U.S. Department of Transportation
Federal Highway Administration

Electric Bicycles (E-bikes)

FHWA-HEP-23-032

Electric bicycles (e-bikes) represent a rapidly growing transportation mode and evolving policy area in the United States, which reflects their benefits for health, accessibility, and tourism. E-bikes are similar to conventional bicycles but have a small electric motor and battery. E-bikes have a number of applications as personally owned bicycles, in bikeshare fleets, for urban freight delivery, as adaptive bicycles for people with disabilities, and as mountain bikes on recreational trails. The Federal Highway Administration (FHWA) is advancing research on e-bikes to better understand trends and impacts, and how jurisdictions around the country are managing them.

Defining E-bikes

There are two main types of e-bikes: pedal-assisted and throttle-assisted. A rider must pedal a pedal-assisted bicycle to engage the electric motor, whereas a rider uses a handlebar-mounted throttle to engage the electric motor of a throttle-assisted bicycle.

Definitions of e-bikes can be found in statutes implemented by the U.S. Department of Transportation (DOT) and, for low-speed e-bikes, the Consumer Product Safety Commission (CPSC).

- DOT: a bicycle equipped with fully operable pedals, a saddle or seat for the rider, and an electric motor of less than 750 watts; that can safely share a bicycle transportation facility with other users of such facility; and that is a class 1, class 2, or class 3 e-bike.[1]
- CPSC: a two- or three-wheeled vehicle with fully operable pedals and an electric motor of less than 750 watts (1 horsepower), whose maximum speed on a paved level surface, when powered solely by such a motor while ridden by an operator who weighs 170 pounds, is less than 20 mph.[2]

E-bike Classes

Class 1: pedal assist, max assisted speed of 20 mph

Class 2: throttle assist, max assisted speed of 20 mph

Class 3: pedal assist, max assisted speed of 28 mph

Source: 23 U.S.C. § 217(j)(2)

The three-tier system classifying e-bikes, originally developed by the Bicycle Product Suppliers Association (BPSA) and the bicycle advocacy coalition PeopleForBikes and later codified at 23 U.S. Code § 217(j)(2), is considered the industry standard and has been adopted by some other Federal agencies and over 39 States.[3]

Regulating E-bikes

There is significant variability across States and localities regarding e-bike regulations. The majority of States specifically define and regulate e-bikes as distinct from other vehicle types. State governments set varying requirements regarding e-bikes registration and labeling; rider and passenger age, licensure, and helmet use; and where e-bikes can be operated. The CPSC is charged with regulating the manufacturing of low-speed electric bicycles.[4]

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[1] 23 U.S.C. 217(j)(2).
[2] 15 U.S.C. 2085(b).
[3] The number of States using the three-tier system changes frequently. This number is reported on by People For Bikes at: https://www.peopleforbikes.org/topics/electric-bikes.
[4] *See* 16 CFR part 1512.

E-Bike Topic Areas

Research on e-bikes has been evolving over the last few decades. Below are summaries of research topic areas. Additional information and references can be found in the FHWA's E-bike Literature Review.

