

APPENDIX

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 proposed 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 stem from the aforementioned U.S. EPA Regulatory Impact Analysis references therein.

1. STATEWIDE COSTS/SAVINGS TO COMPLY WITH THE PROPOSED 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 proposed 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.	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.
Requirements for hazardous waste generators:	Requirements for universal waste generators:

Baseline Parameters	With Regulation Parameters
<ul style="list-style-type: none"> A. Acquire Identification Number B. Comply with accumulation time limit requirements C. Comply with hazardous waste label requirements D. Have emergency procedures/contingency plans E. Train employees F. Ship using a manifest and registered transporter G. Submit a biennial report if RCRA large quantity generator H. Maintain records for at least 3 years 	<ul style="list-style-type: none"> A. Do not require an Identification Number before accumulating 5,000 kg of universal waste B. Comply with longer accumulation time limit requirements C. Comply with universal waste label requirements D. Have emergency procedures, but not required to have contingency plans E. Train employees F. 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 G. Do not require to submit a biennial report H. Do not require record maintenance
<p>All generators send their waste PV modules to 10 disposal facilities 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.</p>	<p>All generators send their waste PV modules to universal waste handlers in California that comply with the self-implementing authorization requirements under chapter 23. There are approximately 10 universal waste handlers authorized in California, evenly distributed geographically throughout the state.</p>
<p>Disposal facility requirements:</p> <ul style="list-style-type: none"> A. Obtain Identification Number for each site that generates hazardous waste B. Comply with requirements for use and management of hazardous waste containers C. Have emergency procedures and contingency plans in place 	<p>Universal waste handler requirements:</p> <ul style="list-style-type: none"> A. Obtain Identification Number for each site that handles universal waste B. Store PV modules for no more than one year from the accumulation start date; Document accumulation time; Label universal waste PV modules C. Conduct authorized treatment

Baseline Parameters	With Regulation Parameters
<p>D. Train all employees to ensure they are thoroughly familiar with proper waste handling and emergency procedures</p> <p>E. 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</p> <p>F. Maintain records for at least 3 years</p> <p>G. Submit a biennial report</p>	<p>D. Train employees in proper universal waste management including handling, packaging, storing and labeling the waste, and in how to respond to releases</p> <p>E. Only ship universal waste to a destination facility 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</p> <p>F. Keep records of all shipments and receipts of universal waste for 3 years</p> <p>G. Do not require to submit a biennial report</p> <p>H. 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.</p>

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.¹ For this analysis, DTSC assumed that the total number of businesses for the economic impact is 2,849, excluding the businesses with rooftop installations that 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.

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 replacing existing businesses that

¹ Source: SEIA/GTM Research U.S. Solar Market Insight.

² <https://www.census.gov/data/tables/2015/econ/susb/2015-susb-employment.html>

choose to no longer operate (and therefore no longer generate or handle PV modules). Based on this assumption, DTSC estimates that 49 businesses will become newly regulated generators of PV modules each year, while 49 similar businesses will cease to operate each year.

As of 2018, there are no businesses in California with a hazardous waste facility permit to store or treat PV modules. For the baseline, DTSC assumes that at least 10 disposal facilities that are established to manage waste PV modules. With the proposed regulation, DTSC assumes that there will be at least 10 handlers that accept waste PV modules for waste management. This assumption 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 proposed regulation, these handlers are authorized to accept waste PV modules as a new universal waste stream. Once the universal waste handler decides 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 proposed regulation does not impact the requirements related to disposal of 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 assumptions made in this analysis do not include residential installation of solar panels. 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 business that receives waste PV modules from other business to treat, store or recycle them. Baseline costs were calculated for both generators and for disposal facilities.

To estimate costs associated with the proposed 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 disposal 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.

Table 1 shows the baseline and with regulation costs calculated by estimating one-time, fixed annual and variable costs. The sums for the categorized costs, the total unit costs of each impacted business, and the total costs for all impacted businesses are further projected for the before and after the proposed regulation.

