Transportation Authority of Marin (TAM)

Electric Bicycles in Marin County

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PLANNING + DESIGN

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Executive Summary

The purpose of this report is to identify the potential role e-bikes can play as part of the transportation system in Marin County, and, if they help reduce the impacts of vehicle use, what public agencies (including TAM) and private entities can do to encourage their use. This report looks at the history of e-bike development, the technical aspects of e-bikes, trends in sales and usage, ridership in Marin County, and specific actions public and private entities can do to support their use for transportation purposes. This includes, for example, subsidies to reduce the cost of e-bikes by employers in Marin County, and supporting facilities (such as secure bike parking) to improve the connection to transit. E-bikes may also be an effective extension of current transit and commuter rail (SMART) services in Marin County, although e-bike weight (50 to 70 pounds) make them too heavy to be loaded onto bus racks and they are not currently allowed on Golden Gate ferries. Finally, some specific neighborhoods and corridors in Marin County may benefit from improved access by the use of e-bikes. For example, neigborhoods like Tam Valley may become more accessible by bicycle with expansion of e-bikes in the County—reducing vehicle traffic. Class III bike route corridors like San Pedro Road in San Rafael may see increased e-bike usage as cyclists are able to easily climb hills and move closer to the speed of vehicle traffic.

E-bikes have many benefits compared to traditional bicycles. These benefits fall into three major buckets: speed and comfort, distance, and terrain. In terms of speed and comfort, e-bikes allow riders to reach slightly higher average speeds than traditional bikes (15 mph compared to 9 mph) and allow riders to reach their average speed quicker. E-bikes foster bicycle trips to destinations that are further away and encourages trip-chaining (stopping at multiple destinations in one journey). Traveling further distances faster while exerting less effort can also promote more commuter trips as e-bikes may not require the same support facilities (such as shower and changing facilities) as traditional bicycles. E-bikes, however, may require more robust and secure bike parking facilities due to their cost.

Studies and surveys have shown that the absence of those items is commonly stated as one of the reasons they opted not to bike to work. Helping to overcome steep terrain is one of the most frequently cited benefits of e-bikes. The electric-assist motor can both physically help riders move up hills and also remove the mental barriers associated with biking through hilly areas. Similarly, the engine can also help those with physical limitations like bad knees. The assist motor allows these users to bike around, on both steep and level terrain, while putting less stress on joints, opening up biking to a broader audience of people. This is important in a place like Marin County where there is an older-than-average population, a large number of young families, and a general interest in health and the environment. Additionally, many trips in Marin County are shorter utility trips (shopping, etc.) and lend themselves well to e-bikes.

The continued adoption of e-bikes is not without drawbacks and limitations. The four main drawbacks of e-bikes currently include costs, technological limitations, weight, and limited distribution channels. E-bikes are more expensive than their traditional bike counterpart. The increased cost can be a major barrier for many looking to enter the e-bike market, with the cheapest e-bikes still costing hundreds of dollars. Top-of-the-line e-bikes can cost in the tens of thousands of dollars. E-bike technology has advanced significantly over time, especially in recent years, but there are still limitations. Battery technology is limited and can have a

shorter lifespan than other bicycle components. E-bikes are also more complicated to maintain and may need special services that are not available at some bike shops. The weight of e-bikes (50 to 70 pounds) is a barrier to putting them on bus racks, storing or parking them where they need to be lifted, and even putting them on bike racks on cars. Weights are slowly dropping as battery manufacturing innovations occur. Lastly, as their market share is still relatively small, e-bikes are currently not as widely available as traditional bikes, further limiting access to them. Hopefully, all three of these limitations will continue to improve over time as technology continues to improve, demand rises, and costs fall.

In recent years, e-bike sales have been increasing, and this growth is expected to continue. Some estimates say that the global e-bike market will grow by over 9% annually and the United States e-bike market by over 19% by 2024. Most of this growth will be supported by Class I pedal-assist bikes (currently over 85% of the market). This type of bike is also the type of e-bike most commonly found in bike share systems.

Government agencies can help e-bike growth by both developing incentive programs but also by continuing to develop bicycle infrastructure and support facilities (secure parking, charging stations, etc.). This memo also includes the results of a survey of Marin County bike shop owners that confirm the global trends are taking hold in Marin County, and the e-bike growth here will continue. A count conducted in May 2020 on the Mill Valley-Sausalito Bike Path revealed that e-bikes make up between four (4) and five (5) percent of bicycles in Marin County currently. An estimate of saved vehicle trips by e-bikes shows that e-bikes reduce about 2.5 million vehicle miles traveled (VMT) per year currently (source: E-bike Demand and Benefit Projections; see Appendix B).

Potential recommendations to facilitate the growth of e-bikes in Marin that emerged from this report include:

(1) Improved secure bicycle parking for e-bikes
(2) Improved infrastructure such as bike lanes
(3) Potential leasing or subscription services to overcome cost barrier
(4) Public agency e-bike fleets for staff
(5) Employer-based incentive programs for e-bikes
(6) Public charge stations such as Swiftmile and Kuhmute
(7) Improved transit/rail/ferry access and/or parking
(8) Improved safety through signage, regulations, enforcement and physical improvements

Introduction

As transportation trends continue to shift, bolstered by COVID-19 induced changes, bicycles – especially e-bikes – have a significant role to play in supporting more active, healthier lifestyles, and the environment. E-bikes have a long history but have only recently begun gaining considerable popularity in America. Due to advancements in technology and design, e-bikes are now available in a wide range of bike types across several price ranges. This memo will break down the benefits and constraints of e-bikes, methods to

incentivize increased use of e-bikes and e-bike trends. Data specific to Marin County will also be discussed, including the results from a survey of local bike shop owners and highlighting specific corridors in Marin County where e-bike and e-bike infrastructure would make the most impact.