- **Ridership Trends** – E-bike use is increasing in the United States and is popular among individuals who would otherwise be deterred from bicycling by physical limitations, hilly terrain, and long distances. E-bikes may replace trips taken by conventional bicycles, and likely lead to a reduction in vehicle miles traveled. The demographics of e-bike users tend to skew older and have higher income and educational attainment than traditional bicycle users.
- **Safety** – E-bike riders typically exhibit approximately the same safety-related behaviors as riders of conventional bicycles. The older demographics of e-bike riders may make them more susceptible to injury risks associated with single-vehicle crashes. E-bikes have the capability to reach higher speeds than traditional bikes, and higher speeds are associated with safety risks. Although unlikely, e-bike batteries have a risk of combustion.
- **Physical Activity, Health, and Accessibility** – Riding e-bikes generally has positive results for a rider's physical and mental health; even though they require less physical exertion than traditional bicycles, riding a pedal assist e-bike still provides enough exercise to maintain good health. Since e-bikes require less physical exertion than conventional bikes, they have potential to support independent mobility for older individuals or those with limited physical ability, enabling bicycle transportation to be feasible for more people and more trips.
- **Equity** – E-bikes present an opportunity to expand access for underserved groups, and shared e-bikes may lower barriers to access for lower income populations. Despite this, their high upfront cost, potential safety risk to novice riders, and the limited availability of shared e-bikes in disadvantaged and underserved communities often are barriers reducing e-bike access. Other equity concerns include rider gender discrepancies and the potential for bias in the enforcement of e-bike bans.
- **Infrastructure Impacts** – E-bikes may impact trail surfaces and natural resources in different ways than traditional bicycles. For example, the additional torque an e-bike's motor applies to the tires may cause more erosion and damage to natural surface trails. E-bikes may impact wildlife behavior differently than other uses of recreational trails.
- **Environmental Impacts** – Compared to traditional internal combustion engine vehicles, e-bikes use less energy and produce fewer greenhouse gas emissions. However, the extent of environmental benefits of e-bikes depends on several factors including mode shift behavior, degree of e-bike market penetration, attributes of electricity generation, net emissions during manufacturing, and battery recycling. E-bikes can reduce human exposure to traditional air pollutants because most environmental impacts of e-bikes are associated with their manufacturing and production as well as the end-of-life management (including disposal or recycling) of their lithium-ion batteries.
- **Freight Uses** – E-bikes show promise for urban freight applications, particularly as a last mile solution for deliveries. Cargo e-bikes have several advantages relative to traditional means of urban delivery, including: reducing noise pollution; navigating congested streets more easily; saving time and money by reducing searching for parking; and improving safety for vulnerable road users.

Future Research Needs

There are several emerging research areas relevant to e-bikes, including some being identified through the FHWA Vulnerable Road User Research Plan. Key future research needs include:

- **Transit Integration** – Research on integrating e-bikes with traditional transit would enable increased amount of multimodal trips. This research could consider co-location of shared e-bike docks at transit stops, provision of e-bike parking and charging at transit stations, and alignment of policies regarding passenger transport of e-bikes on transit. This research area would also support and align with the Federal Transit Administration's Integrated Mobility Innovation demonstration program.

- **Infrastructure Needs** – Research on potential changes to bicycle facility design, right-of-way, and cost implications would enable safer, more comfortable, and convenient e-bike trips for recreational, transportation, and commercial purposes. This research could consider whether and how facility designs need to accommodate larger and heavier e-bike freight vehicles and the potential for faster speeds of e-bikes relative to conventional bicycles. This research area would support and align with FHWA's Complete Streets efforts.

- **Battery Recovery and Recycling** – Research on end-of-life management for lithium-ion batteries typical of e-bikes would ensure safer and more environmentally friendly disposal and recycling. This research could consider best practices for battery storage and use that prolong battery life; policies, regulations, and incentives to encourage battery recycling; planning for end-of-life management in battery design; and advanced materials separation, scale-up, and reintegration of lithium-ion battery materials. This research area would align with the Department of Energy's efforts pursuant Section 40208 of the Bipartisan Infrastructure Law, *Electric Drive Vehicle Battery Recycling and Second Life Applications Program*.

- **Battery Fire Risk** – Further research on risk factors that contribute to battery fire risks in order to prevent battery fires is needed. Such research could address best practices for regulatory approaches (e.g., alternatives to pausing shared micromobility programs); differences in risk between e-bikes and other electric micromobility devices, including electric mobility aids for people with disabilities; differences in risk between personal and shared e-bikes; industry rates of adoption of UL 2849; and equity impacts regarding fire risk in multifamily housing and for people relying on e-bikes for delivery jobs. Two Federal interagency groups, the Lithium Battery Safety Working Group and Lithium Battery Interagency Coordination Group, will continue work on addressing potential electrical hazards, including battery charging, use, storage, and transportation issues.

- **Lifecycle Environmental Impacts** – This research could include location-specific analysis, particularly in the U.S., to validate modeled increases in e-bike mode share and determine climate and emissions benefits. Additional research on the longevity and performance of lithium-ion batteries (and novel energy storage alternatives) may clarify implications for environmental effects associated with production and end-of-life management (e.g., raw materials and appropriate disposal or recycling) of lithium-ion batteries.

- **Total Ownership Costs** – Higher upfront costs may be a barrier to e-bike ownership for some. Research on total ownership costs of e-bikes, relative to other forms of transportation, could inform individual e-bike purchase decisions and design of incentive programs to encourage e-bike adoption.