Table 1. Baseline and With Regulation Costs for Generators and Disposal Facilities or Handlers

	BASELINE		WITH REGULATION	
	Generators	Disposal Facilities (DFs)	Generators	Handlers
	One-time Costs (\$)		One-time Costs (\$)	
Notification of hazardous waste activity	\$62.00	\$0.00	\$62.00	\$0.00
Rule familiarization	\$424.00	\$0.00	\$188.00	\$188.00
Closure plan	\$0.00	\$6,712.00	\$0.00	\$984.40
Contingency plan	\$0.00	\$731.00	\$0.00	\$731.00
Total one-time costs per business	\$486.00	\$7,443.00	\$250.00	\$1,903.40
Number of businesses (Generators or DFs/Handle)	49	10	49	10
Total one-time costs for all impacted businesses	\$23,814.00	\$74,430.00	\$12,250.00	\$19,034.00
	Fixed Annual Costs (\$)		Fixed Annual Costs (\$)	
Annual review	\$0.00	\$93.00	\$0.00	\$93.00
Waste recordkeeping	\$41.00	\$41.00	\$41.00	\$41.00
Annual reporting (biennial report)	\$419.00	\$837.00	\$0.00	\$837.00
Annual employee training	\$1,341.00	\$4,192.00	\$1,326.00	\$1,326.00
Manifest training	\$241.00	\$241.00	\$0.00	\$0.00
Labeling	\$74.00	\$74.00	\$0.00	\$0.00
Facility permit application prepare (annualized)	\$0.00	\$25,000.00	\$0.00	\$0.00
Facility permit application review (annualized)	\$0.00	\$25,000.00	\$0.00	\$0.00
Financial assurance for closure (annualized)	\$0.00	\$10,000.00	\$0.00	\$2,000.00
Annual facility fee	\$0.00	\$11,730.00	\$0.00	\$0.00
Total fixed annual costs per business	\$2,116.00	\$77,208.00	\$1,367.00	\$4,297.00
Number of businesses (Generators or DFs/Handle)	2849	10	2849	10
Total fixed annual costs for all impacted businesses	\$6,028,484.00	\$772,080.00	\$3,894,583.00	\$42,970.00
	Variable Costs (\$)		Variable Costs (\$)	
Hazardous waste analysis and characterization	\$1,200.00	\$0.00	\$0.00	\$0.00
Waste shipping recordkeeping	\$116.00	\$0.00	\$7.42	\$1,847.58
Manifest and land disposal notification	\$126.00	\$29,892.00	\$0.00	\$29,892.00
Waste transportation	\$430.00	\$91,160.00	\$286.00	\$91,160.00
Waste treatment/recycle (Generators)				
Hazardous waste disposal (DFs/Handlers)	\$43,785.36	\$11,851,150.50	\$43,785.36	\$11,851,150.50
Fees (Generator)	\$1,842.00	\$0.00	\$0.00	\$92,080.00
Fees (Disposal)	\$0.00	\$274,201.76	\$0.00	\$274,201.76
Total variable costs per business	\$47,499.36	\$12,246,404.26	\$44,078.78	\$12,340,331.84
Number of businesses (Generators or DFs/Handle)	2849	10	2849	10
Total variable costs for all impacted businesses	\$135,325,676.64	\$122,464,042.62	\$125,580,444.22	\$123,403,318.42
TOTAL COSTS PER BUSINESS	\$50,101.36	\$12,331,055.26	\$45,695.78	\$12,346,532.24
TOTAL COSTS FOR ALL BUSINESSES (Generators = 2849; DFs / Handlers = 10)	\$141,377,974.64	\$123,310,552.62	\$129,487,277.22	\$123,465,322.42

Table 2 is a summary of estimated cost comparison for one-time costs, fixed costs, and variable costs for generators and disposal facilities or handlers, for the baseline and with regulation. The total cost estimated for generators with regulation is lower than that of the baseline. There is a small increase in total cost for handlers after the proposed regulation is adopted, mainly due to having to add a new waste stream to the business

and becoming familiar with a new regulation. Overall, DTSC estimated a total cost savings of \$11,735,928 under the proposed regulation.

