01 | 0.02 | $1.23 | $0 | $1.23 |
| | | | | | Cost per business per Biennial Report cycle | $837.29 |
| | | | | | Annualized cost per business per Biennial Report cycle | $419[3] |

Source:
U.S. EPA, Supporting Statement for EPA Information Collection Request Number "2017 Hazardous Waste Report, Notification of Regulated Waste Activity, and Part A Hazardous Waste Permit Application and Modification," December 2016.
Notes:
[1] Value assumes approximately 19.5 Generation and Management (GM) forms per business on average based on data in the 2015 Biennial Report database.
[2] Waste Generation and Management
[3] This value is calculated to reflect annualized cost for a biennial report and is different from the value reported in the U.S. EPA Impact Analysis for Aerosol Cans.

### 3.3.4 Annual Employee Training - Baseline and With Regulation

For the baseline, costs associated with training relevant employees at generator regulated businesses were estimated assuming generators conduct formalized training, such as an online

training course supplemented with business-specific information.[20] DTSC assumes that four technicians and two managers each receive eight hours of training per year. This estimate also includes 0.6 hours of clerical time for relevant administrative requirements (e.g., updating records, refresher/new class scheduling). The class fee is estimated as $127 per trainee based on pricing from online providers and an additional record-keeping cost of approximately $3 per year. In total, DTSC estimates that hazardous waste generator training costs $1,341 per business per year. Because storage and disposal facilities require additional personnel to manage off-site wastes, DTSC estimates that storage and disposal facility training costs $4,192 per business per year. **Table 14** summarizes these costs.

**Table 14. Annual Employee Training Costs**

| Business Type | Cost | Assumptions |
|---|---|---|
| Generator of hazardous wastes | $1,341 | 2 technicians and 1 manager for 4-hour training, 4 managerial hours to develop training, 1 hour for clerk |
| Storage or Disposal Facility | $4,192 | 4 technicians and 2 managers for 8-hour training, 0.6 hours for clerk, per trainee fee for class. |
| Generator of universal wastes | $1,326 | 4 technicians and 2 managers for 2-hour training |
| Universal waste handler (Removal/Dissembling activities) | $1,326 | 4 technicians and 2 managers for 2-hour training |
| Universal waste handler (Processing activities) | $2667 | Hazardous waste generator training and universal waste handling training |

Under the regulation, universal waste generators and handlers will incur training costs, but they are estimated to be lower than those of the baseline due to having to deal with fewer regulatory requirements under the regulation. DTSC assumes that the training for universal waste regulations involves four technicians and two managers through a two-hour training. Based on this estimate, the cost estimate of universal waste training is $1,326 per business per year for generators and handlers. Additionally, one-third of the handlers will incur additional training costs as hazardous waste generator since 85% of the PV module is disposed of as hazardous

[20] Assumptions based on training cost assumptions in U.S. EPA, Regulatory Impact Analysis for the 2008 Final Rule Amendments to the Industrial Recycling Exclusions of the RCRA Definition of Solid Waste, September 25, 2008.

waste after the processing treatment. Therefore, the costs of annual employee training averaged for eight (8) universal waste handlers is estimated to be $1829 per handler.

### 3.3.5 Manifest Training – Baseline and With Regulation

It is assumed that each generator assigns one technician and one manager to complete a four-hour hazardous waste manifests training once every three years using U.S. EPA's free online hazardous waste manifest video.[21, 22] The cost of manifest training includes one hour of a manager's time to compile the U.S. EPA hazardous wastes manifest instructions and other training materials. Approximately 0.3 hours of administrative time is needed to schedule the training. The estimated cost of manifest training is $777 per business once every three years (an annualized cost of $241,[23] using a 7% discount rate). The manifest training costs of storage and disposal facilities are assumed to be the same as those of generators.

