United States
Consumer Product Safety Commission

Memorandum

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SUBJECT: Safety Standard for Lithium-Ion Batteries Used in Micromobility Products and Electrical Systems of Micromobility Products: Preliminary Regulatory Analysis

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Executive Summary

The U.S. Consumer Product Safety Commission (CPSC) is considering a Notice of Proposed Rulemaking (NPR) to address the unreasonable risks of death, injury, and property damage associated with lithium-ion batteries in micromobility products.[1] To mitigate those risks, CPSC staff's recommended draft proposed rule would adopt the following voluntary standards, with modifications, as requirements: ANSI/CAN/UL-2272:2024, *Electrical Systems for Personal E-Mobility Devices* (UL 2272), ANSI/CAN/UL 2849:2020, *Electrical Systems for eBikes* (UL 2849), and ANSI/CAN/UL/ULC 2271:2023, *Standard for Batteries for Use in Light Electric Vehicle (LEV) Applications* (UL 2271).

UL 2272 and UL 2849 established construction and performance requirements designed to reduce fire and electric shock risks in the electrical systems of micromobility products. UL2271 established similar construction and performance requirements for user replaceable battery packs, eBike conversion kits, and aftermarket battery chargers. The draft proposed rule proposes to incorporate all three standards by reference, with modifications to operating instructions, labeling, safety markings, tamper resistant battery compartments, and additional testing procedures.

Staff identified 24 deaths from reported incidents, and estimate 42 nonfatal medically attended injuries[2], that occurred between 2019 and 2023, which the draft proposed rule could have addressed. Based on an

[1] For the purposes of this NPR, a "micromobility product" means one or more of the following battery-powered vehicles, where "e" represents "electric": eBikes, eScooters, eSBscooters (self-balancing scooters), eSkateboards, eUnicycles, and hybrids of these products.
[2] The 42 nonfatal injuries are an estimate of the medically attended injuries extrapolated from 13 observed NEISS cases. The increase from 13 to 42 includes only injuries that have been medically treated. The 42 estimated are not a national estimate, but represent a likely minimum value of total medically treated injuries, based on the known observations.

engineering assessment, staff estimate the draft proposed rule would mitigate approximately 90 percent of addressable deaths and injuries by largely eliminating the risk of thermal runaway and other fire hazards in covered electrical systems.

The micromobility market includes emerging products, some of which have only been introduced in the last decade and are rapidly growing in popularity and consumer acceptance. The relative novelty of these products poses challenges in the data. For example, fire incident data that CPSC staff use to identify addressable fire incidents do not have a product category for lithium-ion batteries. This could cause lithium-ion battery fires from micromobility products to be mislabeled or not identified if micromobility products were not mentioned in the narrative for the incident. eBike data especially have a high degree of uncertainty because eBikes are the least mature segment of the micromobility marketplace, with substantial uncertainties related to product safety, consumer demand, producer behavior in the absence of a CPSC regulation addressing battery safety, and a growing presence of other regulation—particularly at the state and local levels. The uncertainty surrounding these factors represent the most significant source of variability in this analysis.

Given these uncertainties, staff present the results of the benefits and costs analyses for this draft proposed rule under two framings: (1) a point estimate that uses the incident data collected despite likely underestimation of incidents, and (2) an upper-bound estimate in which staff address the uncertainty in incidents by aligning the eBike fatality rate with the rate of eScooters – which is the most developed micromobility product market.

Staff conduct a benefits analysis for the draft proposed rule, estimating the value of prevented deaths, injuries, and property damage. Staff monetized these benefits using the value of statistical life (VSL) for deaths, CPSC's Injury Cost Model (ICM) for injuries, and historical data on fire damage for property loss. Over the 30-year study period (2027-2056), staff's estimate of the total annualized benefits of the draft proposed rule to be $73.01 million, discounted at 3 percent, and $62.94 million, discounted at 7 percent.[3] The upper-bound estimate identifies total annualized benefits of $508.17 million, discounted at 3 percent.

The draft proposed rule would impose compliance costs on suppliers from the improvement of batteries they use in their new production. It would also generate deadweight loss[4] (DWL) due to higher prices from compliance, leading to reduced demand for covered products. Staff include DWL as a cost in its analysis and conducts a 30-year prospective cost assessment for both cost categories. The total annualized costs of the draft proposed rule are $146.52 million, discounted at 3 percent, and $147.42 million, discounted at 7 percent.

When costs are compared to the point estimate of benefits, the estimated costs of the rule exceed benefits. Staff calculate annualized net benefits (benefits less costs) to be -$73.51 million, discounted at 3 percent, and -$84.48 million, discounted at 7 percent. Based on these estimates, the draft proposed rule would have a benefit-cost ratio of 0.50 under a 3 percent discount rate, and 0.43 under a 7 percent discount rate, for all micromobility products, meaning it returns $0.50 of benefits for every $1 in cost using the 3 percent discounted metric.

For the upper-bound estimate of benefits, staff align the fatality rate per eBike with the level observed for eScooters,[5] at which case the draft proposed rule would yield annualized net benefits of $361.65 million and a benefit-cost ratio of 3.47. Staff consider this plausible projection to represent an upper bound of the estimated net benefits for this draft proposed rule.

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[3] Staff use a discount rate to incorporate the time value of money during the 30-year study period. In the analysis, staff present both costs and benefits in undiscounted dollars, discounted at 3 percent, and discounted at 7 percent.
[4] Deadweight loss is the value of lost transactions due to the exit of some buyers and sellers after major market events, such as a new regulation.
[5] The eScooter death rate is 12.973 deaths per million noncompliant eScooters in use (or 1.297 per million compliant eScooters). If the death rate per million noncompliant eBikes reaches 1.947 deaths per million eBikes in use – or 15 percent the death rate of eScooters, the benefits and costs of the rule would be equal.

Staff also conduct other sensitivity analyses. Given the inherent data uncertainty with eBikes as emerging products, these sensitivity analyses provide insight on the degree of underestimation in key parameters that could alter the economic assessment of the draft proposed rule.

1 Introduction

The CPSC is considering a draft NPR to mitigate the risk of deaths, injuries, and property damage associated with lithium-ion batteries used in micromobility products including after-market lithium-ion batteries. From 2019 through 2023, staff identified 24 deaths and 42 injuries from fires initiated by lithium-ion batteries associated with micromobility products that are addressable by this rule.

Draft Proposed Rule

The draft proposed rule requires all eBikes, eScooters, and other micromobility products (OMPs), as well as all user replaceable battery packs, eBike conversion kits, and aftermarket battery chargers manufactured in, or imported to, the United States to meet the requirements of UL 2272, UL 2849, and UL 2271, with modifications. These modifications address operating instructions, labeling, safety markings, tamper resistant battery compartments, and additional testing procedures. These modifications are described in section IV of the draft NPR.

Preliminary Regulatory Analysis

Pursuant to section 9(c) of the Consumer Product Safety Act, publication of a proposed rule must include a preliminary regulatory analysis containing the following:

(1) a preliminary description of the potential benefits and costs of the proposed rule, including any benefits or costs that cannot be quantified in monetary terms, and an identification of those likely to receive the benefits and bear the costs;
(2) a discussion of relevant voluntary standards; and
(3) a description of any reasonable alternatives to the proposed rule, together with a summary description of their potential costs and benefits, and a brief explanation why such alternatives should not be published as a proposed rule.[6]

An overview of the micromobility products market can be found in section 2 of this memorandum. An explanation of the assumptions, and forecasts of the product populations in-scope, used in this analysis are detailed in section 3. A preliminary description of the potential costs and benefits of the draft proposed rule over a 30-year study period (starting in 2027 through 2056) can be found in sections 4 and 5, respectively. An analysis of benefits relative to costs can be found in section 6. A discussion of the relevant voluntary safety standards and reasonable alternatives to the draft proposed rule can be found in the draft NPR.

2 Market Information

The draft proposed rule would apply to all micromobility products under the scope of the UL 2272 and UL 2849 standards, which include eBikes, eScooters, electronic self-balancing scooters (eSBscooters), eUnicycles, and other micromobility products. The draft proposed rule would also apply to battery chargers and user replaceable battery packs sold separately from a micromobility product as defined in UL 2271. While the voluntary standards and the draft NPR organizes micromobility products into two categories– eBikes and other products –

[6] 15 U.S.C. § 2058(c).

this initial regulatory analysis separates them into three product categories, with user replaceable battery packs included under their specific product:

(1) eBikes,
(2) eScooters, and
(3) other micromobility products (OMPs).

Staff use three categories for the benefit-cost analysis because each of these categories is a distinct market with its own economic data, trends, and assumptions. To more easily measure the impact of the draft proposed rule, staff treat these three markets separately and incorporates their distinct data, trends, and assumptions.

This section provides market information for each product category. In 2021, CPSC contracted Euromonitor to conduct an industry-wide market study on micromobility products. The Euromonitor report, completed in February 2022, is titled *Micro-Mobility Product Market Research*.[7] The information provided in this section, unless otherwise stated, is derived from the Euromonitor report. Staff update values from the 2022 Euromonitor report to reflect current approximations where appropriate and includes the calculations for these updates in the footnotes.

eBikes

2.1.1 The Product

eBikes are generally defined as open frame bicycles with an electric motor and battery installed to assist the rider. These products can be purchased for as little as $200 for some children's models to greater than $10,000 for cargo models intended to carry additional passengers and/or cargo. Premium eBikes start at $2,500 and have more powerful motors that can reach speeds exceeding 28 miles per hour (mph) with pedal assist, hydraulic brakes, and lighter frames. The average price across all eBikes is approximately $3,150. Conversion kits are battery products that convert a traditional bicycle to an eBike. Prices for conversion kits range from $100 to $400 not including a battery.[8]

The two primary motor categories of eBikes are hub motor (the motor is housed within a wheel hub) and mid-drive (the motor is located near the crank arms). These typically range in power from 250 to 1,250 sustained watts. Consumers generally select the motor type and power based on whether it's intended for recreation, commuting, or business.

The batteries that power these motors range from 36 to 72 volts with variations in total capacity from 10 to 40 amp hours. These batteries have an expected product life that ranges from 3 to 5 years.[9,10] Staff base this range on interviews conducted with manufacturers, research on the technical information of these batteries, and the duration and information in the warranties offered by eBike firms.[11,12,13] Staff estimate that nearly all eBike batteries currently sold in the USA are made with lithium-ion cells. These batteries are installed with a mounting

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[7] See section II.C of the draft NPR to access the link for this report.
[8] Batteries are typically purchased separately for conversion kits, but some are sold with an included battery.
[9] Battery manufacturer spec sheets indicate most eBike batteries are designed to last 500 to 1,000 charge/discharge cycles. Product life is, therefore, heavily dependent on intensity of usage by the consumer.
[10] Staff identified 2 manufacturers that provide a 5-year warranty specific to eBike batteries. Warranties offered by other manufacturers range from 1 to 3 years.
[11] Euromonitor, "Micro-Mobility Product Market Research: Custom Report for CPSC Contract No. 61320621P0015", February 2022, Chicago IL.
[12] Warranty information for one such firm reviewed can be found at: https://pedegoelectricbikes.com/ . Other firms reviewed include Aventon, RadPower, Lectric, Electric Bike Company, Himiway, Jetson, and Bosch.
[13] Battery specification sheets obtained from various eBike and battery manufacturers websites such as Bosch and UnitPackPower.

frame on the frame of the eBike, with brackets, or integrated within the frame. As with motors, consumers' preferences on battery voltage and capacity depend on the battery's intended use. Some consumers purchase extra batteries to extend the range of their products.

2.1.2 The Firms

Staff identified 179 firms that manufacture or supply eBikes to the U.S. market. Most of these firms are importers who distribute products that were manufactured in China. Overseas companies produce many components used by domestic manufacturers; nearly all eBike batteries are manufactured overseas. Staff identified 5 domestic eBike manufacturers who likely assemble the eBikes from imported parts. One of the 5 firms also assembles battery packs for their own U.S. produced bikes. Unlike the variety of eBike models in the market, battery packs for eBikes are typically standardized to an average of 3 variations per firm.

2.1.3 The Markets

Currently, the domestic eBike market is growing quickly with a compounding annual growth rate (CAGR) of 31 percent from 2018 to 2024 for units sold. High growth rates in this market may persist in the short run as the market does not appear saturated. Increased recreational use of eBikes and investments made by ride sharing firms in major cities have contributed to the market's quick growth. Despite the recently slowing investments by ride sharing firms, the overall eBike market has continued to grow. The U.S. eBike market is relatively new, emerging just about a decade ago. eBikes are typically sold through physical retail outlets but recently an increasing number are being sold through online retail channels. This trend in online sales is expected to continue in the short run but, as eBike firms maintain a physical dealer network, it is unlikely to exceed 30 percent of total sales volume. Table 1 provides estimates of eBikes units sold from 2018 to 2024.

Table 1: eBikes Sales

Year	Units Sold (Thousands)
2018	271.7
2019	301.6
2020	748.4
2021	898.1
2022*	1,066.6
2023*	1,242.8
2024*	1,420.1

* Forecasted years from Euromonitor 2022

While four large firms account for the plurality of units sold, small importers account for the majority. A single firm accounts for at least 20 percent of eBikes sold in the U.S. The small importers' products are typically manufactured by large Chinese or Taiwanese firms with a small number imported from the European Union.

eScooters

2.1.4 The Product

eScooters are defined as two-wheeled products comprised of a platform (with or without seating) supported by wheels in a longitudinal placement (unlike Segways, which have parallel wheels) and without pedals. eScooters also use handlebars that enable users to steer and brake.

eScooter performance and battery pack specifications vary greatly and depend, at least in part, on the scooter's intended use. Battery pack specifications for child and youth models typically range from 50 to 75 watt-hour (Wh) but may exceed 155 Wh for models intended for use by youths 12 years of age and older. Child and youth models typically limit top speeds to 8 to 10 mph and have a range of 4 to 10 miles. Performance capabilities for eScooters intended for adults are significantly greater with battery packs averaging 360 Wh. Top speeds ranged from 12 to 24 mph (and in some cases higher) with an average cruising range on a single charge of about 25 miles. Across all categories, the most common battery pack specifications are 36 volts, 270 Wh, and 12 amp-hour (Ah).

The typical product life of an eScooter battery pack is 500 to 800 discharge cycles, or 3 to 4 years under optimal conditions. However, recommended replacement is 2 to 3 years for best performance. While dependent upon the intensity of use, eScooter product life is expected to exceed the term of the battery replacement schedule.[14]

Child and youth eScooter model prices range from $79 to $333, with the average at $188. Adult eScooter model prices averaged $780 and ranged from $499 to $7,299. For all categories, the average eScooter model price was about $510.

2.1.5 The Firms

Staff identified 81 firms supplying 704 eScooter models/variants to the U.S. market. Nearly all eScooters are imported from China (including Taiwan). Of the 81 firms, staff identified 7 U.S. domestic eScooter manufacturers.[15] Overseas companies produce many of the components used by domestic manufacturers, including nearly all eScooter battery packs. eScooter battery packs are typically not unique to one eScooter model/variant, but most firms use no more than 3 different battery pack configurations for their product lines.

2.1.6 The Markets

Commercial eScooters are eScooters purchased for business operations instead of personal use and are mostly purchased by ridesharing companies to add to their fleet in urban areas. Commercial eScooters comprise 35 percent of the overall eScooter market and about 10 to 15 percent of the rideshare market. While this market composition is not expected to change in the short run, ongoing market consolidation, through acquisition and exit, is expected to reduce the number of commercial eScooter rideshare firms.

Nearly 85 percent of private eScooter sales are conducted via on-line retail channels. Walmart, Costco, Dick's Sporting Goods, Urban Scooters, and Amazon are important retailers of eScooters for all age groups. Analysis of on-line retail sales suggests the most popular brands are Segway Inc.[16], Razor USA LLC, Hover-1™ and MotoTec Inc. Brand-specific, direct-to-consumer sites such as Segway and Okai represent a large share of adult eScooter sales volumes. A few firms, such as Segway and Unagi, also have a limited brick-and-mortar presence. Other important adult eScooter manufacturers include Schwinn Inc., Shenzhen FWZZ Technology Co Ltd, Hilboy, Shenzhen Tomoloo Technology Industrial Co Ltd, IZIP and MotoTec.

From 2018 to 2021, eScooter sales volume (both commercial and private) increased at a 9.8 percent CAGR from 134,300 to 177,500 units. Over the same period, eScooter revenue increased at a 27.7 percent CAGR from $71.3 million to $148.3 million. The higher growth rate in revenues compared to sales is due to a shift towards higher quality and more durable products. Unit sales and revenues are projected to reach 257,500 units and $250.3 million in 2024; from 2021 this a 13.2 percent CAGR in sales and 19.1 CAGR in revenue, respectively. Table 2 displays eScooter sales estimates for the period 2018 – 2024.

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[14] In this analysis, staff use an eScooter product life equal to twice that of the mean battery replacement schedule or 5 years (2 x 2 years + 2 x 3 years) ÷ 2.
[15] Source: https://pitchbook.com/. Accessed February 29, 2024.
[16] In addition to Segway brand parallel-wheeled, self-balancing scooters, Segway/Ninebot manufactures and sells traditional, tandem-wheeled eScooters. Parallel-wheeled Segway scooters are discussed in the following section.

Table 2: eScooter Sales

Year	Units Sold (Thousands)
2018	134.3
2019	126.6
2020	150.0
2021	177.5
2022*	206.0
2023*	232.7
2024*	257.5

* Forecasted years from Euromonitor 2022

Other Micromobility Products

2.1.7 The Product

OMPs comprise of, but are not limited to, eSBscooters (such as Segways and hoverboards), eSkateboards, and eUnicycles. OMPs are used primarily for recreation rather than as a micro-transportation solution and are considered more difficult to operate than eBikes and eScooters.

Segways are defined as battery-powered mobility products that have two parallel wheels connected by a platform on which the user stands, and a steering bar. Segways are operated by hand or leg gestures with the rider making subtle movements to direct the Segway. The original Segway, introduced at a price of approximately $5,000, never gained wide acceptance and was discontinued in 2020. Since then, less expensive versions have been introduced such as the Segway-Ninebot, and several other versions from Chinese manufacturers, that start as low as $300 and go as high as $1,000.

Segways specific to the children's market range in price from $299 to $499 according to an online sample. The products can travel 8 to10 miles on a single charge and have a load capacity of around 130lbs. Batteries of 72Wh capacity are most common, and top speed falls between 8.7 and 10 mph. Higher-end models' speeds range from 12 to 13 mph with a battery averaging about 300Wh.