E-bikes: A brief History

Electric bikes (e-bikes) have been in existence since the 1800s and saw continual development through the early 1900s. In 1989, one of the most important innovations was created in the form of the first 'Pedelec' or Pedal Electric Cycle (now known as pedal-assist) in which the motor power is triggered as assistance when any pedaling action is registered by the bike. Rather than using a throttle mechanism to control the motor, as all previous models had, this allowed riders to utilize an electric bike not so dissimilar to how one would ride a regular bike. Michael Kutter developed these pedelec systems on a few of his personal bikes and then went on to assist the Velocity Company in creating the 1992 Dolphin Electric Bike for consumers to purchase. Following Kutter's pedelec bicycles, pedal-assist has become commonplace for modern electric bicycles. Further improvements have been made into modern electric bikes as well in the form of Lithium-Ion batteries to increase capacity while keeping overall battery weight significantly lower than some of its competitors and predecessors," (Rad Power Bikes).

Michael Kutter and his early pedelec bicycles.

Types of E-bikes and Legal Definitions

In 2015, AB 1096 amended the California Vehicle Code (CVC) to define electric bicycles and the three classes they fall into. The three classes are described below:

Class 1: Low-Speed Pedal-Assisted (pedelec) Electric Bicycles

The most common type of electric bike is the pedal-assist or pedelec. The rider pedals the bike normally while a motor assists, increasing the power transmitted to the rear wheel. The pedaling takes far less effort than it usually would, even in high gears, which allows for higher speeds and effortless climbing over steep hills and longer journeys while exerting less energy. Settings can control the amount of assistance the rider desires, but to be considered a Class 1 e-bike, the engine can only supply power up to 20 mph. These bikes can travel faster than 20 mph, but the engine will not generate thrust above that threshold.

Class 2: Low-Speed Throttle-Assisted Electric Bicycles

These throttle-assisted electric bikes include a throttle that controls assistance provided by the electric motor. Pedaling is not required for the engine to generate thrust. Similar to Class 1 e-bikes, low-speed throttle-assisted bicycle motors are also limited to 20 mph.

Class 3: High-Speed Pedal-Assisted Electric Bicycles

Class 3 pedal-assisted bicycles operate similarly to Class 1 pedal-assisted bikes, except the Class 3 bikes have an allowed top-assisted speed of 28 mph. In California, Class 3 e-bikes are required to have a speedometer. Riders of Class 3 e-bikes must also be at least 16 years old and are required to wear a helmet.

Other California Legal Requirements

Use:

Class 1 and Class 2 e-bikes are allowed in all on-street bicycle facilities. They are allowed "by default" in off-street bicycle paths and trails unless the governing jurisdiction prohibits them. Class 3 bicycles are prohibited "by default" on both on-street bicycle facilities and off-street bicycle paths and trails but may be allowed by local governing jurisdictions.

A Flux e-bike in San Francisco.

Labels:

Beginning in 2017, all e-bikes manufactured or purchased in California are required to have a manufacturer affixed label that contains the following:

- Classification number
- Top-assisted speed
- The wattage of the motor

Jurisdictional Policies

State of California

California passed AB 1096 Vehicles: Electric Bicycles on 2015 which identified three classes of bicycles (described previously), a 750-watt and 20 mph maximum powered speed for Class I and II e-bikes, and amended the vehicle code to require adequate labeling and warning on e-bikes related to their power and speed capabilities, set limits on persons under the age of 16 to use Class III e-bikes and requirements to wear helmets. The law identifies Class III e-bikes may not be operated on bicycle paths or trails, bikeways, or bike lanes, equestrian trails, hiking, or recreation trails unless they are adjacent to a public roadway. Local agencies have the right to adopt ordinances or permits that provide local exceptions to this law. Class I and II e-bike access to bikeways and trails are also subject to local approval and ordinance. The three classes of e-bikes in AB 1096 have been described previously.

Marin County

In September 2019, the Marin County Board of Supervisors approved updated the Marin County Code to accommodate e-bikes. Marin County policies were updated to allow Class 1 and Class 2 e-bikes on public roads and parking lots, on County-owned paved bicycle and multiuse pathways, and other areas where signed. This includes the Mill Valley-Sausalito Bike Path and the Corte Madera Creek Pathway. E-bikes are

currently not allowed on unpaved trails in Marin Open Space District and Preserve lands. Class 3 e-bikes are allowed on public roads and parking lots but prohibited within parks and on bike paths unless otherwise signed. This may limit the appeal of Class 3 bicycles for many people. Speeds are limited to 10 or 15 mph, dependent on the path.

Marin Municipal Water District

E-bikes, of all classes, are currently prohibited on MMWD lands, except on public roads and parking lots. The MMWD Board most recently received an update on the e-bike policy on District lands in March 2019.

National Park Service

In August of 2019, the Department of Interior updated National Park Service (NPS) policy to allow parks to amend their compendium to allow the use of e-bikes. The GGNRA (which includes Marin Headlands) compendium provides rules and policies for all GGNRA parks and facilities. Class 1 and Class 2 e-bikes will be allowed in areas where traditional bicycles are allowed and are subject to the same speed limits: 15 mph in most places and five mph in high-congestion areas. Pt. Reyes National Seashore has not adopted specific guidance on e-bikes.

Bikes in Chrissy Field (GGNRA). – Image:

E-bikes and Public Transportation

E-bikes can play an important first/last mile for Marin's transit services. E-bikes can facilitate access to and from buses and trains from local residential areas and employment centers. A new e-bike share system is being planned for SMART's stations, which will help expand access. Constraints occur where e-bikes cannot be loaded onto a rail or transit vehicle at a level platform, as the size and weight of the bicycle limits loading. Current policies and practices for Marin's transit providers are summarized below.