Table 2. Comparison of Costs or Savings Before and After Proposed Regulation

COST CATEGORY	NO ACTION ALTERNATIVE (BASELINE)		WITH REGULATION		COSTS OR SAVINGS	
	Generators	Disposal Facilities	Generators	Handlers ¹	Generators	Handlers ¹
One-time Costs	\$23,814	\$74,430	\$12,250	\$19,034	-\$11,564	-\$55,396
Fixed Annual Costs	\$6,028,484	\$772,080	\$3,894,583	\$42,970	-\$2,133,901	-\$729,110
Variable Costs	\$135,325,677	\$122,464,043	\$125,580,444	\$123,403,318	-\$9,745,232	\$939,276
Total Costs	\$141,377,975	\$123,310,553	\$129,487,277	\$123,465,322	-\$11,890,697	\$154,770
Total Costs (Generators and Disposal Facilities / Handlers)	\$264,688,527		\$252,952,600		-\$11,735,928	

¹ Handlers refer to universal waste handlers who treat and store waste PV modules who are authorized to accept PV modules as universal waste. Once handlers dispose of waste PV modules, they become generators of hazardous waste and must comply with full hazardous waste disposal requirements.

1.3.1 Baseline One-Time Costs

One-time costs apply to generators that generate and disposal facilities that accept waste PV modules 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**). For disposal facilities, one-time costs include creating a closure plan and a contingency plan, since these disposal 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% 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.³ The total number of businesses used to estimate the economic impact is 2849. Therefore, this analysis estimates that there will be 49 newly regulated businesses each year that incur the one-time costs specified above⁴ (See **Table 1**). DTSC assumed that there are 10 disposal facilities that manage hazardous waste PV modules as described earlier.

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. Generators are still required to notify DTSC of their hazardous waste activities. For universal waste handlers that manage PV modules as a new universal waste stream, they need to create a closure plan and have a contingency plan in place if they treat PV modules.

³ <https://www.census.gov/data/tables/2015/econ/susb/2015-susb-employment.html>

⁴ If the number of newly regulated businesses increase, it is likely that estimated cost savings will exceed the estimates calculated in this analysis.

The total one-time costs for PV module generators and handlers are as shown in **Table 1**.

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.⁵

Hazardous waste generators 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 reporting, annual employee training, manifest training, and hazardous waste labeling. Disposal facilities' fixed annual costs of compliance are more extensive. They include annual review of hazardous waste regulations, recordkeeping, biennial 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 1**).

1.3.4 With Regulation Fixed Annual Costs

DTSC expects that training requirements will be less for all impacted businesses under the proposed regulation. With the proposed 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 proposed regulation, fixed annual costs for universal waste handlers include an annual review of the relevant regulations, recordkeeping, reporting, and personnel safety training. 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 hazardous waste. These costs are already incurred by universal waste handlers that manage other hazardous wastes.

The costs for personnel safety training for universal waste handlers is lower than that of disposal 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 treatment generate hazardous wastes and are required to ship them using hazardous waste manifests. The manifest training costs were assumed to be the same as disposal facilities manifest training costs (**Table 1**).

Universal waste handlers conducting authorized treatment need to establish and maintain a financial assurance plan to pay for closure costs. Based on the financial

⁵ 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.

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 handlers is \$2,000 (**Table 1**).

For the total fixed annual costs, the number of estimated impacted businesses are multiplied by the sum of all fixed annual costs anticipated under the proposed regulation. For generators, this analysis estimates total fixed annual costs of \$1,367 per business. These costs were applied to the 2,849 PV module generators. For the universal waste handlers, this analysis estimates total fixed annual costs of \$4,297 per business. These costs were applied to the 10 new anticipated universal waste handlers (**Table 1**).

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.⁶ Variable costs are different between generators 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; and (6) cost of any fees for generation or disposal of hazardous wastes.

Variable costs are projected based on the expected number of 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 (2,849 generators or 10 disposal facilities) to obtain the total variable costs (**Table 1**).

1.3.6 With Regulation Variable Costs

Variable costs parameters used in the baseline also apply under the proposed regulation. Variable costs are lower for universal waste generators under the proposed regulation. Universal waste generators are required to complete basic recordkeeping, at an estimated cost of approximately \$4 per shipment, compared to \$56 to \$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; thus, further reducing the shipping costs. This analysis assumes that universal waste shipments cost \$143 per shipment.⁷ This analysis also assumes the same average truck capacity (16 tons) and average travel

⁶ The number of hazardous waste shipments made by each business is dependent on the amount of PV modules they generate.

⁷ Based on the data presented 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.

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 generators, this analysis estimates variable costs of \$44,079 per business per year applied to the 2,849 PV module generators. For handlers, this analysis estimates total variable costs of \$12,340,332 per business applied to the 10 anticipated handlers (Table 1).