Hoverboards are defined as battery-powered mobility products that have two parallel wheels connected by a platform on which the user stands – staff use the term hoverboard to refer to the type of product and not the company with the same name in this initial regulatory analysis.[17] These products overlap in general design with Segways, except that hoverboards lack a steering bar. Hoverboards require a moderately high level of skill to operate safely, as they operate by detecting changes in rider position. Hoverboards are used as a recreational product designed to operate on smooth pavement or in open spaces.

Based on an online sample of hoverboards, the market price for children's models ranges from $89 to $370. These products can travel 5 to 9 miles on a single charge and have a load capacity of 130 to 200 lbs. The most common hoverboard batteries have 72Wh capacity, but some of the cheaper products use batteries with less than 50Wh. Top speeds for hoverboards generally fall between 6 and 9 mph. Hoverboards for adult users' top speeds are still low at 6 to 10 mph, but travel ranges increase to 10 to15 miles due to more powerful batteries averaging approximately 110 Wh. Hoverboards marketed to adults range from $150 to $399 in price.

[17] In the draft NPR, these products are referred to as eSBscooters.

Demand for Segways and hoverboards comes primarily from children and youth, which represent 42.7 percent and 53.7 percent of the market, respectively.

eSkateboards are defined as board platforms supported by four wheels that are powered by electric motors, typically either a hub motor or a belt drive and gear system. eUnicycles are platforms supported by a single wheel, powered by an electric motor. These products have a higher learning curve to ride than Segways or hoverboards and are primarily targeted at the adult market. eSkateboard and eUnicycle products for the adult market are split between entry-level at prices between $200 and $650, and higher-performance varieties at more than double these prices. eUnicycles start at around $1,000. Most premium-priced eSkateboard and eUnicycle models are capable of easily exceeding the 20-mph speed limit set by legislators in some states such as California.

2.1.8 The Firms

Staff identified 67 firms that manufacture or supply OMPs to the U.S. market. Nearly all firms import their products from China. Staff identified 12 U.S. domestic OMPs manufacturers that assemble components largely produced overseas. Most of the lithium-ion batteries used by these firms are produced in China.

2.1.9 The Markets

Roughly 80 percent of OMPs are sold via online retail channels rather than brick-and-mortar retailers. This figure is slightly lower, 75 percent, for hoverboards, due to a more significant presence in big-box retailers. Most retailers sell through Amazon and Walmart. Walmart is the main retail channel for hoverboards and Segways due to its high share of recreational products for children and adults. Manufacturers such as Swagtron and Razor USA are examples of major hoverboard manufacturers selling direct to consumers. Direct to consumer sites also represent a high percentage of Segway sales. Brand-specific, direct-to-consumer sales and brand aggregators are the primary channels for eUnicycles.

Revenue for Segways increased at a 4.3 percent CAGR from 2018 to 2021, while units sold increased to 1.7 percent CAGR during the same period. One reason for the increase in retail value is the increase in cost for batteries and electric motors associated with the COVID-19 pandemic. The most popular Segway brands include Segway-Ninebot, as well as less costly lookalikes from Cozyswan, Hiboy and Smart brands. Staff estimate the product life of a Segway to be on average 5 years.

Hoverboards entered the market in 2015. Hoverboard sales increased at 2.5 percent CAGR from 1.15 million units in 2018 to 1.24 million units in 2021. Hoverboard prices have increased marginally because of higher global demand for batteries but those increases have generally been constrained by the economies of scale from producing over a million units per year. The product life of a hoverboard depends on several factors but on average is about 3 to 4 years.

eSkateboards and eUnicycles have the highest growth from 2018 to 2021. Sales grew from 80,900 units in 2018 to 124,100 units in 2021, a 5.3 percent CAGR. Retail value grew at a 13 percent CAGR during that same period to $138 million. The average product life of eSkateboards and eUnicycles is about 5 years.

Overall, OMPs are forecasted to increase at a 15.6 percent CAGR from 2021 to 2024, reaching a market value of $213.2 million. Table 3 displays OMP unit sales by product from 2018 through 2021.

Table 3: OMP Sales

Year	Units Sold (Thousands)		
	Hoverboards	Segways	eSkateboards/ eUnicycles
2018	1,146.6	81.9	80.9
2019	1,184.1	84.0	90.4
2020	1,229.9	86.5	103.2
2021	1,235.4	86.2	124.1
2022*	1,252.5	86.7	141.5
2023*	1,280.9	88.0	162.7
2024*	1,316.5	89.7	182.9

casted years from Euromonitor 2022

3 Preliminary Regulatory Analysis Assumptions, Forecasts, and Caveats

The preliminary regulatory analysis estimates potential costs and benefits over a 30-year study period that starts in 2027, the expected year the rule would go into effect, and goes through 2056. To perform this prospective analysis, staff must forecast what each product market would look like 30 years into the future. Staff does this by using available data on markets, standardizing the dollar value and year in which these benefits and costs are measured, and making assumptions where there was no readily available data. Once these are set, staff forecast sales and products in use for each micromobility product category through the 30-year study period. This section presents the standardizations and assumptions that staff use in the costs and benefits analyses, as well as the forecasted sales and in-use populations for each product category.

Standardizations and Assumptions

Staff use various data sources for this regulatory analysis that vary in their source and publication year. To use these data and compare them along the same dollar value, along with ensuring dollars could be compared between years within the 30-year study period, staff apply the following standardizations:

- Present all monetized estimates in 2024 dollars.
- Inflate all monetary values and data to 2024 dollars using the Bureau of Labor Statistics' (BLS) Consumer Price Index (CPI).[18]
- Apply the discount rates of 3 percent and 7 percent to monetized values in the future to account for the time value of money in accordance with the Office of Management and Budget's (OMB) Circular A-4.[19]
- Set the dollar year, 2024, as the base year of discounting.[20]

Staff apply these universally throughout the analysis and produce 30-year forecasts for each of the three product categories under two scenarios:

[18] Consumer Price Index for All Urban Consumers (CPI-U), All items in U.S. city average, all urban consumers, not seasonally adjusted, Series Id: CUUR0000SA0.
[19] U.S. Office of Management and Budget, 2003, "Regulatory Analysis", (Circular No. A-4), White House, https://www.federalregister.gov/documents/2003/10/09/03-25606/circular-a-4-regulatory-analysis
[20] Discount Factor = $1 \div (1 + \text{discount rate})^{(\text{current year} - \text{base year})}$. For instance, by the first year of the study period, 2027, staff apply to all dollar estimates the discount factors of 0.915142 for the 3 percent discount estimate and 0.816298 for the 7 percent discount estimate.

(1) Baseline Scenario – The scenario where the draft proposed rule is never implemented.
(2) Alternative Scenario – The scenario where the draft proposed rule is implemented in 2027.

The following section describes the methodology of these forecasts.

Forecast Methodology

Staff use a Weibull distribution to estimate product failure rates and applies these rates to annual sales over the 30-year study period. By combining new sales with remaining products from prior years, staff estimate the number of products in use each year. For each micromobility product, staff assume a Weibull distribution with a scale parameter of 5, consistent with a product life of 5 years, and a shape parameter of 3.37, consistent with modeling age-related failure.[21] Specifics on how staff apply this methodology for each product category in the baseline scenario are described in the next three sections.

eBike Population Forecasts in Baseline Scenario

To calculate the number of eBikes in use over the 30-year study period under the baseline scenario, staff use the Weibull distribution formula with the parameters described in section 3.2 with the forecasted number of sales of eBike from 2011 through 2056.

Euromonitor estimated the historical sales of eBikes from 2018 through 2024 (see Table 1). However, for the Weibull distribution to credibly estimate in-use population for the first year of the rule (2027), staff must estimate sales far enough in the past to account for all lingering units from previous generations. Staff estimate sales of eBikes as far back as 2011, roughly when the product came to market, by using the CAGR of Euromonitor's data (2018-2024), 31.74 percent[22], and applying it in reverse to estimate sales for each year from 2011 through 2017. For example, eBikes sales were 271,678 units in 2018; using the approach just described, staff estimate that in 2011 eBikes sales were 39,454.[23]

Next, staff use estimated and assumed annual growth rates to forecast sales through 2056. Euromonitor forecasted short-run annual growth to be 16.5 percent.[24] Staff apply this growth rate from 2025 through 2027. After 2027, staff assume eBike sales would slow down and converge to the historical long-term growth rate for non-motorized (*i.e.*, traditional) bicycles of 1 percent[25] given the overlap in consumer base. To smooth out this convergence, staff reduce the growth rate by half every three years after 2027 until the growth rate matched 1 percent. Once matched, staff apply the 1 percent growth rate for the remainder of the 30-year study period. Using this approach, staff estimate that the number of eBike sold reaches 4.07 million in 2056.

When estimated sales of all eBikes from 2011 through 2056 are used in the Weibull distribution formula with the previously mentioned parameters, staff estimate that the number of in-use eBikes in the first year of the rule (2027) would be 8.23 million, and then grow to 19.85 million by the end of the study period (2056). Figure 1 displays the sales and in-use units in the baseline scenario throughout the 30-year study period.

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[21] The formula for a Weibull distribution with the described parameters and x as the number of years since the product was first sold is: $f(x) = \frac{5}{3.37}\left(\frac{x}{3.37}\right)^{5-1} e^{-(\frac{x}{3.37})^5}$

[22] 31.74% = (1,420,060 units sold in 2024 ÷ 271,678 units sold in 2018)$^{(1 \div (2024-2018))}$ - 1

[23] 39,454 = 271,678 sold units in 2018 ÷ (1 + 31.74%)$^{(2018-2011)}$

[24] Data gathered by Euromonitor in support of CPSC contract 61320621P0015 shows a high growth rate from 2018 to 2021 with a slowdown forecasted from 2022 to 2024. See Table 3 in Euromonitor Consulting, "Micro-Mobility Product Market Research". The rate was estimated using Euromonitor's estimates for the period 2021 - 2024.

[25] Calculated from import data for HTS code 8712 (Non- motorized Bicycles First Unit of Quantity) from years 2000 to 2021.

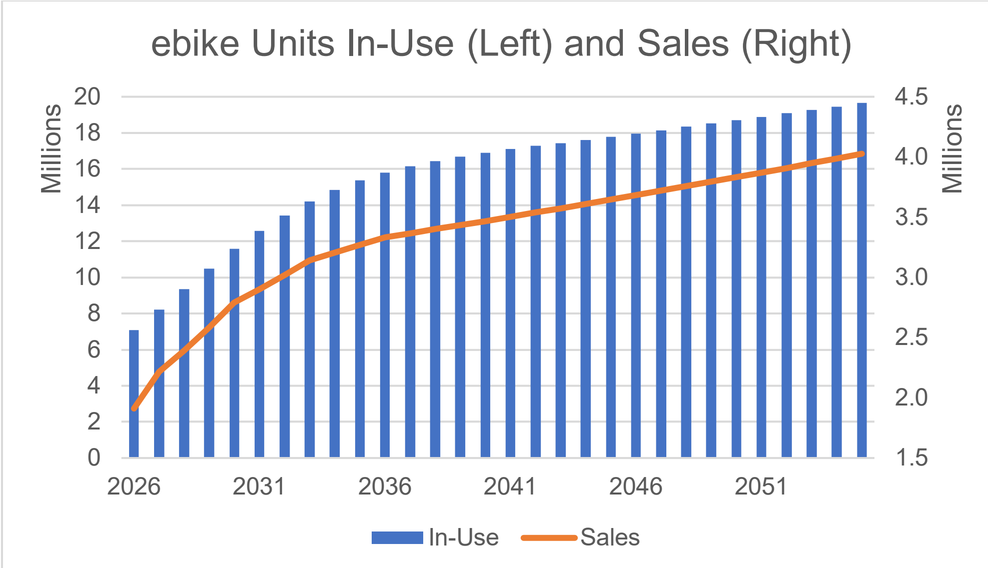

Figure 1: Forecast of eBike Sales and In-Use Units in Baseline Scenario, 2027 – 2056

eScooter Population Forecasts in the Baseline Scenario

To calculate the number of eScooters in use over the 30-year study period under the baseline scenario, staff use the Weibull distribution formula with the parameters described in section 3.2 and applies the corresponding failure rates to the forecasted sales of eScooter batteries from 2011 through 2056.

Euromonitor estimated the historical sales of eScooters from 2018 through 2024 (see Table 2). Staff must estimate sales far enough in the past to account for all lingering units from previous generations. Staff estimate sales of eScooters as far back as 2011, roughly when modern eScooters came to market, by using the CAGR in Euromonitor's data (2018-2024), 11.46 percent, and applying it in reverse to estimate sales for each year from 2011 through 2017. For example, eScooter sales were 134,261 units in 2018; using the approach just described staff estimate that in 2011 eScooters sales were 62,810.[26]

Staff then estimate sales through 2056. While eScooter sales volume and revenues are projected to grow, they will gradually slow down as both commercial rideshare and private eScooter markets mature. Between 2021 and 2024, the Euromonitor report projected annual sales growth rates would decline from 18.33 percent to 10.64 percent. This represents an average -16.55 percent change in the annual growth rate each year between 2021 and 2024. Staff forecast future sales volume by assuming growth would consistently slow down at this rate[27] until the growth rate matches the projected U.S. population growth rate, which occurs in 2050.[28,29] Beyond 2050, staff assume eScooter sales would grow at the same rate as the U.S. population. Using this

[26] 62,810 = 134,261 units in 2018 ÷ $(1 + 11.46\%)^{2018 - 2011}$

[27] Staff estimate future annual growth rates by multiplying the previous year's annual growth by (1 - 16.55%), the average change in growth rates. Then, staff multiply the previous year's sales by the estimated annual growth rate.

[28] The calculation is to estimate sales from 2026 through 2049 is $Sales_n = Sales_{n-1} \times (1 + (Gr.\ Rate \times (1 + \Delta\ Gr.\ Rate)^{(n-2024)}))$, where n is the year for which sales are being estimated. For example, in 2024, projected sales volume was 257,477 units and the growth rate 10.64 percent. Estimated sales in 2025 are computed as 257,500 units $\times (1 + (10.64 \times (1 - 0.1655)^1))$ = 257,500 units x 1.089 ≈ 280,332 units. Estimated sales in 2026 are computed as 280,332 units $\times (1 + (10.64 \times (1 + (-0.1655)^2))$ = 280,332 units x 1.079 ≈ 302,711 units. In 2050 and later years, the calculation is $Sales_n = Sales_{n-1} \times$ U.S. Population Growth Rate.

[29] Projected Population by Age Group for the United States for the Main Series and Alternative Immigration Scenario: 2022 to 2100. Source: U.S. Census Bureau, Population Division. Release Date: November 2023.

methodology, staff estimate eScooter sales will increase to nearly 450 thousand units by the end of the 30-year study period in 2056.

Staff use the Weibull distribution with the sales estimates to forecast the number of in-use eScooters. Staff estimate that the number of eScooters in use in 2027 will be 1.36 million and will reach 2.24 million by the end of the 30-year study period (2056). Figure 2 presents the estimated number of eScooter in use and eScooter sales from 2027 through 2056.

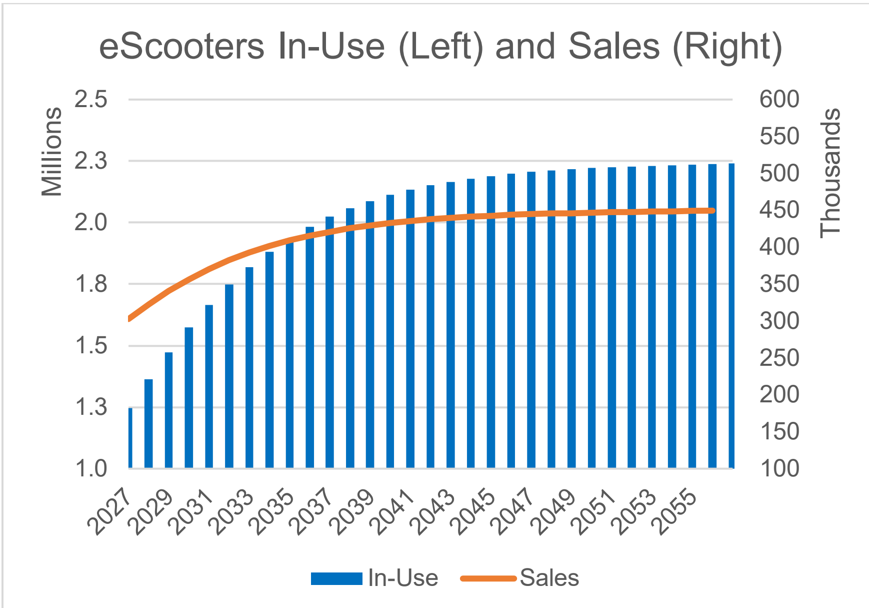

Figure 2: Forecast of eScooters Sales and In-Use Units in Baseline Scenario, 2027 – 2056

OMP Population Forecasts

To calculate the number of OMPs in use over the 30-year study period under the baseline scenario, staff use the Weibull distribution formula with the parameters described in section 3.2 with the forecasted number of sales of OMPs from 2015 through 2056.[30]

Euromonitor estimated the historical sales of OMPs from 2018 through 2024 (see Table 3). Staff must estimate sales far enough in the past to account for all lingering units from previous generations. Staff estimate sales of OMPs as far back as 2015, roughly when existing models came to market, by using the CAGR of Euromonitor's data (2018-2024): 2.33 percent[31] for hoverboards, 1.53 percent[32] for Segways, and 14.56 percent[33] for eSkateboards and eUnicycles. Staff apply these rates in reverse to estimate sales for each year from 2015 through 2017. For example, hoverboard sales were 1.15 million units in 2018; using the approach just described staff estimates that in 2015 hoverboard sales were 1.07 million.[34]

[30] Traditional segways had been in circulation well before 2015 but have since been discontinued. Segway and Ninebot created new cheaper products that were brought into market more recently.
[31] 2.33% = (1,316,500 units sold in 2024 ÷ 1,146,600 units sold in 2018)$^{(1 \div (2024 - 2018))}$ - 1
[32] 1.53% = (89,700 units sold in 2024 ÷ 81,900 units sold in 2018)$^{(1 - (2024 - 2018)}$ - 1
[33] 14.56% = (182,900 units sold in 2024 ÷80,900 units sold in 2018) $^{(1 - (2024 - 2018)}$ - 1
[34] 1.07M = 1.15M sold units in 2018 ÷ (1 + 2.33%)$^{(2018-2015)}$

Staff then estimate sales through 2056. While sales for all OMPs are projected to continue to grow, the growth rates differ by product. Between 2021 and 2024, Euromonitor projected annual growth rate of unit sales of hoverboards, Segways, eSkateboards, and eUnicycles are 2.1 percent, 1.3 percent, and 13.8 percent, respectively. Staff expect these growth rates to slow down in the long run because these products are largely dependent on young consumers, a group that will be one of the slowest growing demographics in the future and whose tastes are likely to change as other recreational products come to market. To account for this, staff halve the growth rates to forecast sales from 2025 through 2035 and halved them again for the remainder of the study period.