Bike racks onboard SMART trains. – Image: SMART

SMART

SMART currently provides bike parking at is stations, and allows up to 24 bicycles onboard its trains. SMART is also developing a multiuse paved pathway along segments of its corridor that are open to e-bikes. A contract was recently awarded to the e-bike share company Gotcha for 300 GPS-enabled e-bikes, being developed by the Transportation Authority of Marin (TAM) and the Sonoma County Transportation Authority (SCTA), to be located at SMART stations in Marin and Sonoma Counties.

Golden Gate Bridge, Highway, & Transportation District

Currently, e-bikes are not allowed on GGBHTD ferries or buses.

Marin Transit

Currently, e-bikes are not allowed on Marin Transit buses.

E-bike Specifics

How to Charge an E-bike

Most e-bikes are charged in the owner's home by removing the battery and plugging into a standard 120 amp household outlet. In some cases the battery can remain on the bicycle and simply be plugged into a standard outlet through a connector. A red light indicates the battery is charging. A green light indicates the battery is full. It will take between two and six hours for the battery to fully charge. A general rule of thumb is about 15 miles per hour of charging.

Power and Range

Power

All e-bikes have batteries, but individual models of e-bikes have batteries of different chemical compositions and sizes and motors with different watt outputs. E-Bike batteries are typically either lithium-ion, lead-acid, nickel-metal-hydride, or nickel-cadmium. Each battery type has different characteristics, including re-charge time, acceleration, and torque. Battery technology is continuously improving and changing, with lithium-ion the most commonly-used today. E-bikes are available with battery type of either 8, 12, or 18-amp hour batteries.

At the heart of any e-bike is an electric motor, and it can be located in one of two places, the center of the frame or one of the hubs. The location of the drive unit determines how the bike fundamentally operates and what it is capable of.

The **front hub motor** is the simplest e-bike design and, as such, is the most limited in capability. Front hub motors are generally only used with throttle systems as it is more challenging to provide assistance based on rider input when the motor is not part of the drivetrain. Exceptions do exist, such as the Brompton folding e-bike, which utilizes a front hub motor and pedal assist. They can also have problems with traction since the majority of the weight on a bicycle is over the rear wheel. Cornering while accelerating can be especially tricky when the drive unit is in the front wheel. Given these limitations, the front hub motor is the least common e-bike system and is most often found on inexpensive conversion kits as they can easily be added to almost any bike.

A **rear hub motor** can accommodate both throttle and pedelec, and many systems offer both with the flip of a switch. They can also be retro-fitted to non-folding bike frames, so they are the most popular for electric conversions. They're fairly inexpensive to produce and can go unnoticed since they appear much like an oversized traditional bike hub. However, they create an uneven distribution of weight with the motor in the rear wheel, which can affect handling.

A **mid-drive** e-bike system places the motor in the center of the bike frame and integrates it with the bottom bracket and cranks. Since the motor is activated by pedaling, a bike with a mid-drive system will always be a pedelec. The mid-drive design offers many benefits over a hub motor, making it the system of choice for most pedal assist production bikes. A mid-drive delivers more torque than a similarly powered hub motor and, by being centrally located, distributes weight more evenly on the bike. The motor is driving

the crank arms rather the wheel so it can take better advantage of the range of gears on the bike. A torque sensor can also be more easily integrated to measure the amount of input from the rider. This sensor allows the amount of assistance to be automatically varied to match the intensity of the rider's pedaling, which creates a smoother, more fluid experience.

Range

The range of any given e-bike is going to vary based on a number of factors including:

- Weight of the bike
- Weight of the rider
- Level of assistance provided
- Ability to control the amount of engine assistance
- Terrain/topography
- Travel speed
- Wind, road conditions
- Temperature (i.e., cold weather makes batteries less effective)

Manufactures provide range estimates for their bicycles, but the actual numbers will vary based on the above factors. The average range of an e-bike in Marin County is between 20 and 35 miles depending on factors above, which should be sufficient to reach most destinations in the US 101 corridor in Marin and back. A re-charge may be needed, for example, if a person were to ride to Pt. Reyes National Seashore and back to a destination such as Larkspur. Bicyclists may also carry a spare battery to extend range, although the weight and cost may limit the potential of this option.

Styles

E-bikes come in an almost endless variety of styles, weights, batteries, and other features. The basic style types, however, are either E-Mountain Bike, E-Road Bike, E-Street (pavement) Bike, or E-Cargo Bike (also known as Dutch cargo bikes or Bakfiets). Mountain E-Bikes have the same suspension, tires, and frames as regular mountain bikes. Street E-bikes have similar frames, tires, and design as touring bicycles,

A cargo e-bike (set up to carry children), a mountain e-bike, and a folding e-bike.

designed primarily to be used on pavement or other hard surfaces. E-Road bikes are lightweight with narrow tires and similar in design to non-electric road bikes. E-cargo bikes can be useful in carrying

groceries or other items home and bringing children to school, and they are increasingly seen around Marin County ridden by parents with children aboard.