Success Stories

State and local jurisdictions are exploring the potential of e-bikes in their own communities. Below are a few highlights discussing how some States and communities are changing laws and regulations to accommodate the growing ridership of e-bikes, and implementing programs to encourage e-bike use. Visit Electric Bicycles page to read these and other case studies.

Portland, OR Establishes Adaptive Bikeshare Program to Expand Mobility for Individuals with Disabilities

In 2016, the City of Portland launched BIKETOWN, a docked bike sharing system operated by the Portland Bureau of Transportation (PBOT), which provides the public with short term bicycle rentals. As the program grew, PBOT explored alternatives that would expand access to bicycles and improve mobility for individuals with disabilities. PBOT ultimately developed a partnership with a local nonprofit and created an adaptive bikeshare program that included the use of e-bikes to expand mobility for residents.

Individuals participating in a group ride with Adaptive BIKETOWN. Image courtesy of PBOT.

Energy Utilities Provide E-bike Purchase Rebates in Vermont

Electric utilities in Vermont have developed e-bike incentive programs. In particular, the Burlington Electric Department's (BED) e-bike rebate program offers current Burlington residents or those purchasing on behalf of a Burlington business a $200 rebate for a new e-bike or retrofit or conversion kit, redeemable at six participating retailers. Local Motion, an organization advocating for active transportation, administers the program. The program has issued a total of 181 rebates since its inception in 2017, while similar programs run through other electric utilities in Vermont have provided approximately 700 rebates in 2020 alone.

Durango, CO Conducts E-bike Pilot on Natural Surface Trails to Expand Access for Users

The City of Durango has taken a methodical approach to permitting the use of e-bikes on its trail systems. After a successful pilot of Class 1 and 2 e-bikes on hard surface trails in 2019, Durango conducted a similar study on soft surface trails. A one-year pilot beginning in June 2020, and extended to November 2021, allowed the use of Class 1 e-bikes on the 10 miles of trails within the Twin Buttes trail system. During that period, surveys and public engagement forums evaluated perceptions and user conflicts between e-bike riders and other recreational users. Following the pilot, the city permanently allowed e-bikes on select soft surface trails.

Electric mountain bike rider riding on one of Twin Buttes natural surface trails in Durango. Image courtesy of City of Durango.

Using E-bikes to Expand Access and Mobility for Essential Workers in Detroit, MI

During the COVID-19 pandemic, the City of Detroit launched a pilot program to provide select frontline employees with e-bikes and electric scooters for their work commute. The pandemic caused public transportation providers to cut services and temporarily remove bikes from bikeshare systems in response to public health mandates. Detroit's Office of Mobility Innovation (OMI) recognized the mobility challenges facing essential workers and loaned e-bikes to qualifying individuals. As a result, an e-bike leasing pilot program conducted from May 2021 to October 2021 saw a 17 percent increase in participants riding to work.

NYC Supports Commercial Cargo E-Bike Pilot to Replace Truck Deliveries

New York City (NYC) is changing how New Yorkers get their packages by managing one of the largest cargo e-bike programs in the country. In 2019, the NYC DOT Corridor Initiatives Freight Mobility Unit began testing a pilot program with select freight delivery service partners to utilize cargo e-bikes for deliveries. The program aims to reduce congestion, improve safety, and cut greenhouse gas emissions. The city provides parking spaces for commercial e-bikes and training to operators in exchange for travel data of the deliveries. The program transitioned from a pilot program to an ongoing program in 2022.

Cargo e-bike corral in front of a grocery store in New York. Image courtesy of NYC DOT.

FHWA E-Bike Points of Contact

- Christopher Douwes, Christopher.Douwes@dot.gov
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Additional Resources

Pedestrian and Bicycle Information Center
- e-Bikes

National Conference of State Legislatures
- State Electric Bicycle Laws: A Legislative Primer

FHWA
- Bicycle and Pedestrian Program
- Pedestrian and Bicycle Funding Opportunities
- Transportation Alternatives Program
- Recreational Trails Program
- Framework for Considering Motorized Use on Nonmotorized Trails and Pedestrian Walkways under 23 U.S.C. 217
- The Future of E-Bikes on Public Lands Research Study