Using this methodology, staff estimate hoverboards sales will be 1.36 million units in the first year of the rule (2027) and by the end of the 30-year study period in 2056, sales would grow to 1.66 million. Staff estimate Segways sales will be 91,509 in the first year of the rule and grow to 103,511 by the end of the study period. Staff estimates eSkateboards and eUnicycles sales will be 223,437 in the first year of the rule and grow to 776,904 by the end of the study period.

Staff use estimated sales of all OMPs from 2015 through 2056 with the Weibull distribution formula to estimate units in use each year of the analysis. Staff estimate 4.87 million hoverboards in use in 2027, which would grow to 5.98 million by 2056. For Segways, staff estimate 448,258 units in use in 2027, and 512,704 units by 2056. For eSkateboards and eUnicycles, staff estimate 949,793 units in use in 2027, and 3.60 million units by 2056.

Figure 3 presents the estimated number of units in use and sold from 2027 through 2056.

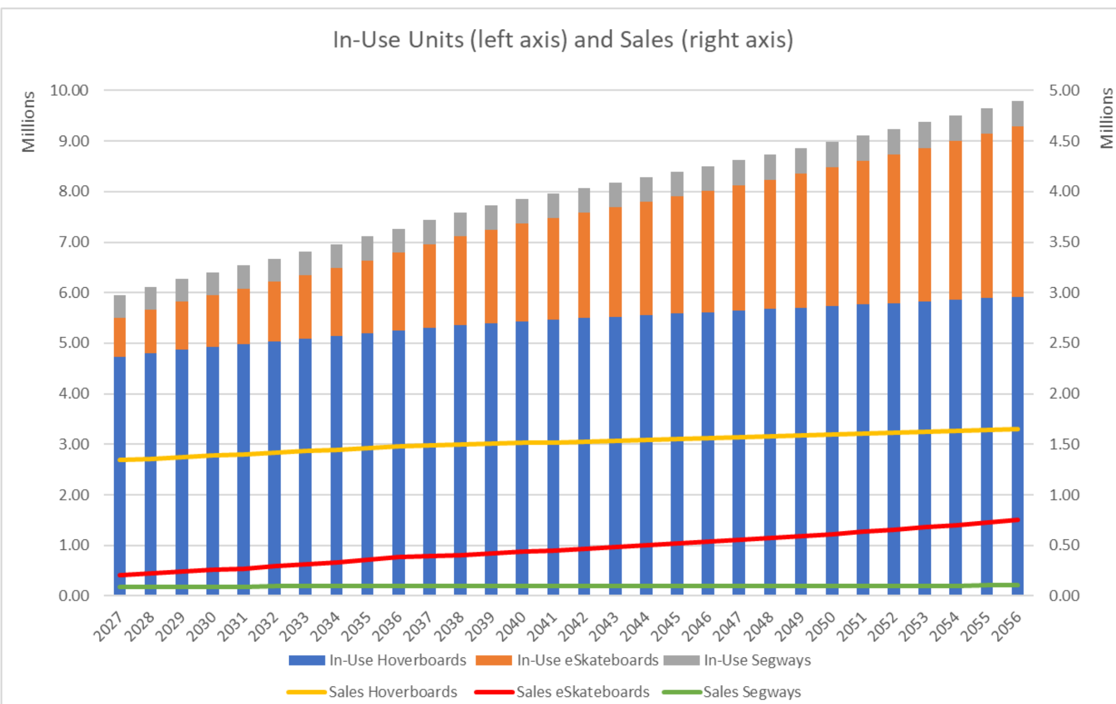

Figure 3: Forecast of OMP Sales and In-Use Units in Baseline Scenario, 2027 – 2056

Industry Assumptions

Staff need to make assumptions about how each market for each product category will perform in the future and their long-term growth potential. While each of the three product categories are identified as micromobility products, they are distinct products that do not serve the identical target markets, nor do they have the same utility. Each of these separate markets would react somewhat differently to the implementation of the draft proposed rule.

eBike is the newest market for micromobility products and has the highest growth potential. Its target market of traditional bike riders, recreationalists, tourists, and commuters give it the widest appeal and highest ceiling for market saturation. eScooters have been the longest serving micromobility product in the market. Starting roughly a decade ago, major cities have been permitting eScooter companies to install large networks of their products within city limits. Their target market has largely been young urban travelers who use them for commuting and intracity travel. As such, their growth potential is tied to this young, urban demographic. While the OMP market encompasses several different products, in general these recreational products appeal to the youngest consumers[35] for micromobility products. Many of these products, like eSBscooters, have been around for ten or more years and have already experienced their high growth period. Going forward, their growth is likely tied to the purchasing behavior and growth of the youth market.

In addition to the products, the draft proposed rule also encompasses individual lithium-ion battery sales. These batteries can be purchased by consumers who own a micromobility product either as a replacement for a failed battery (replacement battery) or as a supplement to their main battery (supplemental battery). A consumer purchases a replacement battery after the failure of the current battery operating the product. A consumer purchases a supplemental battery while its main battery is still functional. The supplemental battery can be charged while the main battery powers the product, then swapped in when the main battery runs out of a charge, and then serve as the main battery until it too needs to be switched out. For eBikes, supplemental batteries can be used concurrently with the main battery to serve as an extender, which allows the eBike to go farther distances. Additionally, lithium-ion batteries can be sold with *conversion kits* which are hub motors that attach to traditional bicycles and converts them into eBikes. For OMPs, staff have not seen information that consumers regularly purchase either replacement or supplemental batteries.

Based on these distinctions, staff make assumptions about these markets to fill any data gaps and produce forecasts of sales and in-use product population for the 30-year study period. Table 4 presents the assumptions made for each product category.

Table 4: Industry Assumptions across Micromobility Products

Assumptions	eBikes	eScooters	OMPs
Annual Growth	Annual growth of 16% until 2027	Average annual growth of 11.5%.	Annual growth rate of 2.1% for hoverboards, 1.3% for Segways, and 13.8% for eSkateboards and eUnicycles until 2024.
Growth Constraints & Forecasts	Post 2027, growth reduces by half every 3 years until it matches traditional bikes' historical growth rate of 1%.	Growth rates decline at a rate of 16.55% per year after 2024. Continues declining at same rate until annual growth matches U.S. population growth rate	Growth rates reduce over the 30-year study period. 1.05% until 2035 and 0.53% past 2035 for hoverboards. 1.3% until 2035 and 0.65% past 2035 for Segways. 6.9%

[35] 53.7% of hoverboard products in private were for individuals under 12, 42.7% of children's Segways in private use were for individuals under 12. (Euromonitor)

Assumptions	eBikes	eScooters	OMPs
			until 2035 and 3.45% past 2035 for the rest of OMPs.
Average Product Life	5 years	5 years	5 years, except for hoverboards which are 4 years
Replacement and Supplemental Batteries	15% of eBikes have an additional supplemental battery. Those batteries are included in eBike population calculation.	5% of eScooters have additional supplemental batteries. Supplemental and replacement batteries are included in the per unit compliance cost.	*De minimis* additional batteries purchased. Not included in population calculation.
Conversion Kits	5% of eBikes are conversions via conversion kits.	N/A	N/A
Compliance Level[36] (Based on CPSC audit of convenience sample[37])	Initial compliance of 10.75 percent. Grows to 89.47 percent (same level as other micromobility products) within 7 years which is the same observed time frame as other micromobility products.[38]	Initial compliance of 89.47 percent. Assumed this rate is the equilibrium and that there is no further increase.	Initial compliance of 89.47 percent. Assumed this rate is the equilibrium and that there is no further increase.

Caveats

These products are relatively new, and these emerging markets have less historical data available than established markets given the short time the emerging products have been available. Emerging market data also carries more uncertainty because these markets, particularly for eBikes, are changing rapidly. To be transparent, staff list the caveats below for this regulatory analysis.

- The assumed baseline compliance rates are based on a convenience sample. These compliance rates determine the share of products that are largely responsible for the historical deaths and injuries. A change in the assumed compliance rates can have significant impact on the estimated benefits and costs of this analysis. See the sensitivity analysis in section 6.2.1 for details on the impact of the assumed compliance rates.
- The pace of compliance with the voluntary standards for eBikes, in the baseline scenario, is aligned with the historical pace for eScooters and OMPs for their voluntary standards. Additionally, certain state and local regulations, for example, California SB-712,[39] as well as insurance requirements, are leading companies to adopt these or similar requirements. While

[36] In the analytic baseline, this proposed regulation is absent; use of the term “compliance” is not necessarily intended to imply otherwise.
[37] A non-probability sampling method where participants are selected based on their availability, proximity, or ease of access, rather than using a random or systematic approach.
[38] UL 2272 published in 2016. By 2023, staff’s audit had captured an 89.47 percent compliance rate among observed eScooters and OMPs.
[39] https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=202320240SB712

based on past behavior for similar products, projecting producer behavior carries inherent uncertainty. A slower pace of compliance for eBikes could significantly increase the cost of the draft proposed rule (see Section 6.2.1).

- Aside from changing state and local regulations, the dynamic nature of emerging markets adds uncertainty to the forecast for the future. This includes the projected long-term growth rates, market forces such as insurance requirements that may push the markets relatively quickly toward compliance with UL standards even in the absence of regulation.
- Fire incidents may be undercounted because lithium-ion battery fires do not have a product category in NEISS and face other data collection obstacles at the state and local level[40]. Additionally, because lithium fires are harder to extinguish than typical fires, and these products are more likely to be stored in multi-unit dwellings, the average property losses from the fire hazard of these products could be greater than typical fire hazards. Accordingly, this analysis may underestimate benefits.

Finally, this analysis could underestimate costs by not including loss in product utility. While staff do not assess any loss in function to these products from the draft proposed rule, these products are consistently changing and there may be unforeseen losses in utility to some specific products or new limits to their capabilities in the future.

4 Cost Analysis

This section discusses the costs that the draft proposed rule would impose on industry, consumers, and the market. Staff assess that the requirements of the draft proposed rule would affect only the electrical system and battery components of micromobility products. In analyzing the costs from these requirements, staff identify two cost categories:

(1) replacing micromobility products' electrical systems with compliant systems and,
(2) the deadweight losses or market impact caused by higher prices due to this rule and the subsequent decline in demand.

The proposed rule incorporates voluntary standards already developed by industry that are widely familiar to firms. In addition to the rule being based on industry-developed standards, CPSC staff has spent time interacting both with voluntary standards organizations and industry directly on the importance of increasing compliance with these standards. Given these facts, it unlikely any firm is unfamiliar with the standards of the rule and staff assesses that familiarization costs, to the extent there are any, are *de minimis*. The remainder of this cost analysis focuses on the two aforementioned cost components that are incurred from the proposed regulation's impact to these markets.

When a market is at equilibrium, consumers and producers experience welfare gains known as consumer surplus[41] and producer surplus[42]. Regulation can induce changes in the market equilibrium price and quantity as shown in Figure 4. In instances where a regulation imposes costs on producers, the supply curve shifts (from S_0 to S_R) to reflect the marginal cost of supplying the newly regulated product. Due to the higher costs,

[40] Press Release, "", Massachusetts Department of Fire Services, https://www.mass.gov/news/after-six-months-new-tracking-tool-identifies-50-lithium-ion-battery-fires
[41] Consumer surplus is the benefit individuals experience from consuming a good. Consumer surplus is measured as the area between the demand curve and the market price of the good. In other words, it is the amount consumers would be willing to pay beyond the price they do pay.
[42] Producer surplus is the benefit to producers from selling a good. Producer surplus is measured as the area between the supply curve and the market price of the good. This area represents the amount by which the price paid by consumers exceeds the marginal costs of production.

consumers respond by purchasing less of the product. The result is a new market equilibrium with a higher price (P_R) and reduced quantity (Q_R).

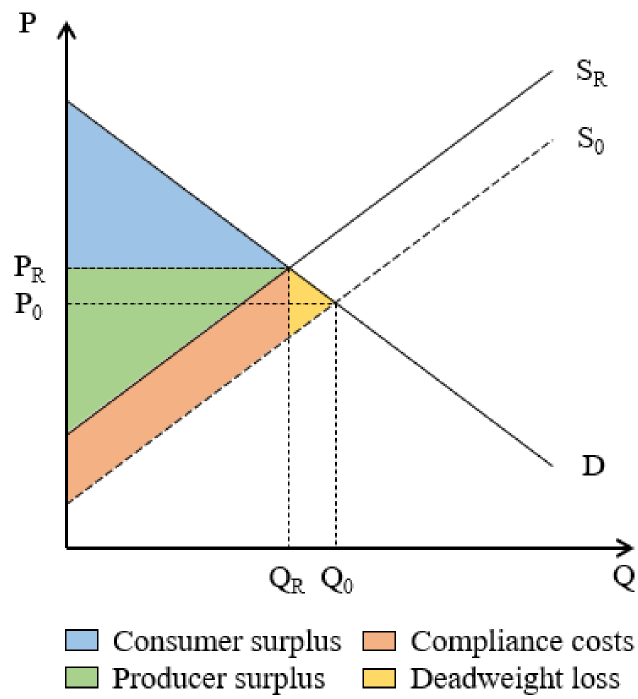

Figure 4: Market Equilibrium After Regulation

At the new market equilibrium (Q_R, P_R), consumer and producer surplus are reduced relative to an unregulated market or status quo. The reductions in both consumer and producer surplus comprise the two elements of regulatory costs: compliance costs (i.e., replacing micromobility products' electrical systems with compliant systems) and deadweight loss represented by the orange and gold section, respectively, in Figure 4. Together, these factors sum to the loss in consumer and producer surplus.

In this cost analysis, staff assume micromobility product manufacturers purchase and incorporate market-available compliant batteries and electrical systems into their noncompliant micromobility products to comply with the rule. For this analysis, staff assume 100 percent compliance with the rule if it is adopted, and that manufacturers would adopt the solution of purchasing and installing compliant batteries and electrical systems.

Staff assess these electrical systems would easily fit in/on to current micromobility product models with little to no required modification of existing frames or other components. Staff also expect that new or modified internal battery components needed to comply with the rule fit within the existing case and frame designs and remain largely indiscernible to product assemblers and consumers.

Micromobility product manufacturers could choose to redesign, manufacture, and test their own electrical systems to meet the standards from this draft proposed rule. Manufacturers would choose this option only if it would be less costly in the long run than purchasing compliant electrical systems. Thus, this analysis may be overestimating the costs of the draft proposed rule if firms find it more cost-efficient to develop their own systems.

This section first covers the general description of costs and estimates a per-unit cost, then estimates costs for each category over the 30-year study period, and finally, presents total estimated cost from the draft proposed rule in annualized terms.

Compliance Cost of Replacing Micromobility Product Batteries

Each subsection below details the cost of upgrading noncompliant micromobility products to batteries that meet the requirements of the draft proposed rule. The primary assumption is that the price of a compliant battery under the draft proposed rule will be similar to that of a compliant battery meeting the current UL standards. While the draft proposed rule adds modifications to the UL standards in the areas of operating instructions, labeling, safety markings, tamper resistant battery compartments, and additional testing procedures, staff consider these costs negligible to the overall cost. Most of these modifications involve minor changes that do not require significant production adjustments, and the additional testing procedures are unlikely to alter the lump sum pricing charged by laboratories for new model testing.

Because each product type operates within a distinct market, the cost analysis for each product category accounts for its unique characteristics, data, and assumptions.

4.1.1 Compliance Cost for eBike Batteries

Staff estimate the per-unit eBike cost to comply with the draft proposed rule as the difference in retail price of a UL2849 or UL2271 compliant eBike battery and a noncompliant replacement battery. While this draft proposed rule has additional labelling, compartment, and testing requirements compared to the UL standards, the primary performance requirements are the same. The difference in price between compliant and noncompliant batteries with UL standards would be similar to the difference in price between a compliant and noncompliant battery with this draft proposed rule. When analyzing price differences, staff compare batteries of the same size, shape, function, voltage, and amp hours. Staff perform this comparison on 8 popular eBike brands purchased by consumers.[43, 44]

Some retailers had recently discounted their prices of noncompliant batteries heavily. Insurance companies are requiring firms to sell UL compliant batteries to maintain liability policies,[45] which could be contributing to the discounts in noncompliant batteries if retailers are selling off their noncompliant battery inventory. Given this, the cost estimates in this analysis could be an overestimate.

Table 5 shows the minimum, maximum, and average difference in retail price from compliant and noncompliant batteries. These price increases have been adjusted to 2024 dollars and represent the per-unit cost for eBike batteries to comply with the draft proposed rule. Over the duration of the study period, staff anticipate improvements in design and manufacturing from economies of scale which reduce the average cost and price of a compliant battery. Staff use the National Aeronautics and Space Administration's (NASA) learning curve calculator's estimate that repetitive electronics manufacturing will experience a 5 percent reduction in cost every time its quantity produced doubles.[46] Based on this formulation, the average per-unit cost of a compliant battery would be $194.55 by the year 2056.

Table 5: Compliance Cost per Unit for eBikes

Min	Max	Average
$69	$466	$230

To estimate compliance costs for eBikes, staff multiply the average compliance cost per unit by the number of noncompliant eBikes batteries that would need to be replaced with compliant batteries. In doing this, staff must account for the reduced quantity demanded (Q_0 to Q_R in Figure 4) from the increase in price. Staff accomplish

[43] Non-compliant batteries were located on battery manufacturer sites listed on AliExpress.com. AliExpress© is a popular site used by consumers to find lower price replacement micromobility batteries.
[44] Comparison completed in March of 2024 with 5 of the 8 eBikes brands being 48-volt models.
[45] Staff reviewed online retailer website offerings and find heavy price discounts for non-certified batteries with two retailers directly advertising insurance as the reason for the discount.
[46] NASA, "Learning Curve Cost Calculator", https://web.archive.org/web/20120830021941/http:/cost.jsc.nasa.gov/learn.html

this by first calculating the number of noncompliant eBike batteries in the baseline scenario (i.e., scenario without the rule) and then adjusting that number downwards in the alternative scenario (i.e., scenario with the rule) to account for the reduced quantity sold.

To calculate the number of noncompliant eBike batteries in the baseline scenario, staff adjust the estimated eBike sales throughout the 30-year study period (orange trend line in Figure 1). Staff multiply the 20 percent factor of additional batteries (see Table 4) by estimated eBike sales to get total batteries sold. Then to exclude compliant batteries (whose minor modifications to their existing batteries would be negligible), staff multiply total batteries sold by the complement of the compliance rate (1 – compliance percentage), to calculate noncompliant eBike batteries. Staff account for the compliance rate increasing, even in the absence of regulation, by assuming the eBike industry will reach the same level of compliance as eScooters and OMPs (89.47 percent) in the same 7-year timeframe (35.35 percent[47] CAGR) (see Table 4), which is 2030 in this analysis. For example, for the baseline scenario eBike sales are estimated to be 2.22 million in 2027 (see Figure 1), from which staff estimate that there are 1.70 million noncompliant batteries[48]. The estimated number of noncompliant batteries at the end of the study period (2056) is 0.51 million[49] in the baseline scenario. The number of noncompliant batteries throughout the study period in the baseline scenario is illustrated as the blue line in Figure 5.