Under the regulation, transporting PV modules to other universal waste handlers does not require a hazardous waste manifest, thus, the manifest training is not required. However, one-third of the universal waste handlers that generate hazardous wastes after conducting authorized processing treatment are required to ship hazardous wastes using hazardous waste manifests. Their training costs are assumed to be the same as disposal facility manifest training costs. Therefore, the costs of manifest training averaged for eight (8) universal waste handlers is estimated to be $90 per handler.

### 3.3.6 Labeling – Baseline and With Regulation

In the baseline, all containers at a generator site must be labelled "Hazardous Waste," indicating hazardous contents in the containers and the accumulation start date. This analysis assumes that a trained technician labels the containers. The annual costs of labeling for generators is estimated to be $49.22 for one hour of technician time for a primary storage area and $24.61 for a half hour of technician time for a satellite storage area.[24] The combined annual cost of labeling per generator is estimated to be $74. The labeling costs of storage and disposal facilities in the baseline are assumed to be the same as those of generators.

Under the regulation, generators are not required to label waste PV modules as "Hazardous Waste" because they are being managed as universal waste. One-third of the universal waste handlers that conduct authorized processing treatment, however, are required to label the waste that will be disposed of as hazardous waste. The labeling costs for universal waste handlers with the regulation is assumed to be the same as those of storage and disposal facilities. Therefore, the costs of hazardous waste labeling averaged for eight (8) universal waste handlers is estimated to be $28 per handler.

### 3.3.7 Storage and Disposal Facility Fixed Annual Costs

The additional fixed annual costs associated with storage and disposal facilities are as follows.

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[21] U.S. EPA, ICR 801.18 "Requirements for Generators, Transporters, and Waste Management Regulated Businesses Under the RCRA Hazardous Waste Manifest System." 2012.
[22] U.S. Environmental Protection Agency, Hazardous Waste Manifest System, accessed at http://www.epa.gov/osw/hazard/transportation/manifest/index.htm on December 24, 2012.
[23] This value is calculated based on the data presented in Table 7 on page 13 in the U.S. EPA Regulatory Impact Analysis for Aerosol Cans and is different from the reported value in the U.S. EPA analysis.
[24] U.S. EPA, Supporting Statement for EPA Information Collection Request Number ICR 0820.14 Hazardous Waste Generator Standards, September 2014.

#### *3.3.7.1 Facility Permit Application Preparation – Baseline and With Regulation*

Any person who stores, treats or disposes of hazardous wastes must obtain a permit or grant of authorization from DTSC. To receive a permit, businesses submit an application that contains information pertinent to their operation, location, and procedures for hazardous waste management. The costs associated with this process apply to storage and disposal facilities in this analysis.

DTSC estimates that a complete permit application can cost an average of $250,000 to prepare and revise through the permit issuance process. A facility permit must be renewed every 10 years, which requires a new application to be submitted for review. To reflect this 10-year renewal cycle, the permit application preparation costs were annualized, so that the annual cost to prepare an application is $25,000 per facility.

#### *3.3.7.2 Facility Permit Application Review – Baseline and With Regulation*

DTSC conducts a detailed review of the permit application to ensure its completeness and adequacy for protecting public health and the environment from hazardous waste management activities. Any person who applies for a permit from DTSC is required to enter into a written agreement to reimburse DTSC for the costs incurred in the process. The costs associated with this process apply to storage and disposal facilities.

DTSC estimates that the review of a permit application and issuance of the permit can cost an average of $250,000. To reflect the 10-year renewal cycle, the permit application review costs were annualized, so that the annual cost to review an application is $25,000 per facility.

#### *3.3.7.3 Financial Assurance for Closure - Baseline and With Regulation*

In the baseline, permitted storage and disposal facilities are required to establish a financial assurance instrument to remain available to pay for the costs to close the facility (remove remaining hazardous wastes, remove hazardous waste management equipment, and clean up contamination that resulted from the Disposal Facility's operations). DTSC estimates that the closure costs of PV modules management unit for a storage or a disposal facility is approximately $1,000,000. The annual cost for financial assurance is $10,000 per facility, reflecting the 10-year renewal cycle.