E-bike Benefits and Constraints

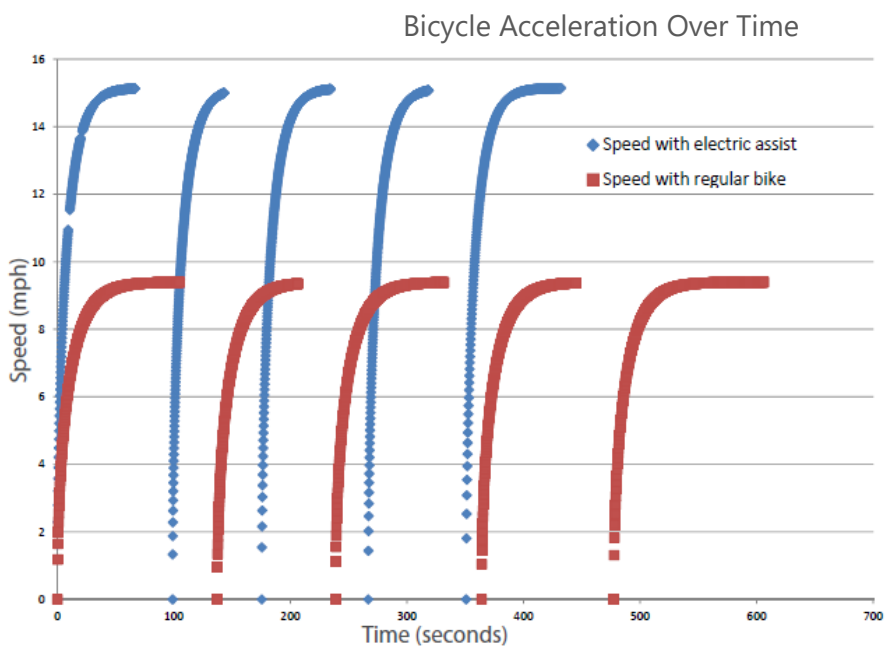
Benefits

Speed and Comfort

Many studies have attempted to quantify the benefits of e-bikes compared to traditional bikes. One study at the University of Tennessee Knoxville studied trends within its hybrid bike share system. The system had a mix of both traditional and electric bicycles. Based on user surveys, researchers found the following:

- Speed and convenience drew users to the bike share system, regardless of bike type.
- Speed and comfort drew users to e-bikes over the traditional bike.
- E-bike trips required about 25% less power from the rider to complete the same trip on a traditional bike.

The following graphic compares the acceleration differences over time between e-bikes and traditional bikes.



Speed-time series illustrating the electric-assist bicycle's faster acceleration from a complete stop, when compared to a standard bicycle

Portland State University - TREC

Distance

The same UT Knoxville study also found many benefits in terms of distance traveled and destinations accessible:

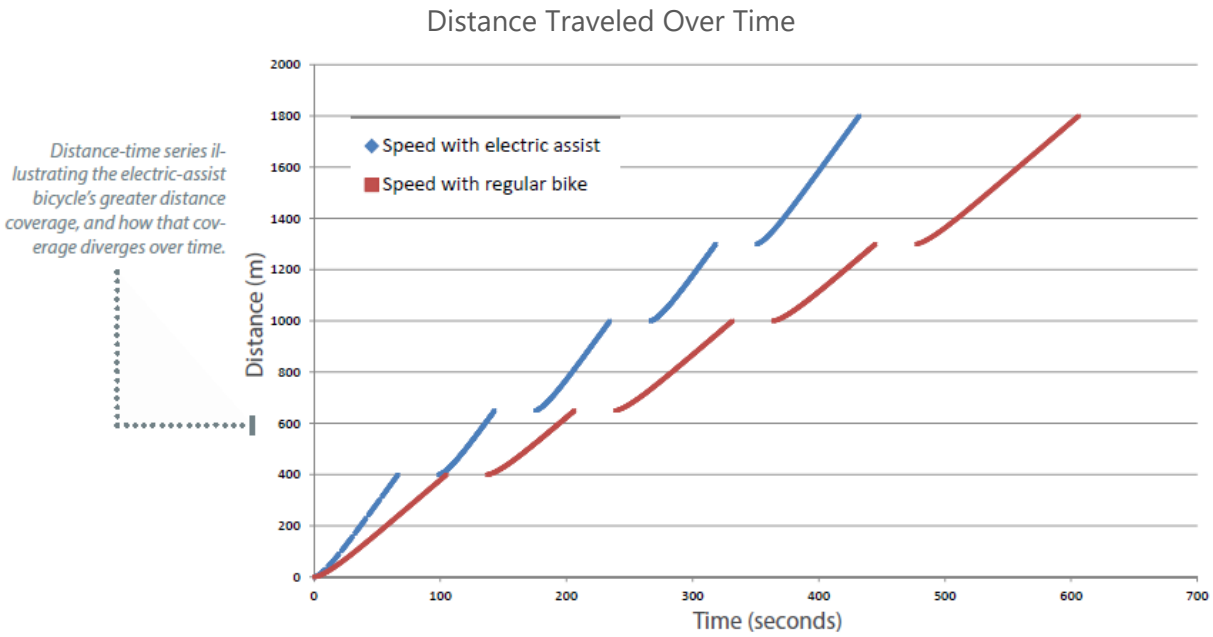
- E-bike trips were typically used for longer trips and allowed for additional stops during those trips.
- E-bikes in the system were used for a larger variety of trip types than traditional bikes.

A 2006 study by Karl Martens quantified the benefits of traditional bicycles in bridging longer distances to and from transit stations. The study found that bicycles can extend the catchment area of transit stations,

creating larger areas for access by bicycling. While e-bikes were not a part of this study, as others have more recently shown, e-bikes can amplify that effect, creating even larger catchment areas. This can be very beneficial, increasing access to SMART stations and the Larkspur, Tiburon, and Sausalito Ferry Terminals.

A 2007 study by Wardman, et. al found one of the additional benefits of e-bikes was that users could go the same or further distances while exerting less energy is that using an e-bike that can entice additional people to bicycle to work. Because e-bike riders exert less energy, there may be reduced demand for showers and changing facilities at their workplace. Other studies have repeatedly shown first/last mile trips as highly-desirable to making bicycling to work a practical option and reducing human effort (thus less sweat and odor). E-bikes can offer approximately a 30% trip time savings over traditional bicycles in average conditions.

The following graphic compares distance traveled over time between traditional and e-bikes.