In the alternative scenario, staff must account for the reduced demand from baseline sales due to the price increase from compliance. Staff use elasticities[50] of supply (1.0) and demand (-1.572) to estimate the change in quantity demanded resulting from price increase of the rule (P_R – P_0 in Figure 4).[51] Staff estimate 78,558 fewer noncompliant eBike batteries would be sold relative to the baseline in 2027 and 20,080 fewer noncompliant batteries in 2056. Staff estimate that over the 30-year study period, approximately 0.68 million fewer noncompliant eBike batteries would be sold relative to the baseline.

Figure 5 displays estimated noncompliant eBike battery sales (i.e., includes batteries sold individually and eBike sales) throughout the 30-year study period for both the baseline scenario and the reduced sales under the alternative scenario (i.e., these sales represent the number of noncompliant batteries that need to be replaced with compliant batteries). The gap from the blue line to the orange line represents the change in the quantity sold. Sales for noncompliant eBike batteries take a sharp dive in the first few years of the study period because this analysis assumes the rapid adoption of the voluntary standards in the next few years, even in absence of the rule, similar to what happened in the eScooter and OMP markets.

[47] 35.35% = (89.47% final compliance rate ÷ 10.75% initial compliance rate)$^{(1 \div 7 \text{ years})}$ - 1

[48] 1.70 million = 2.22 million eBikes in 2027 × (1 - 36.08% compliance) × (1 + 20% replacement and supplemental battery factor)

[49] 0.51 million = 4.06 million eBikes in 2056 × (1 - 89.47% compliance) × (1 + 20% replacement and supplemental battery factor)

[50] Staff use the own price elasticity of demand for Recreation – Wheeled Goods of -1.572 as a proxy for the own price elasticity of demand for micromobility products (Taylor and Houtakker, 2010). Absent estimates for the own price elasticity of supply for micromobility products or suitable proxies, staff assume unitary elastic supply (1.0) that implies the proportional change in quantity equals the proportional change in price.

[51] Change in quantity = Baseline Sales Quantity x ((Observed Retail Price Differential) / Baseline Price) x ((Elasticity of Supply x Elasticity of Demand) / (Elasticity of Supply – Elasticity of Demand)).

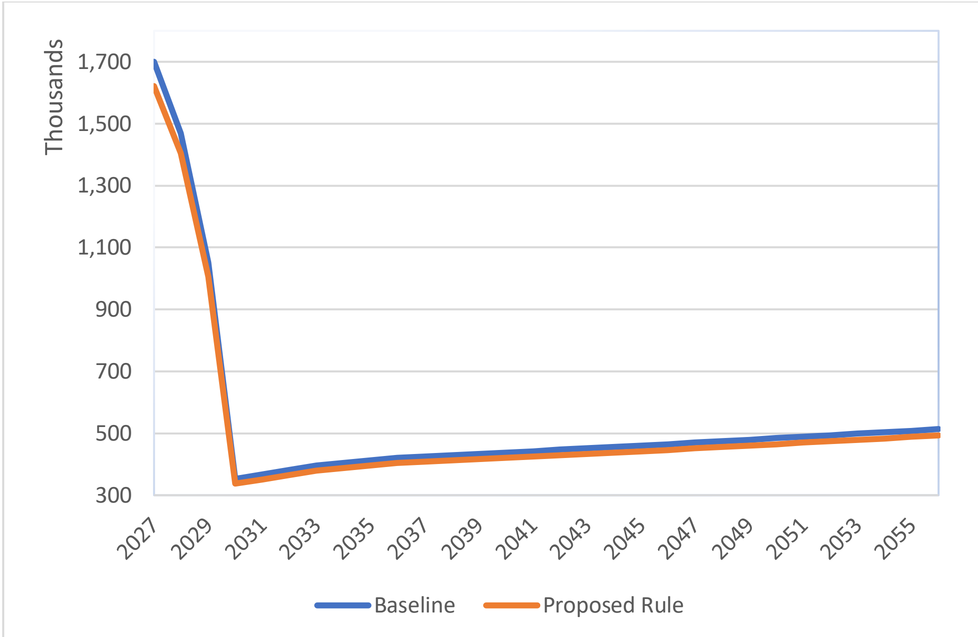

Figure 5: In-Scope eBike Battery Sales

Staff multiply the compliance cost per unit by the reduced sales (of units requiring compliance) in the alternative scenario sold each year (orange line in Figure 5). In the first year of the rule (2027), staff estimate there would be an additional $372.94 million[52] in production cost as firms purchase compliant batteries and electrical systems. By the last year of the study period (2056), the yearly cost would decrease to $96.04 million[53]. Over the 30-year study period, compliance costs aggregate to $3.24 billion, undiscounted, and $2.15 billion discounted at 3 percent.

4.1.2 Compliance Cost for eScooter Batteries

Staff estimate the cost of replacing noncompliant eScooters as the difference in retail prices of noncompliant battery packs and UL-compliant battery packs with the same characteristics (volts, Ah, Wh). While this draft proposed rule has additional labelling, compartment, and testing requirements compared to the UL standards, the primary performance requirements are the same and the difference in price between compliant and noncompliant batteries with UL standards would be similar to the difference in price between a compliant and noncompliant battery with this draft proposed rule. To estimate the difference in price, staff interviewed industry SMEs who estimated the difference in *cost* (i.e., not price) because staff had difficulty in comparing eScooter by battery features based on public listings. These SMEs approximated that 20 percent of the cost can be attributed to upgrading a noncompliant battery pack to a compliant one. Using an average retail price for an eScooter battery of $510.70 as of 2021, staff calculate the average cost to upgrade to a compliant battery to be $102.14, or $118.24 in 2024 dollars.

Next, staff must account for replacement and supplemental batteries. Staff estimate that the average consumer would purchase an average of 1.12 replacement and supplemental batteries[54] (see Table 4) over the life of the eScooter. Staff apply this factor, plus one for the original battery, to the per unit cost to upgrade to a compliant

[52] $372.94 million = $230.00 per unit compliance cost in 2027 × approximately 1.6214 million units sold in 2027.
[53] $96.04 million = $194.55 per unit compliance cost in 2056 × approximately 0.4936 million units sold in 2056.
[54] A Weibull distribution was used to model the population of in-use replacement and supplemental batteries; the results of this model were the basis for estimating this factor.

battery ($118.24) to calculate a lifecycle cost of compliance per eScooter of $251.20.[55] Finally, staff include a 20 percent markup to adjust the difference in cost to the difference in price.[56] This adjustment brings the difference in price per eScooter to $301.44. Table 6 displays this estimated compliance cost per eScooter in 2027.

Table 6: Compliance Cost per Unit for eScooters

Cost	Markup (20%)	Cost + Markup
$251.20	$50.24	$301.44

Staff also include a learning curve throughout the 30-year study period to account for additional efficiencies and economies of scale. As with eBikes, staff use NASA's learning curve calculator. This results in the compliance cost per-eScooter to start at $301.44 in 2027 but lowering to $229.76 by the end of the 30-year study period in 2056.[57]

To estimate cost of compliance for eScooters, staff multiply this compliance cost per eScooter by the number of noncompliant eScooters that would need to have its batteries replaced with compliant batteries. In doing this, staff must account for the reduced quantity demanded (Q_0 to Q_R in Figure 4) from the increase in price. Staff accomplish this by first calculating the number of noncompliant eScooters in the baseline scenario (i.e., scenario without the rule) and then adjusting that number downwards in the alternative scenario (i.e., scenario with the rule) to account for the reduced quantity sold.

To calculate the number of noncompliant eScooters in the baseline scenario, staff must adjust the estimated eScooter sales (see Figure 2). Staff multiply estimated eScooter sales by the complement of the compliance percentage (1 – compliance percentage). Staff assume the eScooter compliance percentage remains constant throughout the study period at 89.47 percent (see Table 4). Using this approach, staff estimate that in the baseline scenario the number of noncompliant eScooters sold in 2027 is 33,987[58] and grows to 47,367[59] by 2056. The number of noncompliant eScooters in the baseline scenario is illustrated as the blue line in Figure 6.

In the alternative scenario, staff must account for the reduced demand from baseline sales due to the price increase from compliance. Staff use elasticities of supply (1.0) and demand (-1.572) to estimate the change in the number of eScooters sold in each year, relative to the baseline, resulting from implementation of the rule. In 2027, an estimated 8,527 fewer noncompliant eScooters would be sold relative to the baseline; an estimated 9,058 fewer noncompliant eScooters would be sold relative to the baseline in 2056.[60] Staff estimate that over

[55] $251.20 ≈ ($510.70 price in 2021 x 20%) x (1 original battery + 1.12 secondary market batteries)) × (313.689 CPI index for 2024 / 270.970 CPI index for 2021).

[56] Staff cannot find enough comparable eScooter products to measure a suitable difference in eScooter prices with, and without, compliant electrical systems. Therefore, staff apply the ratio of 20 percent provided by an industry subject matter expert (SME) of the average eScooter price to develop its estimate. Since the SME was not explicit as to how the change in cost would factor in the determination of the final eScooter price, staff assumed the cost increase would be subject to a 20 percent markup.

[57] A portion of these costs will be borne by consumers in the form of higher prices. Using the elasticities of supply (1.0) and demand (-1.572), staff estimate the change in price resulting from implementation of the rule (P_R– P_O in Figure 45). In 2027, the estimated change in eScooter price is $119.75, declining to $91.28 (undiscounted) by 2056. In the absence of an estimate for the elasticity of supply for eScooters or a suitable proxy, staff take a neutral approach and choose the value 1.0 as the elasticity, staff use Taylor and Houtakker's (2010) estimate (-1.572) for the elasticity of demand for "Wheeled Goods" as a proxy for eScooter elasticity of demand. The calculations for the change in prices follow: $119.75 = ($301.44 x (1 ÷ (1 - (-1.5172))); $91.28 = 229.76 x (1 ÷ (1 - (-1.5172))).

[58] 33,987 = 322,877.33 estimated total eScooter sales in 2027 × (1 - 89.47% compliance percentage)

[59] 47,367 = 449,990.08 estimated total eScooter sales in 2056 × (1 – 89.47% compliance percentage)

[60] See the previous footnote for a discussion of the elasticities of supply and demand. The calculations for the change in the number of eScooters sold relative to the baseline are: 8,527 ≈ 33,987 x ($301.44 /$724.17) x ((1.0 x (-1.5172)/ (1.0 – (-1.5172))); 9,058 ≈ 47,367 x ($229.76 /$724.17) x ((1.0 x (-1.5172))/ (1.0 – (-1.5172))).

the 30-year study period, 273,467 fewer noncompliant eScooters would be sold relative to the baseline. The number of noncompliant eScooters in the alternative scenario is illustrated as the orange line in Figure 6.

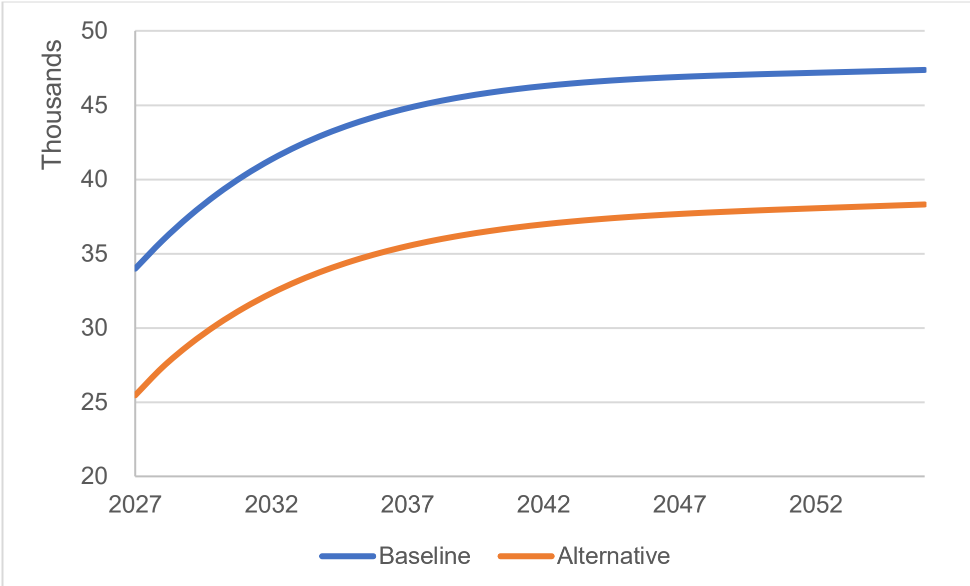

Figure 6: In-Scope eScooter Sales

Staff multiply the compliance cost per unit by the reduced sales (of units requiring compliance) in the alternative scenario sold each year (orange line in Figure 6). In the first year of the rule (2027), staff estimates there would be $7.67 million[61] in compliance cost. By the last year of the study period (2056), the yearly cost increased to $8.80 million[62]. Over the 30-year study period, compliance costs aggregated to $260.87 million, undiscounted, and $159.40 million discounted at 3 percent.

4.1.3 Compliance Cost for OMP Batteries

Staff estimate the cost of replacing noncompliant OMP batteries as the difference in retail price of noncompliant battery packs from the retail price of UL-compliant battery packs with the same characteristics (volts, Ah, Wh) and taking the average for hoverboards, segways and eSkateboards[63]. Staff perform this comparison on popular brands purchased by consumers on Amazon and Walmart.[64,65] Staff estimate the incremental cost of replacing noncompliant OMP battery packs with UL-certified battery packs would be $162.79.

As with the other products, staff also include the NASA learning curve throughout the 30-year study period to account for additional efficiencies and economies of scale. This results in the compliance cost per OMP starting at $162.79 in 2027 and then lowering to $124.43 in 2056.

To estimate cost of compliance for OMPs, staff multiply this compliance cost per unit by the number of noncompliant OMPs that would need to have a compliant battery installed. In doing this, staff must account for the reduced quantity demanded (Q_0 to Q_R in Figure 4) from the increase in price. Staff accomplish this by first calculating the number of noncompliant OMPs in the baseline scenario (i.e., scenario without the rule) and then

[61] $7.67 million = $301.44 compliance cost per unit in 2027 x 25,460 units sold in 2027.
[62] $8.80 million = $229.76 compliance cost per unit in 2056 x 38,309 units sold in 2056.
[63] Onewheel products were not included. As of April 2024, they are not advertised as UL compliant.
[64] Non-compliant batteries were located on battery manufacturer sites listed on AliExpress.com. AliExpress© is a common site used by consumers to find lower price replacement micro-mobility batteries.
[65] Comparison completed in April 2024.

adjusting that number downwards in the alternative scenario (i.e., scenario with the rule) to account for the reduced quantity sold.

To calculate the number of noncompliant OMPs in the baseline scenario, staff must adjust the estimated OMP sales (see Figure 3). Staff multiply estimated OMP sales by the complement of the compliance percentage (1 – compliance percentage). Staff assume the OMP compliance percentage remains constant throughout the study period at 89.47 percent (see Table 4). Using this approach, staff estimate that in the baseline scenario the number of noncompliant OMPs sold in 2027 is 176,232[66] and grows to 266,976[67] in 2056. The number of noncompliant OMPs in the baseline scenario is illustrated by the blue line in Figure 7.

In the alternative scenario, staff must account for the reduced demand from baseline sales due to the price increase from compliance, staff use elasticities of supply (1.0) and demand (-1.572) to estimate that 38,458 fewer noncompliant OMPs would be sold relative to the baseline in 2027, and 44,531 fewer noncompliant OMPs relative to the baseline in 2056.[68] Staff estimate that over the 30-year study period, approximately 1.19 million fewer noncompliant OMPs will be sold relative to the baseline. The number of noncompliant OMPs in the alternative scenario is illustrated by the orange line in Figure 7.

Figure 7 displays estimated noncompliant OMP sales throughout the 30-year study period under the baseline scenario and the reduced sales under the alternative scenario (i.e., these sales represent the number of OMP units that require compliant batteries to be installed in them). The gap between the blue line to the orange line represents the change in the quantity of noncompliant OMPs sold after the draft proposed rule is implemented.

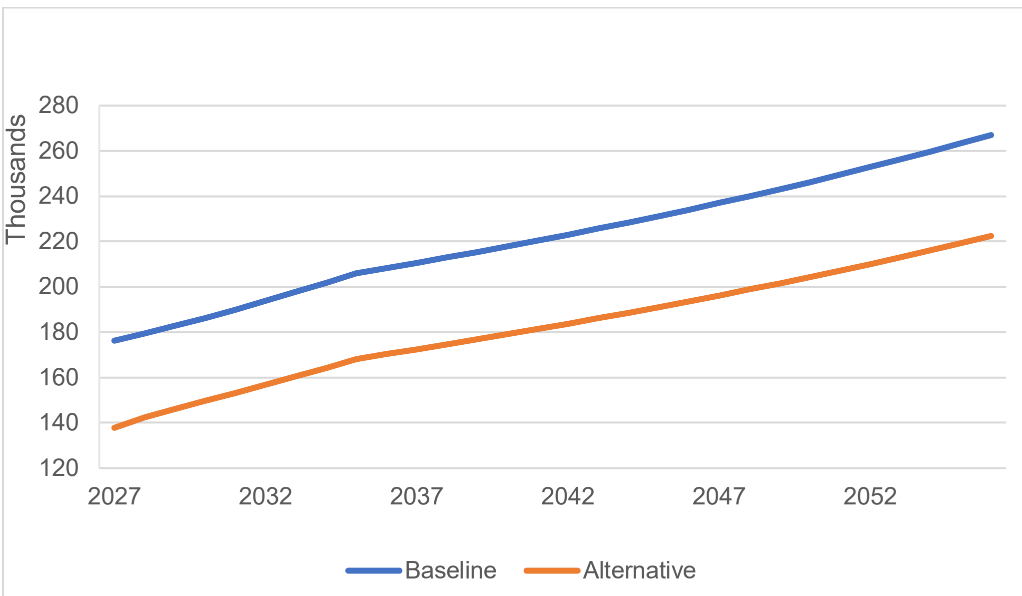

Figure 7: In-Scope OMP Sales

[66] 176,232 ≈ 1.67 million estimated total OMP sales in 2027 × (1 - 89.47% compliance percentage)
[67] 266,976 ≈ 2.54 million estimated total OMP sales in 2056 × (1 – 89.47% compliance percentage)
[68] In the absence of an estimate for the elasticity of supply for eScooters or a suitable proxy, staff take a neutral approach and choose the value 1.0 as the elasticity, staff use Taylor and Houtakker's (2010) estimate (-1.572) for the elasticity of demand for "Wheeled Goods" as a proxy for eScooter elasticity of demand. The calculations for the reduction in the number of OMPs sold relative to the baseline are: 39,108 ≈ 173,133 x ($162.79 /$459.56) x ((1.0 x (- 1.5172))/ (1.0 – (-1.5172))); 45,445 ≈ 263,284 x ($124.40 /$459.56) x ((1.0 x (-1.5172))/ (1.0 – (-1.5172))).