With the regulation, only the universal waste handlers that conduct authorized processing treatment activities need to establish and maintain a financial assurance instrument to remain available to pay for the site closure costs. DTSC estimates that the annualized cost of financial assurance for PV module handlers is $2,000 based on similar activities conducted by e-waste handlers. Therefore, the costs of financial assurance plan averaged for eight (8) universal waste handlers is estimated to be $750 per handler.

#### *3.3.7.4 Annual Facility Fee – Baseline and with Regulation*

A storage facility is subject to an annual facility fee based on the size and type of the facility. Estimating amounts of PV modules handled by each storage facility, DTSC anticipates that these facilities are classified as a Series A standardized permit. Based on DTSC's 2018 Annual Fee Summary, the facility fee for a Series A standardized permit facility is $11,730 per facility per year. Hazardous waste disposal facilities incur the annual facility fee, which is calculated based on DTSC's 2018 Annual Fee Summary.

## 3.4 Variable Costs

Variable costs are experienced throughout the year and vary by the quantity of hazardous wastes generated, quantity of hazardous wastes shipped, and the number of hazardous waste

shipments made by each business. The frequency of shipment is dependent on the amount allowed to be stored as a large quantity generator. DTSC assumes that half of PV modules in service in the state will be hazardous, as presented in **Section 2** of this analysis. Additional information is not available from generators on the number of PV modules generated in California; therefore, DTSC assumes that all impacted businesses generate the same number of PV modules. Half the total amount of PV modules generated is divided by the number of impacted businesses to estimate the annual quantity of PV modules per generator (see **Table 15**).

**Table 15. Projected Annual Generation (in Tons) of PV Modules per Impacted Businesses**

| Year | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|
| Total Estimated Waste Generated (tons) | 32,126 | 40,564 | 49,000 | 108,556 | 168,112 |
| Half the Volume of the Waste Assumed Hazardous (tons) | 16,063 | 20,282 | 24,500 | 54,278 | 84,056 |
| Waste per Generator[1] (tons) | 5 | 7 | 8 | 18 | 29 |
| Shipments per Generator[2] | 1 | 1 | 2 | 2 | 2 |
| Hazardous waste per Storage Facility[3] (tons) | 2,008 | 2,535 | 3,063 | 6,785 | 10,507 |
| Hazardous Waste Shipments per Storage Facility[4] | 125 | 158 | 191 | 424 | 657 |
| Estimated waste to be Disposed as Hazardous Waste per Handler[5] (tons) | 4,551 | 5,747 | 6,942 | 15,379 | 23,816 |
| Hazardous Waste Shipments per Processing Handler | 284 | 359 | 434 | 961 | 14,88 |

[1] The PV module waste per generator was calculated by dividing the total estimated tons of PV modules per year by the total number of businesses expected to be generating PV modules (2,947 businesses).
[2] The number of waste PV modules shipments per generator was calculated by dividing the estimated PV module waste per generator (in tons) by the number of tons in a typical shipment of hazardous wastes (16 tons), rounding up to the next whole number. The typical hazardous waste shipment quantity was the quantity observed in the information on hazardous waste shipments from manifest data in the Hazardous Waste Tracking System.
[3] The hazardous waste PV module per storage facility was calculated by dividing the half the total volume estimated tons of PV modules per year by the total number of storage facilities expected to be generating PV modules (8 businesses).

| Year | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|
| [4] The number of hazardous waste PV module shipments per storage facility was calculated by dividing the estimated PV module hazardous waste per disposal facility by the number of tons in a typical shipment of hazardous waste (16 tons), rounding up to the next whole number. The typical hazardous waste shipment quantity was based on quantity information on hazardous waste shipments from manifest data in the Hazardous Waste Tracking System.<br>[5] The total estimated hazardous waste PV module per handler was calculated by subtracting 15% of the total estimated tons of hazardous waste and by dividing the total number of handlers expected to be generating PV module hazardous waste residuals (3 handlers). PV modules generated. The 15% reduction estimates the proportion of PV modules that is currently potentially recyclable (aluminum frames and ancillary components). Eighty five percent of the weight of PV modules is the glass panes sandwiching the PV cells. There is currently no known recycling market for this material. | | | | | |