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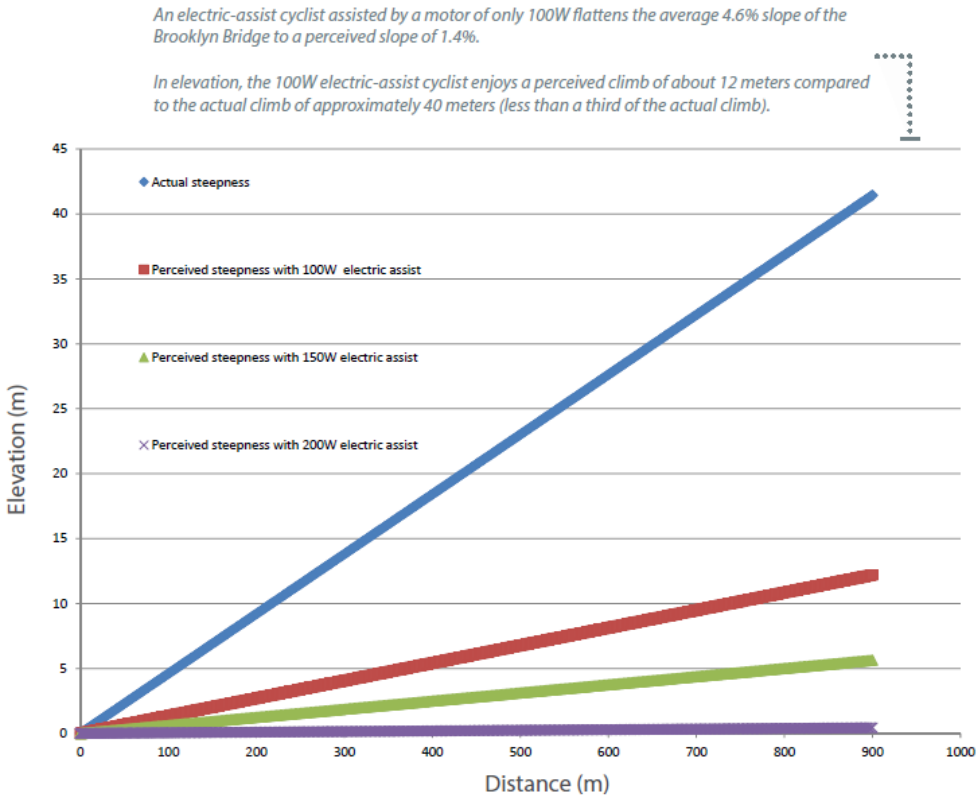
Terrain

E-bikes provide those who live or have destinations in hilly areas new mobility options that a traditional bike cannot provide. Steep terrain is commonly found to be a detriment to bicycling because of the additional effort required. Some people may not have the strength or endurance, and others may have mobility limitations (such as bad knees) that prevent biking over steeper terrain. The electric-assist motor not only provides additional power but also changes perceptions about biking over hills. The following chart shows how electric engine size can change perceptions of steepness while biking over hills.

Biking up an incline with an e-bike. Image: eBike Choices



Perceptions of Steepness by Engine Wattage

Portland State University - TREC

Reflections from the Marin County Bicycle Coalition on the benefits of E-bikes

The Marin County Bicycle Coalition (MCBC) published a list of e-bike benefits, which includes:

- **E-bikes remove barriers to bicycling.** E-bikes flatten hills and enable people to cover longer distances in less time, making bicycling more accessible and enjoyable for people of all ages and abilities.
- **More people on bikes equals fewer people in cars.** Whether on roads, pathways, or trails, every person on an e-bike is someone who isn't in a car. That's a good thing for public health, traffic congestion, and air quality.
- **More people on bikes equals more people enjoying parks.** As more people can access and enjoy our public lands, the more support we will have to protect these lands and expand trail access.
- **Studies show e-bikes have roughly the same impact on trails as traditional bicycles.** In addition, they facilitate access to remote less-visited park areas, reducing stress on primary trails while improving public access to remote trails.

Constraints

Costs

A Civia step Thru e-bike. – Image: Civia

Cost remains the top constraint to the continued growth in e-bike sales and usage. Most e-bies cost anywhere between $1,500 and $6,500, although there are more expensive and less expensive versions available. For example, Costco currently sells an e-bike for about $1,300. Price is a relative factor based on the perceived value of e-bikes as a transportation or recreation investment. There is also a relationship between cost and the quality of infrastructure since the value' of e-bikes is at least partially based on the extent of its perceived use. An e-bike at any price will seem expensive if there are limited places to ride safely. Other constraints are discussed in detail below. The price of e-bikes is also expected to be reduced in the future based on industry consolidation and scale of production.

Technological Challenges

E-bikes have witnessed continuous research and development over the years. Nevertheless, there are still some technological challenges and gaps with the current e-bikes, which can hold back the growth of e-bikes sales and use. Battery maintenance is a major concern with e-bikes. Electric bike batteries have a limited life span, which is about 2-3 years for lithium-ion chemistry. In the case of throttle e-bikes, the throttle may get loose due to the rider's tendency to pull it back and let it go without slow release. This affects the throttle in due time and may need to be replaced. For a mid-motor drive, controllers are not easily accessible and, thus, involve high expenses in the event of a malfunction. A trained technician can open the motor casing. Another common problem is with the chain/belt that can fall off due to inadequate tension or damaged sprocket. Chains and sprockets may get worn due to extensive use and need to be replaced.

Infancy of the Market

The fact that e-bikes are relatively new in the U.S. and the high number of vendors in the market may result in hesitation to purchase an e-bike until the market becomes more mature. People may be concerned that their e-bike manufacturer may go out of business and servicing/parts not available.