Staff multiply the compliance cost per unit by the reduced sales (of units requiring compliance) in the alternative scenario sold each year (orange line in Figure 8). In the first year of the rule (2027), staff estimate there would be an additional $22.43 million[69] in compliance cost. By the last year of the study period (2056), the yearly cost increases to $27.68 million[70]. Over the 30-year study period, compliance costs aggregated to $728.78 million, undiscounted, and $440.99 million discounted at 3 percent.

Deadweight Loss

Deadweight loss reflects consumer and producer surplus lost due to lost transactions (i.e., reduced demand) in the new market equilibrium. While deadweight losses may be minor for small changes in price (and quantity), they comprise an important share of surplus losses for more significant shifts in market equilibria.

To estimate deadweight loss, staff use the change in production cost from regulation and the subsequent reduction in demand. Staff calculate deadweight loss (DWL) using the formula: DWL = ½ × Change in production cost × Change in quantity demanded.[71] Staff applies this formula for each year in the 30-year study period.

4.1.4 eBike Market Dead Weight Loss

In the first year of the rule (2027) for the eBike market, where the production cost increase is $230 (see Table 5) and the reduced demand is 78,558 units (see section 4.1.1), staff estimate the undiscounted DWL to be $9.03 million in 2027.[72] In 2056, where the production cost increase is $194.55 (see section 4.1.1) and the reduced demand is 20,081 units (see section 4.1.1), the undiscounted DWL estimate is approximately $1.95 million[73]. Over the course of the 30-year study period, the total DWL is $70.68 million, undiscounted, and $47.60 million discounted at 3 percent.

4.1.5 eScooter Market Dead Weight Loss

Staff estimate the undiscounted DWL for the first year of the rule (2027) for eScooters, where the production cost increase is $301.44 (Table 6), and the reduced demand is 8,527 units (see section 4.1.2) to be $1.29 million[74]. In 2056, where the production cost increase is $229.76 (see section 4.1.2), and the reduced demand is 9,058 units (see section 4.1.2) the undiscounted DWL estimate is $1.04 million[75]. Over the course of the 30-year study period, DWL is $33.85 million, undiscounted, and $21.11 million discounted at 3 percent.

4.1.6 OMP Market Dead Weight Loss

Staff estimate the undiscounted DWL for the first year of the rule (2027) for OMPs, where the production cost increase is $162.79 (see section 4.1.3) and the reduced sales volume is 38,458 units (see section 4.1.3), to be $3.13 million[76]. In 2056, when the production cost increase is $124.43 (see section 4.1.3) and reduced sales volume is 44,531 (see section 4.1.3), the undiscounted DWL estimate is $2.77 million[77]. Over the course of the 30-year study period, the total DWL is $79.83 million, undiscounted, and $49.30 million discounted at 3 percent.

[69] $22.43 million = $162.79 per unit compliance cost × 137,774 units sold in 2027.
[70] $27.68 million = $124.43 per unit compliance cost in 2056 × 222,445 units sold in 2056.
[71] The implicit assumption of linearity introduces some uncertainty into the resulting estimates.
[72] $9.03 million = $230 increase in cost per unit in 2027 × 78,558 reduced units of demand in 2027 × ½.
[73] $1.95 million = $194.55 increase in cost per unit in 2056 × 20,081 reduced units of demand in 2056 × ½.
[74] $1.29 million = $301.44 increase in cost per unit in 2027 × 8,527 reduced units of demand in 2027 × ½.
[75] $1.04 million = $229.76 increase in cost per unit in 2056 × 9,058 reduced units of demand in 2056 × ½.
[76] $3.13 million = $162.79 increase in cost per unit in 2027 × 38,456 reduced units of demand in 2027 × ½.
[77] $2.77 million = $124.43 increase in cost per unit in 2056 × 44,531 reduced units of demand in 2056 × ½.

Annualized Cost of Draft Proposed Rule

This section converts the aggregate costs over the 30-year study period into annualized amounts. An annualized output converts the aggregate costs over 30 years into a consistent annual amount while considering the time value of money. This metric is helpful when comparing the costs among different rules or policy alternatives that may have different timelines; or those that have similar timelines but costs for one are front-loaded while the other's maybe backloaded.[78]

The following tables summarize the cost of the draft proposed rule in annualized terms:

Table 7: eBike Annualized Costs of the Draft Proposed Rule

Cost Categories	Annualized Costs ($M)		
	Undiscounted	3% Discount	7% Discount
Compliance Cost	$108.10	$109.87	$113.63
Deadweight Loss	$2.36	$2.43	$2.55
Total Costs	**$110.45**	**$112.30**	**$116.18**

Table 8: eScooter Annualized Costs of the Draft Proposed Rule

Cost Categories	Annualized Costs ($M)		
	Undiscounted	3% Discount	7% Discount
Compliance Cost	$8.70	$8.13	$7.45
Deadweight Loss	$1.13	$1.08	$1.01
Total Costs	**$9.82**	**$9.21**	**$8.46**

Table 9: OMP Annualized Costs of the Draft Proposed Rule

Cost Categories	Annualized Costs ($M)		
	Undiscounted	3% Discount	7% Discount
Compliance Cost	$24.29	$22.50	$20.43
Deadweight Loss	$2.66	$2.52	$2.35
Total Costs	**$26.95**	**$25.01**	**$22.78**

Table 10: Total Annualized Costs of the Draft Proposed Rule

Cost Categories	Annualized Costs ($M)		
	Undiscounted	3% Discount	7% Discount
Compliance Cost	$141.09	$140.50	$141.51
Deadweight Loss	$6.15	$6.02	$5.91

[78] The timing of costs along the period of study affects the present value of costs when considering the time value of money. Costs incurred several years into the future are discounted more heavily than costs realized in the short-term.

Total Costs	$147.23	$146.52	$147.42

5 Benefits Analysis

Staff conduct this preliminary regulatory analysis from a societal perspective that considers significant costs of health outcomes (Gold et al., 1996; Haddix, Teutsch, and Corso, 2003; Neumann et al, 2016). Implementing the draft proposed rule would mitigate negative health outcomes thus reducing their associated societal costs. Staff capture the expected reduction in societal costs by estimating the number of deaths and injuries that would be prevented by the draft proposed rule. The Directorate for Epidemiology (EP) retrieved casualties reported through the National Electronic Injury Surveillance System (NEISS), a national probability sample of U.S. hospital emergency departments (ED), and the Consumer Product Safety Risk Management System (CPSRMS), a database that houses personal, proprietary, and confidential data on consumer product related incidents.[79]

Staff use this data to estimate the number of expected deaths and injuries prevented by the draft proposed rule for a 30-year study period (2027-2056). Finally, staff convert prevented death and injuries into monetary terms – specifically, 2024 dollars – using the Value of Statistical Life (VSL) for deaths and CPSC's Injury Cost Model (ICM) for injuries.

In addition to mitigated negative health outcomes, the draft proposed rule would mitigate the property damage caused by fires associated with micromobility lithium-ion batteries. Staff use historical data on property damage from fires to estimate these savings as benefits of this draft proposed rule.

Engineering staff assess that the draft proposed rule would largely prevent all addressable hazards caused by noncompliant batteries; however, staff also recognizes there was at least one recorded fire incident involving a compliant battery. Staff therefore assume that implementing the draft proposed rule would prevent 90 percent of future fatalities and injuries. Staff apply this percentage in this benefit analysis as the effective rate of the rule in preventing both deaths and injuries.

Assessment of Benefits from Prevented Deaths Related to Micromobility Electrical Systems

Using CPSRMS, staff identify 39 deaths, 9 of which were persons under the age of 18, from fire and smoke hazards associated with micromobility electrical systems that occurred from 2019 through 2023. Of these 39 deaths, 24 were attributable to a specific micromobility product and could have been prevented by the draft proposed rule (addressable deaths); 9 of these 24 deaths were persons under 18 years of age. Table 11 shows the number of addressable deaths per year by micromobility product type. Table 12 displays the number of addressable deaths of children under the age of 18 per year by micromobility product type. More details on the incidents examined are in section III in the NPR.

[79] Privacy Impact Assessment of the Consumer Product Safety Risk Management System: https://www.cpsc.gov/s3fs-public/PIACPSRMS2011.pdf

Table 11: Addressable Deaths per Year by Micromobility Product

Year	eBike	eScooter	OMPs	Total
2019	0	0	0	0
2020	0	2	0	2
2021	2	1	6	9
2022	1	2	2	5
2023	4	4	0	8
Total	7	9	8	24

Table 12: Child (< 18-year-old) Addressable Deaths per Year by Micromobility Product

Year	eBikes	eScooters	OMPs	Total
2019	0	0	0	0
2020	0	1	0	1
2021	0	1	4	5
2022	0	1	2	3
2023	0	0	0	0
Total	0	3	6	9

To estimate the societal costs of deaths, staff apply the VSL. VSL is a widely used parameter in cost-benefit analysis, including regulatory analysis, that represents an individual's willingness to pay for reducing their risk of fatality. VSL values a reduction of fatality risk in monetary terms to be used for cost-benefit analysis; it is not an attempt to place a value on any individual life. In regulatory analysis, economists apply VSL to measure the welfare impact of policies that, on a small per-person basis, reduce or increase fatalities.[80]

Staff use the VSL estimate from the U.S. Department of Health and Human Services (HHS).[81] The HHS VSL estimate, when adjusted for inflation[82] is $13.43 million[83] for 2024.

5.1.1 Benefits from Prevented Deaths Related to eBike Electrical Systems

To estimate prevented deaths over a 30-year study period, staff compare the number of deaths in the baseline scenario (i.e., without the rule) and alternative scenario (i.e., with the rule implemented) and measures the difference. Staff project future deaths by applying death rates per million eBike batteries to the forecasted number of eBike batteries in use throughout the study period. Staff then apply an estimated effectiveness rate of the rule, and an estimated compliance rate to determine the death rates for compliant and noncompliant products. Because eBikes are an emerging product with a limited number of years of incident data, staff do not conduct a trend analysis and instead assumes the same death rates throughout the 30-year study period.

[80] Hammitt (2020) suggests a 1/1000 threshold for the maximum mortality risk change that has the potential to be reliably monetized with a standard VSL.
[81] U.S. Health and Human Services, "HHS Standard Values for Regulatory Analysis, 2024", January 25, 2024, standard-ria-values.pdf (hhs.gov).
[82] Bureau of Labor Statistics, "Consumer Price Index for All Urban Consumers (CPI-U)", Series ID: CUUR0000SA0,2013 index = 232.957, 2024 index = 313.689.
[83] $13.43 million = 2013 VSL of $9.0 million × (313.689 ÷ 232.957) × (369 ÷ 333).

Table 13 shows the calculation of death rates based on historical data. Staff calculate the overall death rate, death rate of compliant products, and death rate of noncompliant products. This table is based on the deaths that are addressable by the proposed rule, and staff will reassess after collecting and evaluating comments on the proposed rule.

Table 13: eBike Calculation of Death Rates

Year	Addressable Deaths	In-Use Units
2019	0	1,224,916
2020	0	1,967,715
2021	2	2,841,681
2022	1	3,844,904
2023	4	4,940,721
Total	7	14,819,937
Death Rate per Million Units[84]		0.472
Death Rate for Noncompliant Products per Million Units[85]		0.523
Death Rate for Compliant Products per Million Units[86]		0.052

Next, staff apply death rates to the number of products in use to calculate the number of deaths in the baseline and alternative scenarios. To calculate the number of compliant and noncompliant products in use, staff use the forecast of the number of eBike sales and adjusted them by a 20 percent factor to convert them to the number of batteries and uses the compliance rate for each year, which goes from 10.75 percent in 2024 to 89.47 percent in 2030 (see Section 3.7 for details), to separate the units between compliant and noncompliant subpopulations. Next, staff apply the same approach described in section 3.2 to calculate in-use population for the two subpopulations: compliant and noncompliant products.

To illustrate this method, staff calculates in this paragraph the first year (2027) units in use of noncompliant products in the baseline scenario. As show in Figure 1, the estimated sales in 2027 is 2.22 million units; when staff nets out the estimated 36.09 percent[87] of compliant units in 2027, and include the 20 percent factor for spare batteries, staff has an adjusted sales estimates of 1.70 million[88]. In 2027, the total number of in-use units is 7.55 million, which includes the 1.70 million units sold in 2027 plus the 5.85 million units remaining in circulation from previous years' sales. These remaining units were sold as early as 2017. From 2017 to 2026, sales were estimated using the same method as 2027 and were as follows sequentially: 0.25 million, 0.33 million, 0.36 million, 0.80 million, 0.96 million, 1.14 million, 1.33 million, 1.46 million, 1.59 million, and 1.68

[84] Overall Death Rate per Million Units = Total Deaths ÷ Total In-Use Units × 1 million
[85] Noncompliant Products Death Rate per Million Units = Overall Death Rate ÷ (1 – (10.75% Compliance Rate × 90.00% Effective Rate))
[86] Compliant Products Death Rate per Million Units = Noncompliant Products Death Rate × (1 – 90% Effective Rate)
[87] There is a baseline compliance rate of 10.75% until 2023, after which it grows by 35.35% each year. In 2027, the compliance rate is 36.09%, which is calculated from 10.75% × $(1 + 35.35\%)^{(2027-2023)}$.
[88] 1.70 million = 2.22 million × (1 – 36.09% compliance) × (1 + 20% spare batteries)

million. Staff uses the Weibull probability distribution[89] and calculated the remaining units for each cohort year to be: 8; 232; 2,766; 35,826; 0.15 million; 0.42 million; 0.83 million; 1.22 million; 1.52 million; and 1.67 million.

Staff do this for both the baseline and alternative scenarios, with the alternative scenario accounting for reduced demand from an increase in price. Figure 8 displays the number of in-use compliant and noncompliant eBike batteries in each scenario throughout the study period.

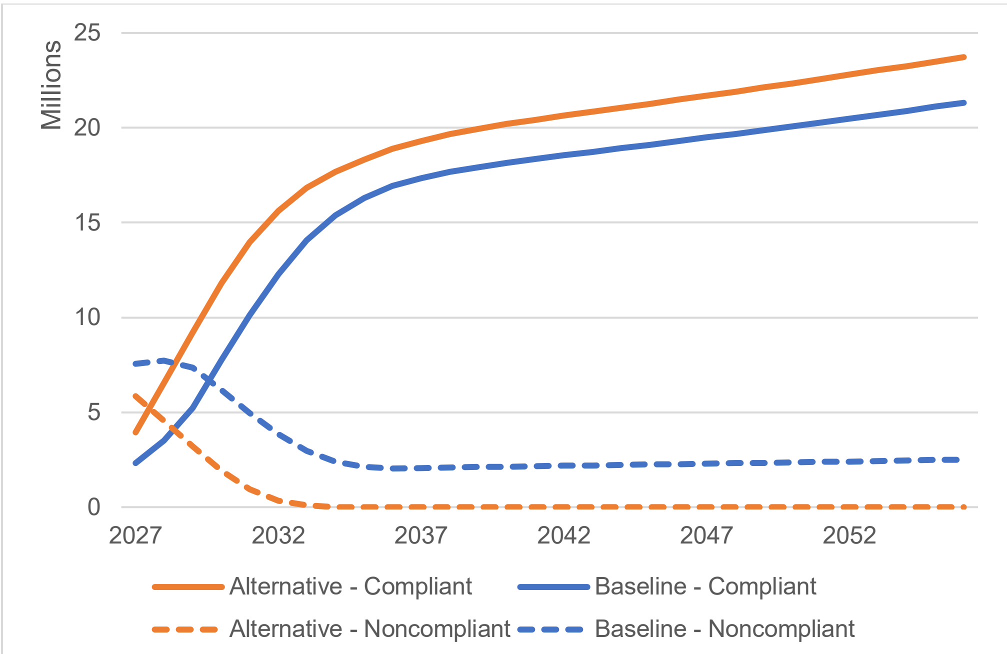

Figure 8: eBike Batteries In Use Throughout 30-Year Study Period

For both scenarios, staff multiply the number of noncompliant and compliant in-use units for each year by their respective calculated death rate to estimate the number of deaths in each scenario. In each scenario, staff multiply the number of deaths in each year by the VSL estimate for that year to calculate the societal costs in each scenario. The difference in societal costs between the scenarios are the benefits from prevented deaths in that given year.

Staff estimate that in the first year of the rule (2027), newly compliant eBikes would prevent an estimated 0.81 deaths and the undiscounted benefits would be $10.80 million;[90] in the last year of the study period (2056), prevented deaths would grow to 1.19 and benefits would reach $15.92 million.[91] Over 30 years, newly compliant eBike batteries would prevent an estimated 38.38 deaths and benefits would aggregate to $515.41 million undiscounted and $304.98 million discounted at 3 percent.

[89] Where the scale parameter is 3.37 and the shape parameter is 5 years, and x is the number of years since the original sales year for each cohort:

$$f(x; 3.37, 5) = \frac{5}{3.37}\left(\frac{x}{3.37}\right)^{5-1} \exp\left[-\left(\frac{x}{3.37}\right)^{5}\right]$$

[90] $10.80 million = [(7.55 million noncompliant products in 2027 in baseline × 0.523 per million + 2.32 million compliant products in 2027 in baseline × 0.052 per million) – (5.85 million noncompliant products in 2027 in alternative × 0.523 per million + 3.94 million compliant products in 2027 in alternative × 0.052 per million)] x VSL $13.43 million.

[91] $15.92 million = [(2.51 million noncompliant products in 2056 baseline × 0.523 per million + 21.32 million compliant products in 2056 baseline × 0.052 per million) – (0.0 million noncompliant products in 2056 alternative × 0.523 per million + 23.73 million compliant products in 2056 alternative × 0.052 per million)] x VSL $13.43 million.

5.1.2 Benefits from Prevented Deaths Related to eScooter Electrical Systems

To forecast deaths in the future, staff examine the historic deaths, the number of products in use along the same period, the effectiveness of the rule, and the estimated compliance rate to determine the death rates for compliant and noncompliant products. Based on an audit of stores of micromobility retailers that staff conducted in 2023, staff estimate that 89.47 percent of eScooters offered for sale in 2023 complied with UL 2272, which staff use as the compliance rate. Recognizing that no rule is 100 percent effective, staff applied a 90 percent effective rate of the rule.