Variable cost estimates for generators were calculated using half the average projections for the years 2018-2022, for both total expected tons of hazardous waste PV modules generated and expected frequency of hazardous waste PV modules shipped by generators: an average of 13.5 tons of PV modules per year per generator (approximately 818 PV modules, assuming each panel weighs 33 pounds), or 1 shipment of PV modules per year per generator.[25]

Storage facilities accept hazardous waste PV modules from the generator and send 100% of the waste (4980 tons), which is equivalent to 312 shipments, to the hazardous waste disposal facilities.

The variable costs estimated for universal waste handlers that manage universal waste PV modules were calculated using the average projections for the years 2018-2022. All universal waste handlers were assumed to manage an average of 4979.5 tons of PV modules per year. Two-thirds of the handlers conduct removal and disassembling activities and ship the wastes as universal waste to the remaining one-third of the handlers that perform processing treatment activities. Fifteen percent of the total tons of universal waste PV modules are recycled. Therefore, only eighty five percent of the half the total universal waste PV modules are shipped as hazardous waste residuals to a disposal facility, which is equivalent to 706 shipments of hazardous PV module waste residual per year, shipped from the three handlers that conduct processing treatment (see footnote 23).

### 3.4.1 Analyzing and Characterizing Waste - Baseline and with Regulation

Generators of wastes are required to determine if the wastes are hazardous.[26] In addition, generators of hazardous waste are required to determine whether the amount of regulated substances in their waste exceeds levels that would restrict disposal in a landfill (land disposal restriction).

[25] The estimated number of shipments is a function of both shipment weight and volume. The estimated number shipments may be greater due to size limitations of the vehicle or container used to ship the PV modules.
[26] See California Code of Regulations, title 22, division 4.5, chapter 12, section 66262.11

PV modules are predominantly glass; therefore, the samples must be analyzed using U.S. EPA Method 3052 (Microwave Assisted Acid Digestion of Siliceous and Organically Based Matrices).[27] DTSC gathered information indicating that laboratories charge approximately $1,200 per sample to analyze glass samples and assumed that each generator sends one sample from the total waste PV modules to be chemically analyzed before sending them to a permitted hazardous waste disposal facility. Therefore, the estimated cost to analyze and characterize PV modules is $1,200 per generator. In the baseline, it is assumed that storage and disposal facilities received PV modules that are already tested by generators. Therefore, these facilities do not incur costs for testing waste PV modules.

Testing is not required of universal waste generators since a category of waste is presumed hazardous once the generator decides to manage it as a universal waste. However, one-third of the universal waste handlers of PV modules become a hazardous waste generator once they determine to dispose of the PV module residuals after the authorized processing treatment activities. Therefore, DTSC assumes that one-third of the universal waste handlers conduct hazardous waste testing on a quarterly basis, in compliance with the large quantity generator accumulation time limit of 90 days at a cost of $1200 per testing. Therefore, the costs of hazardous waste characteristic testing averaged for eight (8) universal waste handlers is estimated to be $1,800 per handler.

### 3.4.2 Shipping Recordkeeping – Baseline and With Regulation

In the baseline, hazardous waste generators and storage facilities are required to keep record of hazardous waste shipment. For the generators, the cost of shipment recordkeeping is $58 for 1 shipment. For the storage facilities, there are a total of 312 hazardous waste shipments at $58 per shipment.

Under the universal waste regulation requirements, universal waste generators and handlers must record all shipments received or shipped and maintain records for at least three years: logs, invoices, bills of lading, or other shipping documents. The estimate cost to complete and maintain a record of universal waste shipments is $3.71 per shipment.[28] DTSC assumes that two-third of universal waste handlers received 265 universal waste shipments (calculated based on half of the average waste generated by generators distributed among the 8 handlers) whereas one-third of the universal waste handlers receives universal waste from other handlers and conducts authorized processing treatment activities, 85% of which results as PV module hazardous waste residuals (706 shipments) that will be disposed of. These universal waste handlers are therefore required to keep record of hazardous waste shipments once they determine to dispose of the hazardous waste residuals after treatment activities in addition to universal waste recordkeeping. The costs for shipping recordkeeping is estimated to be $15,970 per handler, averaged among eight handlers.