Limited Distribution Channels

The distribution channel is vital for the growth of a product in the market. An e-bike is a product with technically advanced components. It, thus, requires exclusive distribution channels and technically sound representatives who can guide customers about the technology to fulfill their requirements. Unfortunately, at present, there are limited e-bike retailers and distributors in many global markets. Many merchants and traditional bicycle retailers deal in e-bikes but lack the expertise and maintenance facilities to support the growing e-bike industry. Marin County is fortunate to have several e-bike retailers, yet their capacity to service and maintain e-bikes is relatively limited. Many e-bike manufacturers are trying to collaborate with independent dealers and mass retailers that will effectively deliver and provide aftersales services**.**

Safety Concerns

Bay Trail Sign – Image: Marin Ind. Journal

E-bicycle collisions are not tracked separately from traditional bicycles, and therefore individual rates of collisions are not currently available. It is a fact, however, that e-bikes weigh more than traditional bicycles and also travel at a higher speed on average. This would likely translate into more significant injuries than traditional bicycles unless adequate facilities were constructed and managed. According to Ari Golan of Marin County Parks, "we definitely had and heard concerns regarding potential speed violations associated with e-bikes when we were considering allowing them on the paved paths. We have very few, if any, actual specific reports of speeding e-bikes on the paved paths since allowing them last year. Bikes are speeding on the paths, and we get reports of bikes speeding on the path, but folks may not be recognizing the bikes as e-bikes when/if they are. I am hoping to have staff out on the paths soon to monitor how things are going and if there is a speeding issue associated with e-bikes."

Weight

E-bike weight is a significant factor in its portability and potential uses. E-bikes tend to weigh more than traditional bikes, with some weighing over 50 pounds. This means that some users cannot lift the bike for storage, access transit, or otherwise lift the bicycle.

Infrastructure

The available roadway and bikeway network for e-bikes greatly impact the level of use in a community. Marin County is fortunate to have numerous developed Class II bike lanes and Class I bike paths, yet critical gaps remain where bicyclists must use heavily-trafficked roadways. Most of the existing bike paths are so crowded during peak periods that they are constrained by the volumes of other bicyclists, pedestrians, dog-walkers, and others, with limited or no opportunity be widened. The inability to be loaded onto ferries and buses also restricts the available trip making in Marin.

Battery range/charge life

As discussed in the technical section of this report, battery life and range are a potential key issue for e-bikes, although most e-bikes have a range up to five (5) hours and 20-35 miles, which would allow users to access most Marin destinations. Longer trips, such as riding to West Marin or Sonoma County, might be limited by battery life. The lack of publicly available e-bike chargers, and standardized public charging equipment, is a constraint for the upper end of e-bike trips in terms of distance.

"Cheating' factor

Some surveys of e-bike users indicate there is a perception by traditional bicyclists that e-bike users are 'cheating' by using assisted power. This is more often reported with e-mountain bicycles than street e-bikes. This perceived stigma should fade as more and more people ride e-bikes. Also, most e-bike users own traditional bicycles, diminishing the 'cheating' perception.

Secure bike parking

The lack of secure parking for e-bikes is a constraint in that it limits trips people might make to destinations to transit, work, school, or downtowns. The cost of e-bikes makes the availability of secure parking even more critical. Secure parking for E-bikes would include (a) the placemnt of the rack in a high visibility location, (b) the ability to lock the wheels and frame to the rack, and (c) where possible, a bike locker option to reduce the impacts of weather and vandalism.

Insurance

Insurance coverage for e-bikes is similar to that of traditional bicycles, although, as the cost of e-bikes is typically more than a traditional bicycle, the issue is of increasing importance. Like a traditional bicycle, e-bikes are covered by homeowners or renter's insurance if they are stolen or damaged when at home. They are also covered by general liability or tenant insurance if they are stolen or damaged at work. E-bicyclists are also covered by automobile insurance if they are involved in an accident while riding and it is nor their fault. If an e-bike causes an accident, however, coverage is less certain. Some automobile policies may cover this type of incident, and specialized e-bike insurance is also available. If an e-bike is stolen or damaged while riding or parked outside the home, coverage is also less certain. This uncertainty may be resolved eventually as the insurance industry catches up with this new trend.

Potential E-bike Enhanced Routes in Marin County

Figures 1-5 on the following pages illustrate bikeway routes in Marin County that would likely attract additional e-bike users. The three types of areas that would benefit from increased e-bike usage are:

(1) Pink: routes with moderate to steep gradients. E-bikes will help people overcome these areas with minimal physical effort.
(2) Red routes: primarily existing or planned Class III bike routes where bicyclists have no bike lane and are expected to mix with vehicle traffic. E-bikes allow cyclists to travel closer to vehicle speeds on these routes and should see increased trips to work, school, and recreation.
(3) Green circles: these neigborhoods include numerous steep and narrow residential streets that serve as barriers for some people to use a bicycle to reach work, shopping, or transit. E-bikes can make these neighboirhoods more accessible to cyclists.

Some key routes to have improved access via e-bike usage include:

(a) Novato Blvd and San Marin Drive, Novato
(b) North and South San Pedro Road, San Rafael
(c) Fourth Street, San Rafael
(d) East Francisco Blvd, San Rafael
(e) Camino Alto/Corte Madera Grade, Mill Valley-Corte Madera
(f) San Anselmo Ave, San Anselmo
(g) Paradise Drive, Corte Madera/Tiburon
(h) Magnolia Ave-College Ave, Larkspur, Kentfield
(i) Kent Ave-Shady Lane, Ross
(j) Trestle Glen Blvd, Tiburon
(k) East Strawberry Drive-Belvedere Drive, Strawberry
(l) Bridgeway-East Road, Sausalito-GGNRA

The increased use of these routes by e-bikes would help complete some of the major barriers to increased bicycling in the County.