Table 14 shows the calculation of addressable death rates for compliant and noncompliant products.

Table 14: eScooter Calculation of Death Rates

Year	Addressable Deaths	In-Use Units
2019	0	574,090
2020	2	625,886
2021	1	694,771
2022	2	781,999
2023	4	885,778
Total	9	3,562,525
Death Rate per Million Units[92]		2.526
Death Rate for Noncompliant Products per Million Units[93]		12.973
Death Rate for Compliant Products per Million Units[94]		1.297

To forecast the number of prevented deaths resulting from the proposed rule, staff multiply the death rates with the number of compliant and noncompliant products in use in both the baseline and alternative scenarios. To estimate how many compliant and noncompliant products would be in use, staff use the forecast of the number of sales and the compliance rate to separate the sales between compliant and noncompliant subpopulations. Next, staff apply the same methodology described in Section 3.2 to calculate the number of in use products for both subpopulations in both the baseline and alternative scenarios.

To illustrate this method, staff calculates in this paragraph the first year (2027) units in use of noncompliant products in the baseline scenario. As show in Figure 2, the estimated sales in 2027 is 322,877; when staff nets out the estimated 89.47 percent of compliant units, staff has an adjusted sales estimates of 33.987[95]. In 2027, the total number of in-use units is 143,594, which includes the 33,877 units sold in 2027 plus the 136,360 units remaining in circulation from previous years' sales. These remaining units were sold as early as 2020. From 2020 to 2026, sales were estimated using the same method as 2027 and were as follows sequentially: 15,789; 18,684; 21,679; 24,497; 27,103; 29,509; and 31,864. Staff uses the Weibull probability distribution and calculated the remaining units for each cohort year to be: 10; 102; 706; 2,942; 7,975; 15,289; 22,665; 28,193; and 31,724.

[92] Death Rate per Million Units = Total Deaths ÷ Total In-Use Units × 1 million
[93] Death Rate for Noncompliant Products per Million Units = Overall Death Rate ÷ (1 – (89.47% Compliance Rate × 90.00% Effective Rate))
[94] Death Rate for Compliant Products per Million Units = Noncompliant Death Rate × (1 – 90.00% Effective Rate)
[95] 33,897 = 322,877 × (1 – 89.47% compliance)

Staff do this for both the baseline and alternative scenarios, with the alternative scenario accounting for reduced demand from an increase in price. Figure 9 illustrates the number of in-use compliant and noncompliant eScooters throughout the study period for both scenarios.

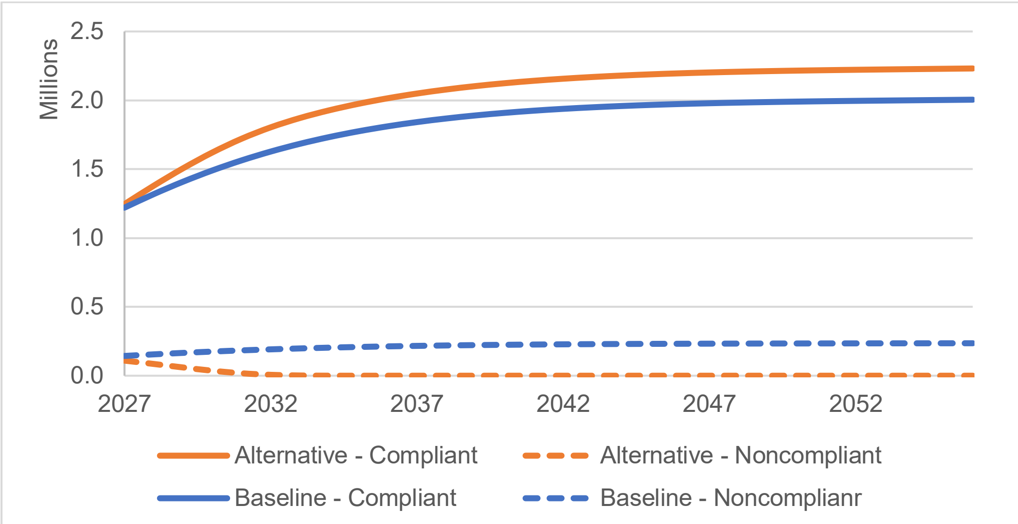

Figure 9: eScooters In Use Throughout 30-Year Study Period

To calculate estimated deaths in both scenarios, staff multiply the number of noncompliant in-use units for each year by the noncompliant death rate; and the number of compliant in-use units by the compliant death rate. Next, staff multiply the number of deaths in each year by the VSL estimate to calculate societal costs from deaths in each scenario. The difference in societal costs between the scenarios are the benefits from prevented deaths in that given year.

Staff estimate that in the first year of the rule (2027), the draft proposed rule would prevent 0.41 deaths[96] from eScooter products and the undiscounted benefits would be $5.48 million;[97] in the last year of the study period (2056), this would increase to 2.77 deaths[98] and benefits would reach $37.13 million[99]. Over 30 years, the draft proposed rule would prevent an estimated 71.90 deaths from eScooter products and benefits would aggregate to $965.62 million undiscounted and $563.99 million discounted at 3 percent.

5.1.3 Benefits from Prevented Deaths Related to OMP Electrical Systems

To forecast deaths in the future, staff examine the historical deaths, the number of products in use along the same period, the effectiveness rate for the rule, and the estimated compliance rate to determine the death rates for compliant and noncompliant products. Based on a 2023 audit of retail stores that staff conducted, staff estimate that approximately 89.47 percent of OMP offered for sale in 2023 complied with UL 2272. Since OMPs are an emerging product with a limited number of years of incident data, staff do not conduct a trend analysis

[96] 0.41 = (0.14 million noncompliant products in 2027 in baseline × 12.973 per million + 1.22 million compliant products in 2027 in baseline × 1.297 per million) – (0.11 million noncompliant products in 2027 in alternative × 12.973 per million + 1.25 million compliant products in 2027 in alternative × 1.297 per million).
[97] $5.48 million = 0.41 prevented deaths in 2027 × $13.43 million VSL.
[98] 2.77 = (0.24 million noncompliant products in 2056 in baseline × 12.973 per million + 2.00 million compliant products in 2056 in baseline × 1.297 per million) – (0.00 million noncompliant products in 2056 in alternative × 12.973 per million + 2.23 million compliant products in 2056 in alternative × 1.297 per million).
[99] $37.13 million = 2.77 prevented deaths in 2056 × $13.43 million VSL.

and instead assume the same death rate throughout the 30-year study period. Table 15 shows the calculation of addressable death rates for both compliant and noncompliant products.

Table 15: OMP Calculation of Death Rates

Year	Addressable Deaths	In-Use Units
2019	0	5,653,793
2020	0	6,295,312
2021	6	6,686,945
2022	2	6,944,672
2023	0	7,168,082
Total	8	32,748,805
Overall Death Rate per Million Units[100]		0.244
Death Rate for Noncompliant Products per Million Units[101]		1.254
Death Rate for Compliant Products per Million Units[102]		0.125

Staff forecast the number of deaths from OMPs in the baseline and alternative scenarios by multiplying the death rates by the number of compliant and noncompliant products in use for both the baseline and alternative scenarios. Staff estimate how many compliant and noncompliant products would be in use by using the same approach described in section 3.2 with forecasted sales for compliant and noncompliant products in both the baseline and alternative (with its reduced demand) scenarios.[103]

The calculation of in-use products is not detailed in this paragraph, as is done for other categories, because this category comprises three distinct sales streams and would necessitate lengthy descriptions of each. Nevertheless, the same methodology applied to eBikes and eScooters is also employed for these products.

Figure 10 displays the number of in-use products of OMPs throughout the study period.

[100] Overall Death Rate per Million Units = Total Deaths ÷ Total In-Use Units × 1 million
[101] Death Rate for Noncompliant Products per Million Units = Overall Death Rate ÷ (1 – 89.47% Compliance Rate × 95% Effective Rate)
[102] Death Rate for Compliant Products per Million Units = Noncompliant Death Rate × (1 –95% Effective Rate)
[103] Staff use a Weibull distribution forecast to produce survival rates with a shape parameter of 5 and scale parameter of 3.37.

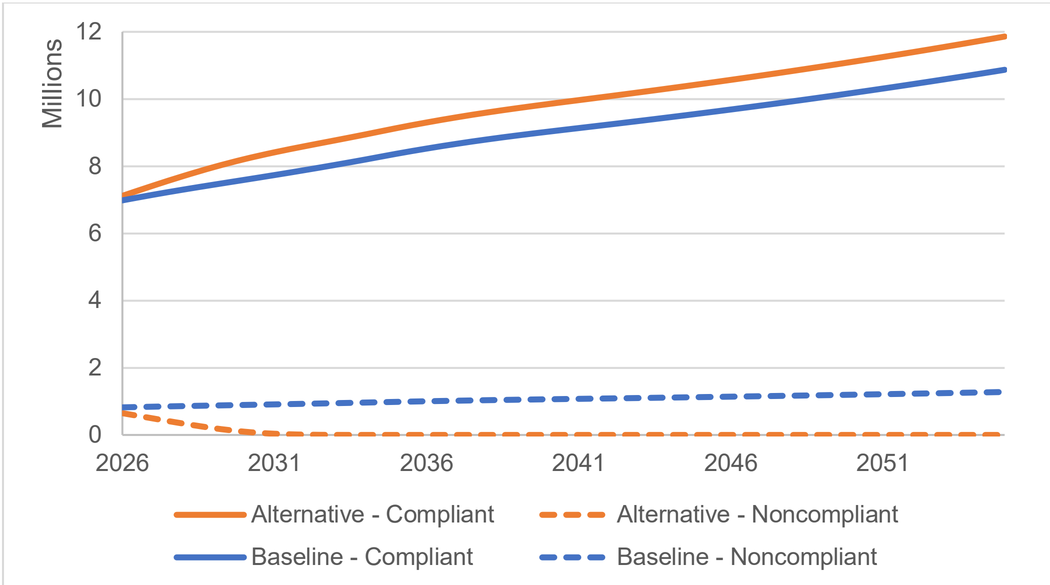

Figure 10: OMPs In Use Throughout 30-Year Study Period

To estimate the number of deaths for both scenarios, staff multiply the number of noncompliant in-use units for each year by the noncompliant death rate; and the number of compliant in-use units by the compliant death rate. Staff then multiply the number of deaths in each year by the VSL estimate to calculate societal costs from deaths in each scenario. The difference between the scenarios is the benefits from prevented deaths from the draft proposed rule.

Staff estimate that in the first year of the rule (2027), the draft proposed rule would prevent an estimated 0.20 deaths[104] from OMPs, and the undiscounted benefits would be $2.74 million[105]; in the last year of the study period (2056), the draft proposed rule would prevent an estimated 1.49 deaths[106] from OMPs, and benefits would reach $19.96 million[107]. Over 30 years, the draft proposed rule would prevent an estimated 35.61 deaths from OMPs, and benefits would aggregate to $478.18 million undiscounted and $279.63 million discounted at 3 percent.

Assessment of Benefits from Prevented Non-Fatal Injuries Related to Micromobility Electrical Systems

Staff estimate the societal costs of nonfatal injuries using the ICM. The societal cost components provided by the ICM include medical costs, work losses, and the intangible costs associated with pain and suffering (Lawrence et al., 2018).

[104] 0.20 = (0.84 million noncompliant products in 2027 in baseline × 1.254 per million + 7.15 million compliant products in 2027 in baseline × 0.125 per million) – (0.66 million noncompliant products in 2027 in alternative × 1.254 per million + 7.29 million compliant products in 2027 in alternative × 0.125 per million).
[105] $2.74 million = 0.2 prevented deaths in 2027 × $13.43 million VSL.
[106] 1.49 = (1.29 million noncompliant products in 2056 in baseline × 1.254 per million + 10.99 million compliant products in 2056 in baseline × 0.125 per million) – (0.00 million noncompliant products in 2056 in alternative × 1.254 1.per million + 12.06 million compliant products in 2056 in alternative × 0.125 per million).
[107] $19.96 million = 1.49 prevented deaths in 2056 × $13.43 million VSL.

Medical costs include three categories of expenditures: (1) medical and hospital costs associated with treating the injured victim during the initial recovery period and in the long run, including the costs associated with corrective surgery, the treatment of chronic injuries, and rehabilitation services; (2) ancillary costs, such as costs for prescriptions, medical equipment, and ambulance transport; and (3) costs of health insurance claims processing. The ICM derives cost estimates for these expenditure categories from several national and state databases, including the Medical Expenditure Panel Survey (MEPS), the Nationwide Inpatient Sample of the Healthcare Cost and Utilization Project (HCUP-NIS), the Nationwide Emergency Department Sample (NEDS), the National Nursing Home Survey (NNHS), MarketScan® claims data, and a variety of other federal, state, and private databases.

Work loss estimates include: (1) the forgone earnings of the victim, including lost wage work and household work; (2) the forgone earnings of parents and visitors, including lost wage work and household work; (3) imputed long-term work losses of the victim that would be associated with permanent impairment; and (4) employer productivity losses, such as the costs incurred when employers spend time rearranging schedules or training replacement workers. The ICM bases these estimates on information from the MEPS, the Detailed Claim Information (a workers' compensation database) maintained by the National Council on Compensation Insurance, the National Health Interview Survey, the U.S. Bureau of Labor Statistics, and other sources.

The intangible costs of injury reflect the physical and emotional trauma of injury, as well as the mental anguish of victims and caregivers. Intangible costs are difficult to quantify because they do not represent products or resources traded in the marketplace. Nevertheless, they typically represent the largest component of injury cost and need to be accounted for in any benefit-cost analysis involving health outcomes (Rice et al., 1989; Haddix, Teutsch, and Corso, 2003; Cohen and Miller, 2003; Neumann et al, 2016). The ICM develops a monetary estimate of these intangible costs from jury awards for pain and suffering. Although these awards can vary widely on a case-by-case basis, studies have shown these are systematically related to several factors, including economic losses, the type and severity of injury, and the age of the victim (Viscusi, 1988; Rodgers, 1993; Cohen and Miller, 2003). The ICM derives these estimates from a regression analysis of jury awards in nonfatal product liability cases involving consumer products compiled by Jury Verdicts Research, Inc.

Staff use incident data from NEISS on the fire/electrical shock hazards associated with micromobility products to forecast the number of injuries treated in emergency department (ED) and other settings throughout the 30-year study period. Typically, staff use reported injuries from NEISS, which records injuries from a sample of U.S. hospitals, and then extrapolates the data into a national estimate. However, the number of recorded incidents reported by the sample hospitals was lower than the publication criteria established in NEISS. Therefore, staff cannot develop a statistically sound national estimate. Instead, staff estimate benefits using injuries reported by the sample hospitals from NEISS as a minimum value of incidents occurring. There are likely many additional incidents not captured in the sample hospital reports and therefore not accounted for in this analysis. Consequently, these estimated benefits are likely an underestimate.

5.1.4 Benefits from Prevented Non-Fatal Injuries Related to eBike Electrical Systems

Staff use NEISS to identify 7 addressable nonfatal injuries related to eBike fire/electrical shock hazards that occurred from 2019 through 2023.[108] The 7 nonfatal injuries were treated in the ED and released.[109] Next, the ICM uses these ED incidents to extrapolate in other settings such as doctor offices and clinics. The ICM calculated 15 injuries treated in an outpatient setting (e.g., doctor's office, or clinic).

[108] The number of incidents recorded in NEISS for the hazard do not meet CPSC reporting requirements due to so few records. As a result, no stable and statistically sound national estimate of the non-fatal injuries can be produced. The estimates described are to be considered anecdotal but do serve as a minimum bounding value.
[109] There are no NEISS records associated with the eBike fire hazard that resulted in hospital admission.

To extrapolate nonfatal injuries to national figures across multiple settings, the ICM begins with data from the NEISS, which captures injuries treated in hospital emergency departments. To estimate the total number of nonfatal injuries nationally, including those treated in other settings, the model applies multipliers to NEISS data. These multipliers are derived from the Medical Expenditure Panel Survey (MEPS) and other sources, which provide information on injuries treated in physician offices, clinics, outpatient departments, and other non-ED settings.

The extrapolation process involves:

- Identifying injury types and severities from NEISS,
- Applying setting-specific multipliers to estimate how many similar injuries are treated outside of emergency departments, and
- Adjusting for underreporting and differences in treatment patterns across settings.

This methodology allows the ICM to produce a more comprehensive national estimate of nonfatal injuries, not limited to emergency care.

Table 16 calculates injury rates for compliant and noncompliant products using incident data, population in use, eBike compliance rate (see Table 4), and an assumed 90 percent effective rate for the proposed rule.

Table 16: Calculation of eBike Addressable Injury Rates

Injury Type	Incidents	Aggregate In-Use Units from 2019 – 2023	Injury Rate per Million Units	Injury Rate per Million Noncompliant Units	Injury Rate per Million Compliant Units
	(a)	(b)	(c) = [(a) ÷ (b)] × 1 million	(d) = (c) ÷ (1 – 10.75% × 90%)	(e) = (d) × (1 – 90%)
ED Treatment	7	14,819,937	0.472	0.522	0.052
Doctor/Clinic	15		1.012	1.120	0.112

To forecast injuries into the future, staff multiply the injury rates with forecasted eBike batteries in use throughout the study period (Figure 8) for each scenario, and then multiplies the number of injuries by the cost of injury to estimate societal costs from injuries in each scenario. The ICM estimates that the costs associated with eBike hazard injuries are: $30,449 for injuries treated at the doctor’s office/clinic, and $45,930 for injuries treated at the emergency department. The difference in societal costs between the scenarios is the benefits from prevented injuries.

Staff estimate that in the first year of the rule (2027), the undiscounted benefits from prevented injuries would be $0.09 million,[110] and reach $0.13 million[111] in the last year of the study period (2056). Over 30 years, these cost savings aggregate to $3.99 million undiscounted and $2.52 million discounted at 3 percent.

5.1.5 Benefits from Prevented Non-Fatal Injuries Related to eScooter Electrical Systems

Staff use NEISS to identify two nonfatal injuries related to fire/electrical shock hazards with eScooters that occurred from 2019 through 2023. The two nonfatal injuries were ED admissions (treated and released). Next, the ICM calculated a total of 4 nonfatal injuries treated in an outpatient setting.

Table 17 shows the calculation of the injury rates for compliant and noncompliant eScooters for each injury type using incident data, population in use, eScooter compliance rate (see Table 4), and an assumed 90 percent effective rate for the proposed rule.