### 3.4.3 Manifests - Baseline and With Regulation

Hazardous waste generators are required to prepare a manifest for each hazardous waste shipment and maintain a copy of the manifest for three years. In addition, hazardous waste generators are required to complete the California Verification Questionnaire annually, by providing DTSC with the number of manifests they used the previous calendar year. Once the

[27] "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," SW-846, 3rd edition, 1986.
[28] U.S. EPA, Modification of the Hazardous Waste Program: Hazardous Waste Lamps, Final Economic Assessment, March 11, 1999. and Economic Analysis of Including Mercury Containing Devices in the Universal Waste System, Notice of Proposed Rulemaking, February 15, 2002.

manifest is prepared, the same manifest is used for storage and disposal facilities to track the wastes. Generators then pay $7.50 per manifest for each manifest for California. DTSC waives the first four manifests for businesses with less than 100 employees, but generators must pay for every manifest beyond the first four. All regulated businesses are also required to submit a land disposal restriction notification for each shipment.

The cost to complete the manifest and land disposal restriction notification is estimated at $58 per shipment. The California Manifest Fee is $7.50 per manifest. DTSC estimates that 98.3% of the business are small businesses (see Attachment). For this analysis, DTSC assumed that all generators qualified for the California Manifest Fee exemption. DTSC also assumed that all generators are qualified for the lower $5 federal Manifest Fee by using electronic manifests. For the baseline, the total variable manifest cost for generators used in this analysis is $63 per shipment for generators to transport hazardous waste to storage facilities. Storage facilities incur the costs for manifests to transport hazardous wastes to disposal facilities at $65.50.

With the regulation, two-thirds of the universal waste handlers conduct authorized removal and disassembling activities that do not generate hazardous waste. Therefore, two-thirds of the universal waste handlers do not incur costs for manifest. However, one-third of the universal waste handlers, that conduct authorized processing treatment activities, generate 85% of the universal waste they handle as hazardous waste residuals for disposal. Therefore, these universal waste handlers incur costs for manifest estimated at $65.50 per shipment. The costs for manifests and land disposal notification is estimated to be $17,341, averaged among eight handlers.

### 3.4.4 Transportation - Baseline and with Regulation

Shipments of hazardous waste must be done using a registered hazardous waste transporter. This analysis assumes that each hazardous waste shipment has a fixed cost of $215. For generators in the baseline, which equals $215 per business per year. For storage facilities, this equals to $67,080 per business per year.

Shipments of universal waste PV modules to handlers do not require a registered hazardous waste transporter, reducing shipping costs. This analysis assumes that universal waste transportation costs $143 per shipment.[29] Two-thirds of the universal waste handlers will only transport PV modules as universal waste and thus incur the transportation costs of $143 per shipment. For the remaining one-third of the universal waste handlers that process PV modules as authorized by the regulation, the remaining portion of the PV modules are considered hazardous waste residuals and must be transported as hazardous waste. These universal waste handlers will incur the hazardous waste transportation costs in addition to the universal waste transportation. The costs for hazardous waste transportation is estimated to be $80,605 per handler, averaged among eight handlers.

### 3.4.5 The Costs of Hazardous Waste Management - Baseline and with Regulation

There are currently no treatment facilities permitted to treat PV modules in California. This analysis assumes that businesses will be established to serve the PV module generators. DTSC

[29] ICF Incorporated (1998), “Baseline Costs and Cost Comparisons Between Hazardous Waste, Hazardous Material, and Non- Hazardous Shipments,” prepared for the U.S. Environmental Protection Agency, August 31, 1998.

cannot estimate fees a treatment facility may charge generators for this process but assumes that the price will be at least equivalent to dispose of the residual, nonrecyclable components of the PV modules, approximately $1,842 per ton[30] (the cost to dispose of the entire PV module). The disposal costs were calculated as $23,625 per generator for both the baseline and with regulation.