1.4 Net Cost Impacts

The proposed 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 proposed 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 Table 2 (above).

This analysis estimates cost savings of \$11,890,697 for PV module generators and incremental additional costs of \$154,770 for handlers of PV modules per year, as shown in Table 3. Most notable in this analysis is that because there is no recycling market for PV module glass in California, the variable costs under both the baseline and the with regulation are nearly identical. There is a shift in Generator Fee liability from the PV module generators in the baseline to the universal waste handlers in the proposed 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.

Table 3. Costs or Savings for Generators and Handlers With Regulation

COST CATEGORY	Generators		Disposal Facilities / Handlers	
	Cost Savings	Change from Baseline (%)	Cost Savings	Change from Baseline (%)
One-Time Cost Savings	\$11,564	48.6	\$55,396	0.0
Fixed Annual Cost Savings	\$2,133,901	35.4	\$729,110	94.4
Variable Cost Savings	\$9,745,232	7.2	-\$939,276 ¹	-0.8
Total Cost Savings	\$11,890,697	8.4	-\$154,770 ¹	-0.1

¹The increased costs to PV module handlers is attributable to the Generator Fee. Under the baseline scenario, the PV module generators pay the Generator Fee. Under the post-rule scenario, the PV module universal waste generators are not subject to the Generator Fee, but

COST CATEGORY	Generators		Disposal Facilities / Handlers	
	Cost Savings	Change from Baseline (%)	Cost Savings	Change from Baseline (%)
the PV module universal waste handlers become subject to the generator fee for the PV module waste being sent for disposal as hazardous waste.				

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.).⁸ In the June 2016 publication by The International Renewable Energy Agency (IRENA), titled “*End of Life Management: Solar Photovoltaic Panels*,”⁹ 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 4** below.

Table 4. 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 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 4**. It is assumed that nearly half of all solar electricity generating capacity in the U.S. currently is located in California.¹⁰

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 (**Table 5**).

⁸ In the proposed regulations, PV panels are referred to as PV modules.

⁹ <http://www.irena.org/publications/2016/Jun/End-of-life-management-Solar-Photovoltaic-Panels>

¹⁰ “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>

Table 5. 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

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 6** (see following page) 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 proposed regulation also affects the one-time costs incurred by new generators of hazardous waste PV modules (e.g., the cost of establishing a contingency plan).¹¹

Table 6. 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.

¹¹ Because these are sunk costs for existing businesses, this analysis does not include these costs.

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 2,849.

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,¹² 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 49 businesses will become newly regulated generators of PV modules each year.

3.1.3 Disposal Facilities/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 10 disposal facilities to manage hazardous waste PV modules. For the proposed regulation, DTSC assumed that there will be at least 10 handlers that manage universal waste PV modules, based on the interest expressed by e-waste handlers at the communication workshop held by DTSC in 2017.

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 Notification¹³ - Baseline and With Regulation

This estimates notification costs under the baseline for new generators and under the proposed 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.

¹² https://www.census.gov/ces/dataproducts/bds/data_firm.html

¹³ 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.

For disposal facilities and 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 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.¹⁴

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

Under the proposed regulation, the universal waste system for businesses that exclusively generate PV modules is less complicated than full hazardous waste requirements; thus, regulation familiarization costs are assumed to be less. Based on the data used in U.S. EPA regulatory impact analyses for other universal wastes,¹⁵ DTSC estimates regulation familiarization costs of \$188 for businesses generating PV modules. DTSC assumes that there will be no new handlers being established in subsequent years; the universal waste handlers that manage e-waste will become handlers of PV modules, and thus no additional cost is incurred.

3.2.3 Development of a Closure Plan¹⁶ – Baseline and With Regulation

This analysis assumes that 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 7** includes costs associated with the development of a closure plan: writing descriptions, estimating costs, and creating a closure schedule. These costs are approximated to be \$6,712 per disposal facility. A closure plan needs to be established for handlers under the proposed regulation, but at a lesser cost of \$984, compared to the cost of full hazardous waste management.

¹⁴ U.S. EPA, Economic Analysis of Including Mercury Containing Equipment in the Universal Waste System: Final Rule. February 15, 2002 (revised May 9, 2005).

¹⁵ Based on the data presented 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.