Table 17: Calculation of eScooter Addressable Injury Rates

Injury Type	Incidents (a)	Aggregate In-Use Units* from 2019 – 2023 (b)	Injury Rate per Million Units (c) = [(a) ÷ (b)] × 1 million	Injury Rate per Million Noncompliant Units (d) = (c) ÷ (1 – 89.47% × 90.00%)[112]	Injury Rate per Million Compliant Units (e) = (d) × (1 – 90.00%)
ED Treatment	2	3,562,525	0.561	2.883	0.288
Doctor/Clinic	4		1.142	5.867	0.587

To forecast injuries into the future, staff multiply injury rates with its forecast of eScooters in use throughout the study period (Figure 9) for each scenario, and then multiplies the number of injuries by the cost of injury to estimate societal costs from injuries in each scenario. The ICM estimates that the costs associated with eScooter injuries are: $48,055 for each injury treated at the emergency department, and $34,544 for each injury treated at the doctor's office/clinic. The difference in societal costs between the scenarios is the benefits from prevented injuries.

[110] $89,412 = [(7.55 million noncompliant products in 2027 in baseline × 0.52 per million products) + (2.32 million compliant products in 2027 baseline × 0.052 per million products) – (5.85 million noncompliant products in 2027 in alternative × 0.52 per million products) + (3.94 million compliant products in 2027 alternative × 0.052 per million products) × $45,930] + [(7.55 million noncompliant products in 2027 in baseline × 1.12 per million products) + (2.32 million compliant products in 2027 baseline × 0.112 per million products) – (5.85 million noncompliant products in 2027 in alternative × 1.12 per million products) + (3.94 million compliant products in 2027 alternative × 0.112 per million products) × $30,449].
[111] $131,796 = [(2.51 million noncompliant products in 2056 in baseline × 0.52 per million products) + (21.32 million compliant products in 2056 baseline × 0.052 per million products) – (0.0 million noncompliant products in 2056 in alternative × 0.52 per million products) + (23.73 million compliant products in 2056 alternative × 0.052 per million products) × $45,930] + [(2.51 million noncompliant products in 2056 in baseline × 1.12 per million products) + (21.32 million compliant products in 2027 baseline × 0.11 per million products) – (0.0 million noncompliant products in 2056 in alternative × 1.12 per million products) + (23.73 million compliant products in 2056 alternative × 0.11 per million products) × $30,499].
[112] Staff estimate compliance with the voluntary standard will prevent 90.00 percent of injuries related to micromobility electrical systems.

Staff estimate that in the first year of the rule (2027), the undiscounted benefits from prevented injuries would be $10,728[113] and reach $72,726[114] in the last year of the rule (2056). Over 30 years, benefits from prevented injuries aggregate to $1.89 million undiscounted and $1.10 million discounted at 3 percent.

5.1.6 Benefits from Prevented Non-Fatal Injuries Related to OMP Electrical Systems

Staff use NEISS to identify 6 nonfatal injuries related to fire/electrical shock hazards with OMPs from 2019 to 2023. Of the 6 NEISS injuries for OMPs, 4 were ED admissions, one was a direct hospital admission, and one resulted in a hospital admission via the ED. The ICM calculated that an additional 12 injuries were treated in an outpatient setting (e.g., doctor's office, or clinic).

Table 18 calculates injury rates for compliant and noncompliant OMPs for each injury type using incident data, population in use, OMP compliance rate (see Table 4), and an assumed 90 percent effective rate for the proposed rule.

Table 18: Calculation of OMP Addressable Injury Rates

Injury Type	Incidents (a)	Aggregate In-Use Units from 2019 – 2023 (b)	Injury Rate per Million Units (c) =[(a) ÷ (b)] × 1 million	Injury Rate per Million Noncompliant Units (d) = (c) ÷ (1 – 89.47% × 90%)[115]	Injury Rate per Million Compliant Units (e) = (d) × (1 – 90%)
ED Admissions	4	32,748,905	0.122	0.627	0.062
Hospital Admission	1		0.031	0.162	0.016
Hospital Admissions via ED	1		0.031	0.157	0.016
Doctor/Clinic	12		0.365	1.873	0.187

To forecast injuries into the future, staff multiply injury rates with forecasted OMPs in use throughout the study period (Figure 10) for each scenario, and then multiplies the number of injuries by the cost of injury to estimate societal costs from injuries in each scenario. The ICM estimates that the costs with OMP injuries are: $18,449 for injuries treated at the doctor's office/clinic, $31,543 for injuries treated at the emergency department, and $198,875 for injuries treated at the hospital directly or via the emergency department. The difference in societal costs between the scenarios is the benefits from prevented injuries.

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[113] $10,728 = [(0.14 million noncompliant products in 2027 in baseline × 2.883 per million products) + (1.22 million compliant products in 2027 baseline × 0.288 per million products) – (0.11 million noncompliant products in 2027 in alternative × 2.883 per million products) + (1.25 million compliant products in 2027 alternative × 0.288 per million products) × $48,055] + [(0.14 million noncompliant products in 2027 in baseline × 5.867 per million products) + (1.22 million compliant products in 2027 baseline × 0.587 per million products) – (0.11 million noncompliant products in 2027 in alternative × 5.867 per million products) + (1.25 million compliant products in 2027 alternative × 0.587 per million products) × $34,544].

[114] $72,726 = (0.24 million noncompliant products in 2056 in baseline × 2.833 per million products) + (2.00 million compliant products in 2056 baseline × 0.288 per million products) – (0.00 million noncompliant products in 2056 in alternative × 2.883 per million products) + (2.23 million compliant products in 2056 in alternative × 0.288 per million products) × $48,055) + [(0.24 million noncompliant products in 2056 in baseline × 5.867 per million products) +(2.00 million compliant products in 2056 baseline × 0.587 per million products) – (0.00 million noncompliant products in 2056 in alternative × 5.867 per million products) + (2.23 million compliant products in 2056 in alternative × 0.587 per million products) × $34,544)].

[115] Staff estimate compliance with the voluntary standard will prevent 90.00 percent of injuries related to micromobility electrical systems.

Staff estimate that in the first year of the rule (2027), the undiscounted benefits from prevented injuries would be $0.02 million,[116] and reach $0.14 million[117] in the last year of the study period (2056). Over 30 years, these cost savings aggregate to $3.34 million undiscounted and $1.95 million discounted at 3 percent.

Estimate of Benefits of Prevented Property Losses Related to Micromobility Electrical Systems

Staff reviewed CPSRMS for incident narratives between 2019 and 2023 to develop an estimate of property loss from fires caused by micromobility electrical systems. Of the 189 incidents reviewed, 104 narratives contained estimates of property loss, or language from which property loss could be inferred. Of these 104 incidents, 52 narratives contained estimates of the dollar value of the property loss. CPSC Engineering staff assessed that 43 of the 52 incidents were related to a specific micromobility product and would have been addressable—meaning that the requirements of this rule are capable of preventing the source of the fire—by the draft proposed rule. Table 19 presents the distribution of these 43 incidents by year and product type.

Table 19: Micromobility Property Loss Incidents by Year and Product

Year	eBikes	eScooters	OMP	Total
2019	0	2	5	7
2020	1	3	6	10
2021	4	4	5	13
2022	3	2	1	6
2023	3	0	4	7
All Years	11	11	21	43

Staff estimate the number and rates of property loss incidents for compliant and noncompliant products using the same techniques to calculate death and injury rates. Because these estimates are based on the known property loss incidents that staff were able to associate with micromobility products, and there are almost certainly other incidents not reflected in the data or not able to be associated with micromobility products based on the information given, the estimates are likely underestimating potential benefits.

5.1.7 Benefits from Prevented Property Loss Related to eBike Electrical Systems

Staff identify 11 CPSRMS incidents involving property loss associated with eBike batteries that occurred from 2019 to 2023. The estimated property loss from these incidents totaled $1.49 million or $139,125 per incident in 2024 dollars[118]. Table 20 below presents the values by type and year.

[116] $0.02 million = (0.84 million noncompliant products in 2027 in baseline – 0.66 million noncompliant products in 2027 in alternative) × (0.627 ED admissions per million × $31,543 + 0.162 hospital admissions per million x $198,875 + 0.157 hospital admissions via ED per million x $198,875 + 1.873 doctor office/outpatient per million × $18,449) + (6.98 million compliant products in 2027 in baseline – 7.29 million compliant products in 2027 in alternative) × (0.063 ED admissions per million × $31,543 + 0.016 hospital admissions per million x $198,875 + 0.016 hospital admissions via ED per million x $198,875 + 0.187 doctor office/outpatient per million × $18,449).

[117] $0.14 million = (1.29 million noncompliant products in 2056 in baseline – 0.00 million noncompliant products in 2056 in alternative) × (0.627 ED admissions per million × $31,543 + 0.162 hospital admissions per million x $198,543 + 0.157 hospital admissions via ED per million x $198,875 + 1.874 doctor office/outpatient per million × $18,449) + (10.99 million compliant products in 2056 in baseline – 12.06 million compliant products in 2056 in alternative) × (0.063 ED admissions per million × $31,543 + 0.016 hospital admissions per million x $198,875 + 0.016 hospital admissions via ED per million x $198,875 + 0.187 doctor office/outpatient per million × $18,449).

118 $139,125 = ($1,486,532 ÷ 11 incidents) × (313.689 CPI index in 2024 ÷ 292.655 CPI index in 2022)

Table 20: Historical eBike Fire Incident Property Damages

Year	Property	Contents	Not Specified	Total
2019	$ -	$ -	$ -	$ -
2020	$ -	$ -	$ 3,532	$ 3,532
2021	$ 11,245	$ 1,124	$ 448,329	$ 460,699
2022	$ 171,792	$ 6,247	$ 234,262	$ 412,301
2023	$ 100,000	$ 10,000	$ 500,000	$ 610,000
All Years	$ 283,037	$ 17,371	$ 1,186,123	$ 1,486,532

Table 21 calculates property loss rates for compliant and noncompliant eBike batteries.

Table 21: Property Loss Rate for eBikes

Property Incidents	Aggregate In-Use Units from 2019 – 2023	Property Loss Rate per Million Units	Property Loss Rate per Million Noncompliant Units	Property Loss Rate per Million Compliant Units
(a)	(b)	(c) = [(a) ÷ (b)] × 1 million	(d) = (c) ÷ (1 – 10.75% × 90%)	(e) = (d) × (1 – 90%)
11	14,819,937	0.742	0.822	0.078

To forecast future fire incidents, staff multiply incident rates with the forecasted eBikes batteries in use during the study period (Figure 8) for both the baseline and alternative scenarios, and then multiply the number of incidents by the average cost per incident to estimate property damage in each scenario. The difference between scenarios are the benefits from prevented property damage.

Staff estimate that in the first year of the rule (2027), the undiscounted benefits from prevented property loss would be $0.18 million[119] and reach $0.26 million[120] in the last year of the rule (2056). Over 30 years, benefits from prevented property loss aggregate to $7.84 million undiscounted and $4.97 million discounted at 3 percent.

5.1.8 Benefits from Prevented Property Loss Related to eScooter Electrical Systems

Staff review CPSRMS incident narratives to identify 11 instances of property loss related to fire from eScooter electrical systems that occurred from 2019 through 2023. The estimated property loss in these 11 incident

[119] $175,826 = [(7.55 million noncompliant products in 2027 in baseline × 0.822 per million products) + (2.32 million compliant products in 2027 baseline × 0.082 per million products) – (5.85 million noncompliant products in 2027 in alternative × 0.822 per million products) + (3.94 million compliant products in 2027 alternative × 0.082 per million products)] × $139,125 property loss per incident.

[120] $259,171 = [(2.51 million noncompliant products in 2056 in baseline × 0.822 per million products) + (21.32 million compliant products in 2056 baseline × 0.082 per million products) – (0.0 million noncompliant products in 2056 in alternative × 0.822 per million products) + (23.73 million compliant products in 2056 alternative × 0.082 per million products)] × $139,125 property loss per incident.

narratives total $6.53 million, or $610,765 per incident in 2024 dollars[121]. Table 22 presents these property losses by type and year.

Table 22: Historical eScooter Fire Incident Property Damages

Year	Property	Contents	Not Specified	Total
2019	-	-	$96,107	$96,107
2020	$4,714,580	$176,597	$58,866	$4,950,043
2021	$449,791	$112,448	$857,158	$1,419,397
2022	$52,058	$8,329	-	$60,388
2023	-	-	-	-
All Years	$5,216,430	$297,374	$1,012,130	$6,525,934

Table 23 calculates the property damage rates for compliant and noncompliant eScooters.

Table 23: Property Loss Rate for eScooters

Incidents (a)	Aggregate In-Use Units* from 2019 – 2023 (b)	Injury Rate per Million Units (c) = [(a) ÷ (b)] × 1 million	Injury Rate per Million Noncompliant Units (d) = (c) ÷ (1 – 89.47% × 90.00%)	Injury Rate per Million Compliant Units (e) = (d) × (1 – 90.00%)
11	3,562,525	3.088	15.856	1.586

To forecast future fire incidents, staff multiply incident rates with forecasted eScooters in use throughout the study period (Figure 9) for both the baseline and alternative scenarios, and then multiplies the number of incidents by the average cost per incident to estimate property damage in each scenario. The difference between scenarios are the benefits from prevented property damage.

Staff estimate that in the first year of the rule (2027), the undiscounted benefits from prevented property loss would be $0.30 million[122] and reach $2.06 million[123] in the last year of the rule (2056). Over 30 years, benefits from prevented property loss aggregate to $53.68 million undiscounted and $31.35 million discounted at 3 percent.

5.1.9 Benefits from Prevented Property Loss Related to OMP Electrical Systems

Staff identify 21 CPSRMS incidents involving property loss associated with OMP battery fires that occurred from 2019 to 2023. Table 24 displays the estimated property loss from these incidents totaling $3.26 million or $159,699 per incident in 2024 dollars.

121 $610,765 = ($6,525,934 ÷ 11 incidents) × (313.689 CPI index in 2024 ÷ 304.702 CPI index in 2023)

122 $304,480 = [(0.14 million noncompliant products in 2027 in baseline × 15.856 per million products) + (1.22 million compliant products in 2027 baseline × 1.586 per million products) – (0.11 million noncompliant products in 2027 in alternative × 15.856 per million products) + (1.25 million compliant products in 2027 alternative × 1.586 per million products)] × $610,765

123 $2,06 million = [(0.24 million noncompliant products in 2056 in baseline × 15.856 per million products) + (2.00 million compliant products in 2056 baseline × 1.586 per million products) – (0.00 million noncompliant products in 2056 in alternative × 15.856 per million products) + (2.23 million compliant products in 2056 in alternative × 1.586 per million products)] × $610,765.

Table 24: Historical OMP Fire Incident Property Damages

Year	Property	Contents	Not Specified	Total
2019	$ 553,527	$ 81,829	$ 214,531	$ 986,271
2020	$ 523,905	$ 118	$ 62,986	$ 587,009
2021	$ 921,195	$ 403,688	$ -	$ 1,324,882
2022	$ 208,233	$ 104,116	$ -	$ 312,349
2023	$ 46,980	$ 100	$ -	$ 47,080
All Years	$ 2,253,840	$ 589,851	$ 277,517	$ 3,257,592

Table 25 calculates property loss rates for compliant and noncompliant OMPs.

Table 25: Property Loss Rate for OMPs

Property Incidents (a)	Aggregate In-Use Units from 2019 – 2023 (b)	Property Loss Rate per Million Units (c) = [(a) ÷ (b)] × 1 million	Property Loss Rate per Million Noncompliant Units (d) = (c) ÷ (1 – 89.47% × 90.00%)	Property Loss Rate per Million Compliant Units (e) = (d) × (1 – 90.00%)
21	32,748,805	0.6412	3.2929	0.3293

To forecast future losses, staff multiply incident rates with forecasted OMPs in use during the study period (Figure 10) for both the baseline and alternative scenarios, and then multiplies the number of incidents by the average cost per incident to estimate property damage in each scenario. The difference between scenarios are the benefits from prevented property damage.

Staff estimate that in the first year of the rule (2027), the undiscounted benefits from prevented property loss from OMP fires would be $0.08 million[124] and reach $0.62 million[125] in the last year of the rule (2056). Over 30 years, benefits from prevented property loss aggregated to $14.63 million undiscounted and $8.48 million discounted at 3 percent.

Annualized Benefits of Draft Proposed Rule Under the Assumptions

This section converts the calculated aggregate benefits over the 30-year study period into annualized amounts. An annualized output converts the aggregate benefits over 30 years into a consistent annual amount while considering the time value of money. This metric is helpful when comparing the benefits among different rules or policy alternatives that may have different timelines; or those that have similar timelines but benefits for one are front-loaded while the other's maybe backloaded.

[124] $85,430 = [(0.84 million noncompliant products in 2027 in baseline × 3.2929 per million products) + (7.15 million compliant products in 2027 baseline × 0.3293 per million products) – (0.66 million noncompliant products in 2027 in alternative × 3.2929 per million products) + (7.29 million compliant products in 2027 alternative × 0.3293 per million products)] × $159,699 property loss per incident.

[125] $623,188 = [(1.29 million noncompliant products in 2056 in baseline × 3.2929 per million products) + (10.99 million compliant products in 2056 baseline × 0.3293 per million products) – (0.0 million noncompliant products in 2056 in alternative × 3.2929 per million products) + (12.06 million compliant products in 2056 alternative × 0.3293 per million products)] × $159,699 property loss per incident.

The following tables summarize the benefits of the draft proposed rule in annualized terms for each product type. The final table summarizes these estimated benefits in annualized terms for the rule as whole.

Table 26: eBike Annualized Benefits of the Draft Proposed Rule

Prevented Casualties	Annualized Benefits ($M)		
	Undiscounted	3% Discount	7% Discount
Deaths	$16.05	$15.56	$14.99
Injuries	$0.13	$0.13	$0.12
Property	$0.26	$0.25	$0.24
Total Benefits	**$16.44**	**$15.94**	**$15.36**

Table 27: eScooter Annualized Benefits of the Draft Proposed Rule

Prevented Casualties	Annualized Benefits ($M)		
	Undiscounted	3% Discount	7% Discount
Deaths	$32.19	$28.77	$24.63
Injuries	$0.06	$0.06	$0.05
Property	$1.79	$1.60	$1.37
Total Benefits	**$34.04**	**$30.43**	**$26.04**

Table 28: OMP Annualized Benefits of the Draft Proposed Rule

Prevented Casualties	Annualized Benefits ($M)		
	Undiscounted	3% Discount	7% Discount
Deaths	$15.94	$14.27	$12.29
Injuries	$0.11	$0.10	$0.09
Property	$0.49	$0.43	$0.37
Total Benefits	**$16.54**	**$14.80**	**$12.75**

Table 29: Total Annualized Benefits of the Draft Proposed Rule

Prevented Casualties	Annualized Benefits ($M)		
	Undiscounted	3% Discount	7% Discount
Deaths	$64.17	$58.60	$51.91
Injuries	$0.31	$0.28	$0.26
Property	$2.54	$2.29	$1.98
Total Benefits	**$67.02**	**$61.17**	**$54.15**

Upper-Bound Estimate

eBikes are the least mature segment of the micromobility marketplace, with substantial uncertainties related to product safety, consumer demand, producer behavior in the absence of CPSC regulation, and other regulation, particularly at the state and local levels, etc. Specifically, data of fire incidents likely do not include every relevant incident that occurred and, for the reported incidents, did not have a product category for lithium-ion batteries. The data categorization limitation could have caused lithium-ion battery fires from micromobility products—even when reported—to be uncounted by staff if micromobility products were not mentioned in the narrative for the incident. Consequently, this analysis expectably understates actual benefits from the proposed rule by underestimating the number of incidents and magnitude of loss from fires from these batteries.