This analysis assumes the most conservative cost assumption that all hazardous waste PV modules are disposed of in California. The disposal of hazardous waste costs $350 per cubic yard,[31] and each truckload is approximately 80 cubic yards (about 16 tons); the cost for disposal is $1,750 per ton. In the baseline, DTSC assumes that storage facilities disposed of a hundred percent of the wastes as hazardous waste. The estimated annual disposal costs for each storage facility per year is $8,714,125.

Under the regulation, DTSC assumes that 15% of the PV modules is recovered. Therefore, the amount of PV modules that disposal facilities could receive as hazardous wastes is 4,233 tons (85% of total wastes) per year. For universal waste handlers that conduct PV module processing treatment activities, 85% of the PV modules after treatment is hazardous waste and must be disposed of as such. The estimated annual disposal costs is estimated as $7,406,963, averaged among eight handlers.

### 3.4.6 Generator Fees - Baseline and with Regulation

Generators that produce five tons or more of hazardous waste must pay a Generator Fee each year. The fee is a function of a base rate (adjusted annually to reflect changes in the Consumer Price Index) multiplied by a factor based on the amount of hazardous waste generated. Disposal facilities that pay an annual facility fee are not required to pay the Generator Fee. The Generator Fee rates for 2018 are provided in **Table 16**.

[30] This fee is calculated based on the generator fee rates in 2018 and assumption.
[31] Disposal cost estimate provided by Chemical Waste Management facility in Kettleman City for glass from cathode ray tubes, a waste type expected to be similar to PV modules.

**Table 16. Generator Fee Rates (2018)**

| Generator Fee | | |
|---|---|---|
| **Base Rate** | $4,604 | |
| **Tons Generated per Year** | **Rate** | **Fee (2018)** |
| Less than 5 tons | 0% base rate | $0 |
| Less than 25 tons | 5% base rate | $230 |
| Greater than 25, less than 50 | 40% base rate | $1,842 |
| Greater than 50, less than 250 | 100% base rate | $4,604 |
| Greater than 250, less than 500 | 5 x base rate | $23,020 |
| Greater than 500, less than 1,000 | 10 x base rate | $46,040 |
| Greater than 1,000, less than 2,000 | 15 x base rate | $69,060 |
| Greater than 2000 | 20 x base rate | $92,080 |

Based on the average annual quantity of PV Modules estimated above (13.5 tons per year for generators), the Generator Fee is $230 per generator per year.

With the regulation, the PV module generators will not be subject to the Generator Fee, but the one-third of the universal waste handlers, that conduct authorized processing treatment activities under the assumptions used in this analysis, will be subject to the Generator Fee to dispose of the hazardous waste residuals. Based on the amounts projected to be generated each year (4,233 tons), the Generator Fee for those handlers is $92,080 per year. Therefore, the estimated hazardous waste generator fee is estimated as $34,530, averaged among eight handlers.

### 3.4.7 Disposal Fee - Baseline and with Regulation

A disposal fee is required for disposal of hazardous wastes at a permitted hazardous waste disposal facility in California, and it is assessed per ton and type of hazardous waste. The disposal fee for California-only hazardous waste is $23.29 per ton. For federally regulated hazardous waste, the disposal fee is $57.68 per ton. Since DTSC cannot predict the proportion of hazardous PV modules that will be federally regulated versus California only hazardous waste, it assumed 50% for each, and used an average of the two fee rates ($40.49 per ton). For the baseline, disposal fee for the projected 19,918 tons waste is calculated as $806,480 per disposal facility. With regulation, the disposal fee for the projected 16,930.2 tons (85% of total wastes) disposal equals to $685,504 per disposal facility per year.