¹⁶ 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 7. 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 cost	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 Planning¹⁷ – Baseline and With Regulation

In the baseline, disposal facilities incur costs for development of a contingency plan for a new waste stream, PV modules. **Table 8** 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.

Universal waste handlers of PV modules as a new waste stream also incur similar costs under the proposed regulation.

¹⁷ U.S. EPA, Supporting Statement for EPA Information Collection Request Number ICR 0820.14 Hazardous Waste Generator Standards, September 2014.

Table 8. 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 disposal facilities and handlers conduct an annual review of the regulations, but generators of waste PV modules do not. **Table 9** shows a limited amount of legal, managerial, and technician time estimated for the annual review.

Table 9. 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
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 Recordkeeping¹⁸ – Baseline and With Regulation

Under hazardous waste regulations and with the proposed 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 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 10** 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 proposed regulation are not required to submit a similar biennial report.

In California under current regulations, disposal facilities are required to submit an annual report. DTSC estimates that each year, disposal facilities will incur costs similar to those estimated in **Table 10** (see following page), \$837 per business per year.

Under the proposed 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.

Table 10. 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

¹⁸ 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.

Activity	Manager Time (hours)	Technician Time (hours)	Administrative Time (hours)	Labor Cost	Operation and Maintenance Cost	Total Cost
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
<p>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.</p> <p>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.</p>						

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.¹⁹ 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 disposal facilities require additional personnel to manage

¹⁹ 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.

off-site wastes, DTSC estimates that disposal facility training costs \$4,192 per business per year. **Table 11** summarizes these costs.

Table 11. 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
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	\$1,326	4 technicians and 2 managers for 2-hour training

Under the proposed 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 proposed 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.

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.^{20, 21} 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 \$241,²² using a 7% discount rate). The manifest training costs of disposal facilities are assumed to be the same as those of generators.

Under the proposed regulation, transporting PV modules to other universal waste handlers does not require a hazardous waste manifest, thus, the manifest training is not required. Universal waste handlers that generate hazardous wastes while conducting authorized treatment are required to ship hazardous wastes using

²⁰ U.S. EPA, ICR 801.18 "Requirements for Generators, Transporters, and Waste Management Regulated Businesses Under the RCRA Hazardous Waste Manifest System." 2012.

²¹ 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.

²² This value is calculated based on the data presented in the U.S. EPA Regulatory Impact Analysis for Aerosol Cans and is different from the reported value in the U.S. EPA analysis.

hazardous waste manifests. Their training costs are assumed to be the same as disposal facility manifest training costs, which are already incurred by having managed other hazardous wastes.

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.²³ The combined annual cost of labeling per generator is estimated to be \$74. The labeling costs of disposal facilities in the baseline are assumed to be the same as those of generators.

Under the proposed regulation, generators are not required to label waste PV modules as “Hazardous Waste” because they are being disposed of as universal waste. Handlers, however, are required to label the waste that will be disposed of as hazardous waste. The labeling costs for handlers in the proposed regulation is assumed to be the same as those of disposal facilities but already incurred as a part of the business.

3.3.7 Disposal Facility Fixed Annual Costs

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

3.3.7.1 Facility Permit Application Preparation – Baseline Only

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.

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.

²³ U.S. EPA, Supporting Statement for EPA Information Collection Request Number ICR 0820.14 Hazardous Waste Generator Standards, September 2014.

3.3.7.2 Facility Permit Application Review – Baseline Only

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.

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 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 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 proposed regulation, universal waste handlers that conduct authorized treatment 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.

3.3.7.4 Annual Facility Fee – Baseline Only

A disposal 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 disposal facility, DTSC anticipates that these facilities are classified as a Series A standardized permit. Based on DTSC's Annual Fee Summary, the facility fee for a Series A standardized permit facility is \$11,730 per facility per year.

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 an LQG. DTSC assumes an estimate for all PV modules in service in the state 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. The total amount of PV modules generated is divided

by that of impacted businesses to estimate the annual quantity of PV modules per generator (Table 12).

Table 12. 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
Waste per Generator ¹ (tons)	11.28	14.24	17.19	38.10	59.01
Shipments per Generator ²	1	1	2	3	4
Total Estimated waste to be Disposed as Hazardous Waste ³ (tons)	27,307	34,479	41,650	92,273	142,895
Hazardous waste per Disposal Facility ⁴ (tons)	2,731	3,448	4,165	9,227	14,290
Hazardous Waste Shipments per Disposal Facility ⁵	171	216	261	577	894

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 (2,849 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 total estimated hazardous waste PV module was calculated by subtracting 15% of the total estimated tons of 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.