The uncertainty surrounding these factors represents the most significant source of variability in this analysis. If the fatality rate per eBike in fact aligns with the level observed for eScooters, then estimated annualized benefits of the draft proposed rule for eBikes are $412.12 million discounted at 3 percent; and the proposed rule overall provides $472.97 million in annualized benefits discounted at 3 percent. Staff consider this projection to represent a plausible upper bound of the benefits for this draft proposed rule.

6 Application of the Analysis to the Draft Proposed Rule

This section applies the foregoing economic analysis to several subjects at issue in staff's recommended draft proposed rule. First it provides the net benefits derived from the preceding cost and benefits assessment. Next, staff conduct sensitivity analyses on certain key parameters for the benefit-cost analysis. Finally, staff make a recommendation on an effective date for the rule based on the findings from the benefit-cost analysis along with other factors.

Net Benefits

Staff assess the relation between benefits and costs of the draft proposed rule for each micromobility product type and in total. The following tables present benefits, costs, and net benefits of the rule (difference between benefits and costs) undiscounted and discounted at 3 and 7 percent; and a benefit-cost ratio of the rule (benefits divided by costs).

For the eBike market, the costs of the rule would outweigh the benefits by $93.64 million annualized, discounted at 3 percent. For the eBike market, the draft proposed rule would have a benefit-cost ratio of 0.14 at a 3 percent discount rate. For every $1 in cost of the draft proposed rule, there would be a return of $0.14 in benefits from mitigated deaths, injuries, and property damage.

Table 30: eBike Annualized Net Benefits and B/C Ratio

	Benefits Compared to Costs		
Annualized Net Benefits ($M)	**Undiscounted**	**3% Discount**	**7% Discount**
Benefits	$16.44	$15.94	$15.36
Costs	$110.45	$112.30	$116.18
Net Benefits (Benefits – Costs)	**($94.01)**	**($96.36)**	**($100.82)**
B/C Ratio	**0.15**	**0.14**	**0.13**

For the eScooter market, the benefits of the rule would outweigh the costs by $21.22 million annualized at a 3 percent discount rate, with a benefit-cost ratio of 3.30 discounted at a 3 percent discount rate. In other words, for every $1 in cost of the draft proposed rule, there would be a return of $3.30 in benefits from mitigated deaths, injuries, and property damage.

Table 31: eScooter Annualized Net Benefits and B/C Ratio

	Benefits Compared to Costs		
Annualized Net Benefits ($M)	**Undiscounted**	**3% Discount**	**7% Discount**
Benefits	$34.04	$30.43	$26.04
Costs	$9.82	$9.21	$8.46
Net Benefits (Benefits – Costs)	**$24.22**	**$21.22**	**$17.58**
B/C Ratio	**3.46**	**3.30**	**3.08**

For the OMP market, the costs of the rule outweigh the benefits by $10.22 million annualized, discounted at 3 percent. For the OMP market, the draft proposed rule has a benefit-cost ratio of 0.59 discounted at a 3 percent discount rate. For every $1 in cost of the draft proposed rule, there is a return of $0.59 in benefits from mitigated deaths, injuries, and property damage. Table 32 displays OMP annualized benefits, costs, net benefits, and the benefit-cost ratio.

Table 32: OMP Annualized Net Benefits and B/C Ratio

	Benefits Compared to Costs		
Annualized Net Benefits ($M)	**Undiscounted**	**3% Discount**	**7% Discount**
Benefits	$16.54	$14.80	$12.75
Costs	$26.95	$25.01	$22.78
Net Benefits (Benefits – Costs)	**($10.42)**	**($10.22)**	**($10.03)**
B/C Ratio	**0.61**	**0.59**	**0.56**

For the entire micromobility market, the costs of the rule would outweigh the benefits by $85.35 million annualized at a 3 percent discount rate. For the entire in-scope micromobility market, the draft proposed rule would have a benefit-cost ratio of 0.42 discounted at 3 percent. For every $1 in cost of the draft proposed rule, there is a return of $0.42 in benefits from mitigated deaths, injuries, and property damage.

Table 33: Total Annualized Net Benefits and B/C Ratio

Annualized Net Benefits ($M)	Benefits Compared to Costs		
	Undiscounted	3% Discount	7% Discount
Benefits	$67.02	$61.17	$54.15
Costs	$147.23	$146.52	$147.42
Net Benefits (Benefits – Costs)	**($80.21)**	**($85.35)**	**($93.27)**
B/C Ratio	**0.46**	**0.42**	**0.37**

Applying the plausible upper-bound estimate for benefits, with the fatality rate per eBike aligned with the level observed for eScooters (Table 14), the draft proposed rule would yield annualized net benefits of $361.65 million when discounted at 3 percent. For the entire in-scope micromobility market, the draft proposed rule would have a benefit-cost ratio of 3.23 discounted at 3 percent. For every $1 in cost of the draft proposed rule, there is a return of $3.23 in benefits from mitigated deaths, injuries, and property damage.

Table 34: Total Annualized Net Benefits and B/C Ratio (Upper-Bound Assumptions)

Annualized Net Benefits ($M)	Benefits Compared to Costs		
	Undiscounted	3% Discount	7% Discount
Benefits	$491.74	$472.97	$450.91
Costs	$147.23	$146.52	$147.42
Net Benefits (Benefits – Costs)	$344.51	$326.45	$303.49
B/C Ratio	3.34	3.23	3.06

Sensitivity Analyses

The estimated benefits and costs of the draft proposed rule are based on various inputs and assumptions. The benefits, for instance, depend on factors such as incidents considered, the VSL, the societal cost of the different injury types, the number of units in use, and many other inputs. Similarly, costs are influenced by manufacturers' compliance costs, the number of units in use, how many noncompliant products would require compliant batteries, among other inputs. Some of these inputs significantly affect the analysis, while others have less impact.

This section examines the effects of using alternative values for key inputs and assumptions. Sensitivity analysis evaluates how changes to a single input affect a key outcome, such as the benefit-cost ratio.

In the main analysis, staff assume that eBike firms will rapidly adopt UL 2849 in the same timeline as eScooter and OMP firms adopted UL 2272. However, if in the baseline scenario eBike firms would be much slower to adopt these standards, that would result in more noncompliant products requiring upgrading to compliance with the draft proposed rule, and therefore the rule would be more costly. For this sensitivity analysis, staff use the assumption that the share of eBikes that are compliant grows at a 5 percent CAGR throughout the 30-year study period, as opposed to the 35.35 percent CAGR in the main analysis.

Table 35 shows the results of this sensitivity analysis for eBikes, while Table 36 shows the results of this sensitivity analysis for the draft proposed rule overall. These tables show that the annualized costs for eBikes increase more than two-fold. This has the effect of decreasing net benefits for the rule overall, from -$85.35

million to -$420.31 million, and decreasing the benefit/cost ratio from 0.42 to 0.23 under a 3 percent discount rate.

Table 35: Sensitivity of eBike Outcomes to Slower eBike Compliance in Baseline

	eBike Benefits Compared to Costs		
Annualized Net Benefits ($M)	**Undiscounted**	**3% Discount**	**7% Discount**
Benefits	$87.00	$79.28	$69.24
Costs	$530.62	$510.60	$482.03
Net Benefits (Benefits – Costs)	**($443.62)**	**($431.32)**	**($412.79)**
B/C Ratio	**0.16**	**0.16**	**0.14**

Table 36: Sensitivity of Proposed Rule Outcomes to Slower eBike Compliance in Baseline

	Benefits Compared to Costs		
Annualized Net Benefits ($M)	**Undiscounted**	**3% Discount**	**7% Discount**
Benefits	$137.58	$124.51	$108.03
Costs	$567.40	$544.82	$513.27
Net Benefits (Benefits – Costs)	**($429.82)**	**($420.31)**	**($405.24)**
B/C Ratio	**0.24**	**0.23**	**0.21**

Unquantified Benefits and Costs

Staff assess that there are likely both unquantified benefits and costs from the proposed rule.

6.1.1 Benefits

Data of fire incidents did not have a product category for lithium-ion batteries. This could have caused lithium-ion battery fires from micromobility products to be mislabeled or not identified if micromobility products were not mentioned in the narrative for the incident. Consequently, this analysis could underestimate benefits by underestimating the number of incidents or magnitude of loss from fires from these batteries. The products source is not identified in many of these cases, but it serves as an example of the potential magnitude of the unquantified benefit of the proposed rule.[126] Additionally, fires that result in total loss of multi-dwelling units have the potential to impose significant negative externalities on consumers.[127] Data collected and presented to Congress indicate that in New York alone, over 400 buildings were damaged from lithium battery fires. Staff

[126] Butler, John S. (2024 February 15). Examining Fire Hazards: Lithium-Ion Batteries and Other Threats to Fire Safety. US House of Representatives Subcommittee on Emergency Management and Technology of the Committee on Homeland Security & Governmental Affairs. Washington DC.

[127] A negative externality is a cost imposed on a party as an indirect effect of the actions of another party, in this case, an micromobility product consumer. For example, an eBike owner charging an eBike that catches fire and burns down both their own apartment and a neighbor's apartment. The neighbor suffers the loss of their apartment and possession even though they did not purchase or use the eBike. Negative externalities are a form of market failure resulting in inefficient market outcomes.

cannot reliably quantify these potential benefits due to a lack of data specificity in the various data sources reviewed.[128]

There can be also legal costs when fires spread to nearby structures that result in losses to other parties. These costs are likely just a fraction of the total property losses associated with these fires. However, the potential large magnitude of these losses could make some legal fees significant.[129] Staff do not have robust data to estimate potential legal costs avoided as a result of the proposed rule.

Finally, staff may be overestimating benefits by not accounting for the slowdown in insurance premiums in the baseline. One firm interviewed by staff stated that liability coverage could not be obtained without a commitment to only sell UL certified products. Consequently, staff may be underestimating the growth of compliance in the baseline scenario, which would reduce the growth of insurance premiums. Staff do not have the data to quantify this impact.

6.1.2 Costs

The potential unquantified costs of the proposed rule are largely expected to be related to consumer utility. Some of the requirements in the proposed rule may limit the availability of higher performance micromobility products or components. These would be items with higher voltages or certain modifications to extend range.

Effective Date

The Commission determines an appropriate effective date based on what is in the public interest, utilizing information and recommendations provided by staff, along with other evidence and policy considerations, as documented in the Commission's final rule.

Staff recommend an effective date for this draft proposed rule of 180 days after promulgation of the final rule. Staff makes this recommendation after evaluating three relevant factors: (1) the benefits from mitigated deaths and injuries; (2) the number and complexity of actions most firms would need to take to bring compliant products to market; and (3) the vulnerability of the market to significant supply chain and market disruptions.

Added Benefits

The purpose of an earlier effective date is to realize safety benefits of the rule more quickly: injuries that are prevented and lives that are saved. Staff estimate an additional $7.65 million in benefits ($4.30 million from eBikes, $2.25 million from eScooters, and $1.10 million from OMPs) under a 30-day effective date (the earliest effective date allowed under CPSA and the Administrative Procedure Act unless the Commission for good cause determines that an earlier effective date is in the public interest), using a 3 percent discount rate. However, because the cost would also increase, the net benefits would further decrease by $148.99 million.

Firm Actions for Compliance

Based on the assessment of CPSC's Directorate for Engineering Science, firms would have to do the following in preparation for compliance with the new rule:

(1) Procure or develop compliant lithium-ion batteries and electrical systems.
(2) Design and incorporate the battery and electrical system into the product.

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128 The need for this data collection effort is documented in various recent presentations to Congress and government agencies. The current data published by the U.S. Fire Administration (USFA) lacks specificity and staff is unable to isolate the estimates to only the in-scope products.

129 Previous research completed for CPSC's Injury Cost Model indicated that legal costs associated with consumer product cases where an injury occurred amounted to approximately 0.5 to 1 percent of the total award. While not a direct proxy for property loss it serves as an example of the potential size of avoided costs.

(3) Test all models with newly added compliant batteries and electrical systems.

Based on these actions, staff estimate that most firms, and all firms with significant market share, would be able to complete these actions and manufacture or import compliant products within 180 days from promulgation of a final rule. The draft proposed rule adopts existing voluntary standards, which have already been adopted by many firms; those firms not currently complying with the standards would need to procure compliant batteries for all their products, develop designs to include these batteries into all its models, execute these designs, and set up and perform testing for all newly compliant models. This could prove challenging to do in less than 180 days as most manufacturing is done overseas and currently does not require testing.

Impact of Effective Date on Industry

An earlier effective date (i.e., shorter duration between promulgation and implementation) could have a likelihood of misaligning the rollout of the rule with the typical cyclical demand of the industry for all three product categories. Sales for these products are at their peak during warm weather months and the holidays. If the effective date is during the peak demand cycle, firms may not be able to comply at that high level of demand, which could lead to shortages and decreased sales which would negatively affect firms and consumers.

An earlier effective date also could cause significant costs for eBike firms and consumers if the effective date is misaligned with the industry's redesign cycle. eBike manufacturers issue yearly models, similar to automobiles. A 30-day effective date would likely not allow firms enough time to align compliance with their redesign cycles and potentially cause shortages and supply chain issues.

Anti-stockpiling Provision

The draft proposed rule includes an anti-stockpiling provision[130] that would prohibit manufacturing and/or importing noncompliant products between the promulgation of the final rule and the effective date, at a rate greater than 120 percent of the base period. The base period is described in the draft proposed rule as the average monthly manufacturing or import volume of the 13 months immediately preceding the month of promulgation of the final rule.

Staff base the recommendation on whether the product is susceptible to being stockpiled, expected growth in the market, and the market demand cycle. Micromobility products are less susceptible to being stockpiled because of their large size, high price points, uneven demand cycles, and high inventory costs. High inventory costs can significantly reduce or eliminate the financial benefits of stockpiling. Given this, staff recommend a provision in line with historical sales growth that will prevent egregious attempts to stockpile noncompliant products but allow flexibility for firms to avoid potential shortages.

A Euromonitor Consulting (Euromonitor) marketing report projects these products to grow around 15 percent annually, which indicates sales in a particular month could be 115 percent more than sales in the same month from the prior year, on average. While the average estimated growth rate is 15 percent, that growth is not necessarily distributed evenly among the months of the year. Some micromobility products have an uneven demand cycle as the summer months and holidays can see more sales than at other times of the year.[131] The market's uneven demand cycle means a skewed distribution of sales throughout the year. A stockpiling limit set at the average growth rate could cause complications during a high sales period when the volume of sales is

[130] According to Section 9 paragraph (g)(2) of the CPSA, CPSC may prohibit stockpiling from the date of promulgation of the rule to the effective date of the rule. Stockpiling is defined as manufacturing or importing a non-complying product which is significantly greater than the rate at which such products were produced or imported during a base period.
[131] An uneven demand cycle means high variability in monthly sales. Since the base period of the anti-stockpiling provision refers to the average of the last 13 months, this average may well be significantly below peak month demand, which could lead to shortages.

likely to exceed the yearly average. Taking these facts into consideration, staff recommend a 120 percent level above the average monthly volume for the base period. This would provide firms with some flexibility to meet demand at peak levels while preventing any significant stockpiling.

Staff acknowledge that setting a single, 120 percent level as the measure of stockpiling will be more restrictive for eBike firms that are experiencing faster market growth than for other micromobility product firms. For a final rule the Commission may wish to consider a more segmented approach to preventing stockpiling, that differentiates among the different categories of micromobility products.

7 Description of the Voluntary Standards

Described in section IV of the NPR.

8 Alternatives to the Draft Proposed Rule

CPSC considers three alternatives to the proposed rule: (1) limit the scope of the rule to eScooters; (2) conduct marketing campaigns instead of promulgating a final rule; and (3) propose a later effective date.

Limit the Scope of the Rule to eScooters

The Commission could limit the scope of the NPR to eScooters, removing eBikes and OMPs, because the estimated benefits and costs from those products are more certain. With this alternative, annualized estimated benefits of the NPR would be $30.43 million at a 3 percent discount rate, which exceeds the annualized cost of the rule of $9.21 million. This yields annualized net benefits of $21.22 million, and a B/C ratio of 3.03.

This alternative would leave the fire hazard from lithium-ion batteries high for eBikes and OMPs, and expose riders and others, including vulnerable young children and seniors, to this fire hazard.

Conduct Marketing Campaigns Instead of Promulgating a Final Rule

Rather than promulgating a final rule, the Commission could issue news releases or utilize other information and marketing techniques to warn consumers about the identified associated hazards with micromobility product electrical systems, including lithium-ion batteries. For a fuller marketing campaign effort which would include earned media outreach or a media tour in addition to a PSA, previous campaigns have cost as much as $400,000 for CPSC.

While campaigns can raise awareness, staff estimate that the resulting, market-driven compliance rate for producers would be well below the (nearly) 100 percent compliance rate that a final rule can produce. Moreover, CPSC already conducts education campaigns and the incidents continue to occur. Therefore, much of the societal costs would continue to be incurred by consumers in the form of deaths, injuries, and property damage.

Set a Later Effective Date

The Commission could establish an effective date for its proposed rule later than 180 days. The proposed rule includes an effective date that is 180 days after the final rule is published in the Federal Register. An effective date of one year would allow manufacturers more time to redesign their micromobility products, modify production lines, spread research and development costs over a greater period, and mitigate supply chain issues. Additionally, since the estimated costs are greater than the benefits of the rule, delaying the rule to one year would also generate positive net benefits. Specifically, it would delay benefits of prevented deaths and injury equaling $1.32 million discounted at 3 percent, while delaying costs of $11.86 million.

However, staff analysis indicates existing micromobility products and associated lithium-ion battery pack containers may accommodate UL-compliant cells, battery management systems, and controllers with little or no required modifications. Because the proposed rule is based on well-known requirements, the Commission is not proposing an effective date later than 180 days.

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