⁴ The hazardous waste PV module per disposal facility was calculated by dividing the total estimated tons of PV modules per year by the total number of disposal facilities expected to be generating PV modules (10 businesses).

Year	2018	2019	2020	2021	2022
<p>⁵ The number of hazardous waste PV module shipments per disposal 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.</p>					

Variable cost estimates for generators were calculated using the average projections for the years 2018-2022, for both total expected tons of PV modules generated and expected frequency of PV modules shipped by generators: an average of 27.97 tons of PV modules per year per generator (approximately 1,695 PV modules, assuming each panel weighs 33 pounds), 2 shipments of PV modules per year per generator.²⁴

The variable costs estimated for handlers that manage waste PV modules were calculated using the average projections for the years 2018-2022. All handlers were assumed to manage an average of 7,967 tons of PV modules per year. Fifteen percent of the total tons of waste PV modules are recycled. Therefore, only 85% of the total PV waste (6,772 tons) are shipped as hazardous waste to a disposal facility, which is equivalent to 424 shipments of PV modules per year (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.²⁵ 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).

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).²⁶ DTSC gathered 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 disposal facilities received PV modules that are already tested by generators. Therefore, disposal facilities do not incur costs for testing waste PV modules.

²⁴ 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.

²⁵ See California Code of Regulations, title 22, division 4.5, chapter 12, section 66262.11

²⁶ "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," SW-846, 3rd edition, 1986.

Testing is not required of universal wastes. Once a category of waste is listed as a universal waste, it is presumed hazardous.

3.4.2 Shipping Recordkeeping - With Regulation

Under the universal waste regulation requirements, 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.²⁷ DTSC assumed that each universal waste handler received 498 shipments (calculated based on the average waste generated by generators distributed among the 10 handlers). The total costs for shipping recordkeeping is estimated to be \$1,848 per handler.

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. 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 and disposal facilities / handlers are qualified for the lower \$5 federal Manifest Fee by using electronic manifests.

The total variable manifest cost for generators used in this analysis is \$63 per shipment for generators and \$70.50 per shipment for disposal facilities and 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, this equals \$430 per business per year. For disposal facilities, this equals to \$91,160 per business per year.

²⁷ 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.

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.²⁸ For universal waste handlers that treat PV modules as authorized by the proposed regulation, the remaining portion of the PV modules are hazardous waste and must be transported as hazardous waste. Handlers will incur the same transportation costs as disposal facilities (\$91,160 per business per year).

3.4.5 Recycling or Disposal - 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 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 \$1,566 per ton²⁹ (85% of the cost to dispose the entire PV module). The disposal costs were calculated as \$43,785 per generator.

PV modules under universal waste are hazardous wastes; therefore, they must be disposed of at permitted hazardous waste disposal facilities. 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,³⁰ and each truckload is approximately 80 cubic yards (about 16 tons); the cost for disposal is \$1,750 per ton. Assuming that 15% of the PV modules is recovered, the amount of PV modules that disposal facilities could receive as hazardous wastes is 6,772 tons (85% of total wastes) per year. The estimated annual disposal costs for all waste PV modules in California are \$11,851,151 per disposal facility per year. For universal waste handlers that treat PV modules, 85% of the PV modules after treatment is hazardous waste and must be disposed of as such.

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 13**.

²⁸ 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.

²⁹ This fee is calculated based on the generator fee rates in 2018 and assumption that 85% of the total waste generated by generators is considered hazardous waste.

³⁰ 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 13. 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 (27.97 tons per year for generators), the Generator Fee is \$1,842 per generator per year.

With the proposed regulation, the PV module generators will not be subject to the Generator Fee, but the universal waste handlers will be subject to the Generator Fee upon the decision to dispose of the components of the PV module that cannot be further treated. Based on the amounts projected to be generated each year (6,772 tons), the Generator Fee for each handler is \$92,080 per handler per year.

3.4.7 Disposal Fee - Baseline and with Regulation

A disposal fee is required for those that dispose 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 projected 6,772 tons (85% of total wastes) disposal, this equals to \$274,202 per handler per year.