Some communities that would benefit from increased e-bike usage include:

(a) Sausalito
(b) Tam Valley
(c) Paradise Ave
(d) Mill Valley Hills
(e) Kent Woodlands
(f) Wolfe Grade neighborhoods
(g) Bolinas-Cascade Canyon, Fairfax
(h) Glenwood
(i) Los Ranchitos
(j) Sleepy Hollow
(k) Black Point-Green Point
(l) West Novato

Figure 1: Northern Marin County

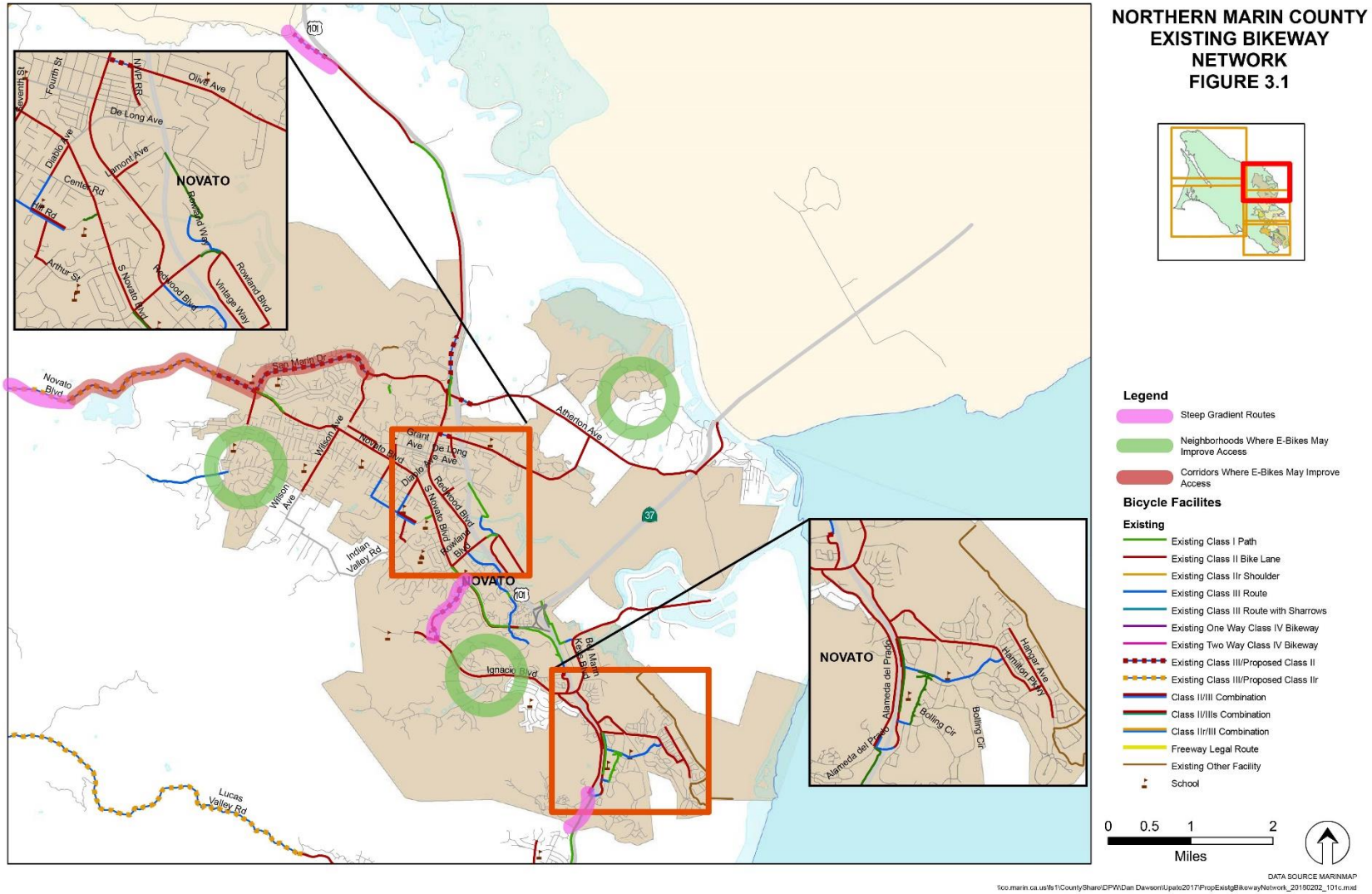


Figure 2: Central Marin County

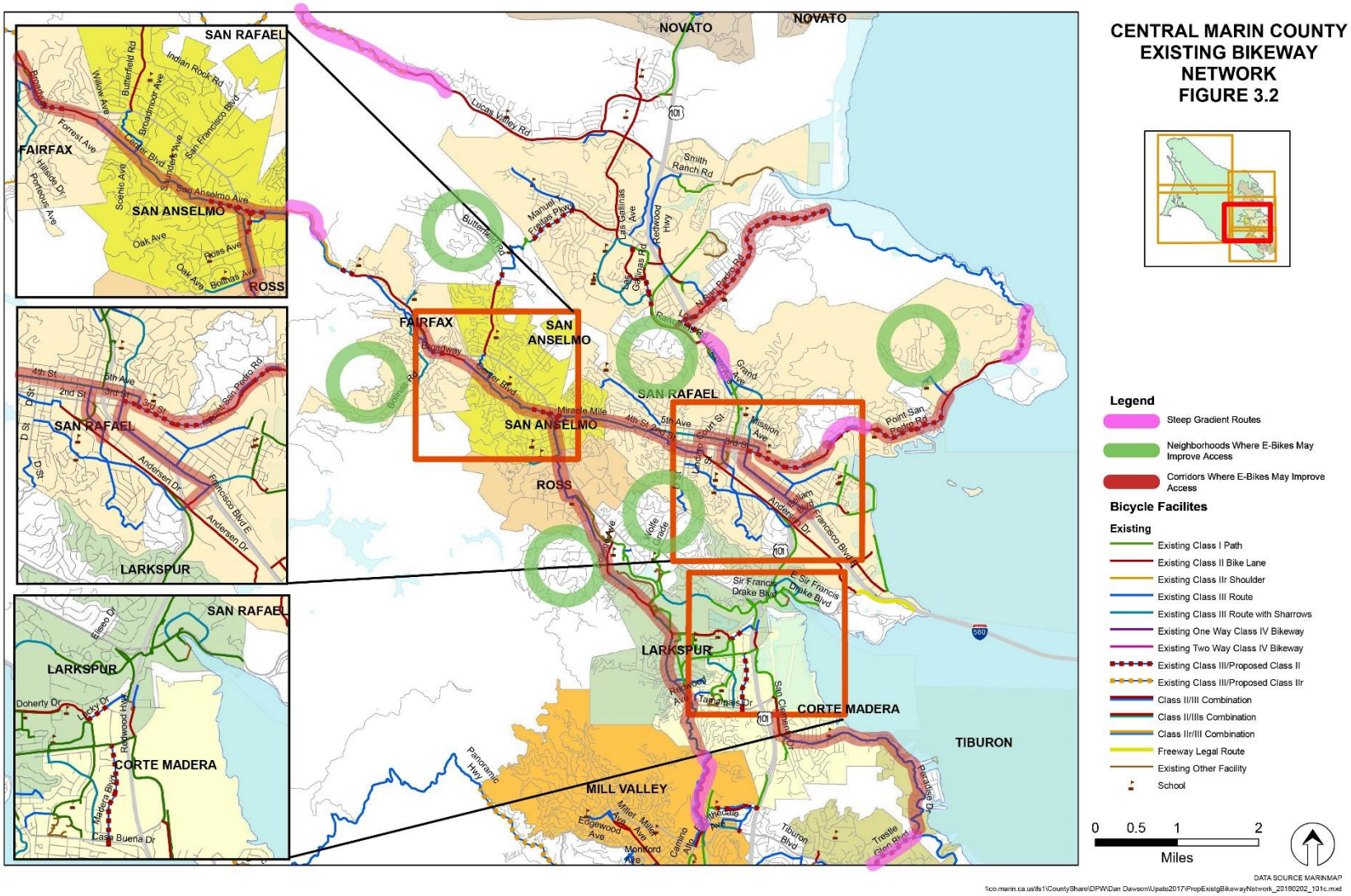


Figure 3: Southern Marin County

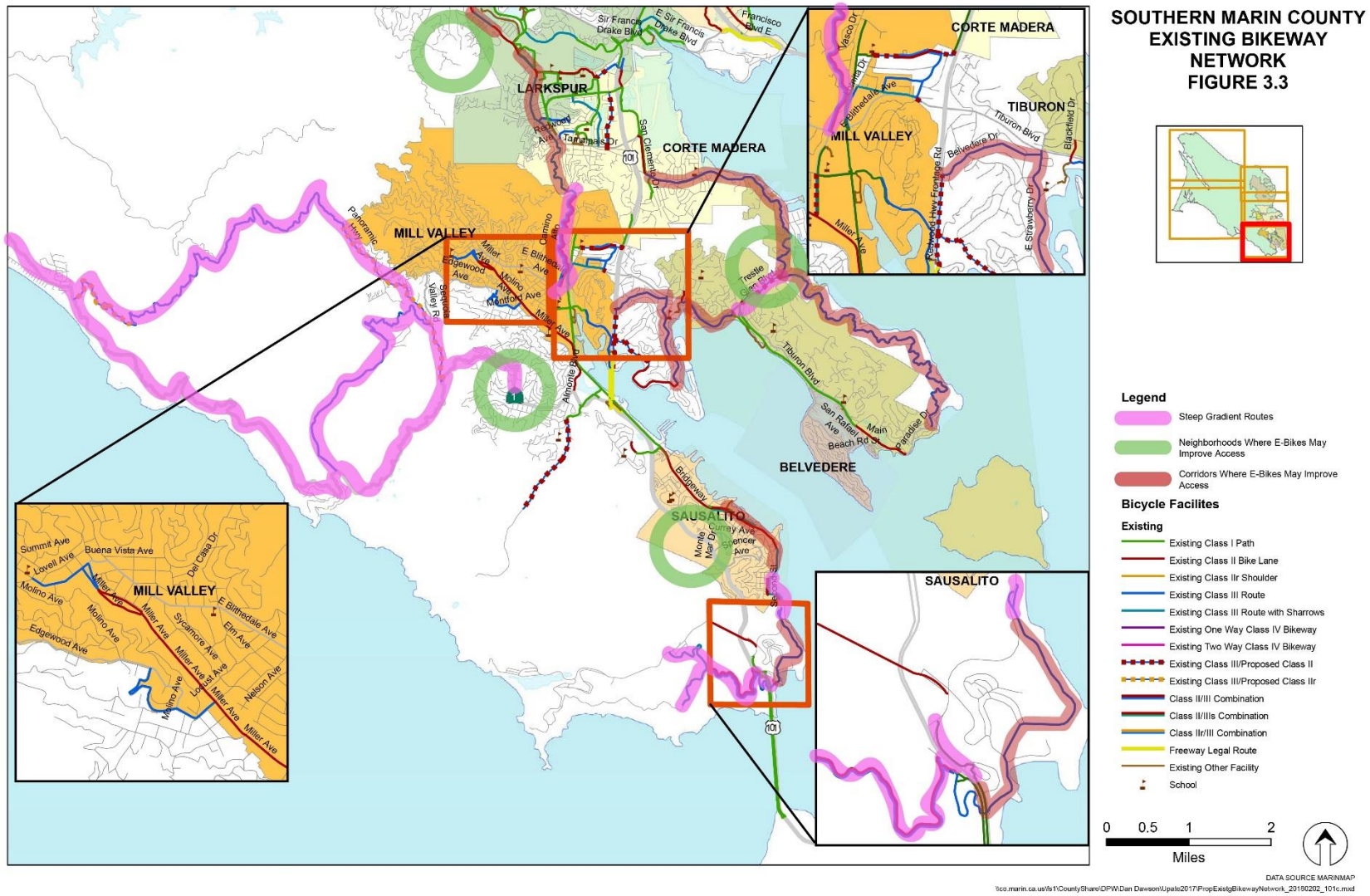


Figure 4: Western Marin County

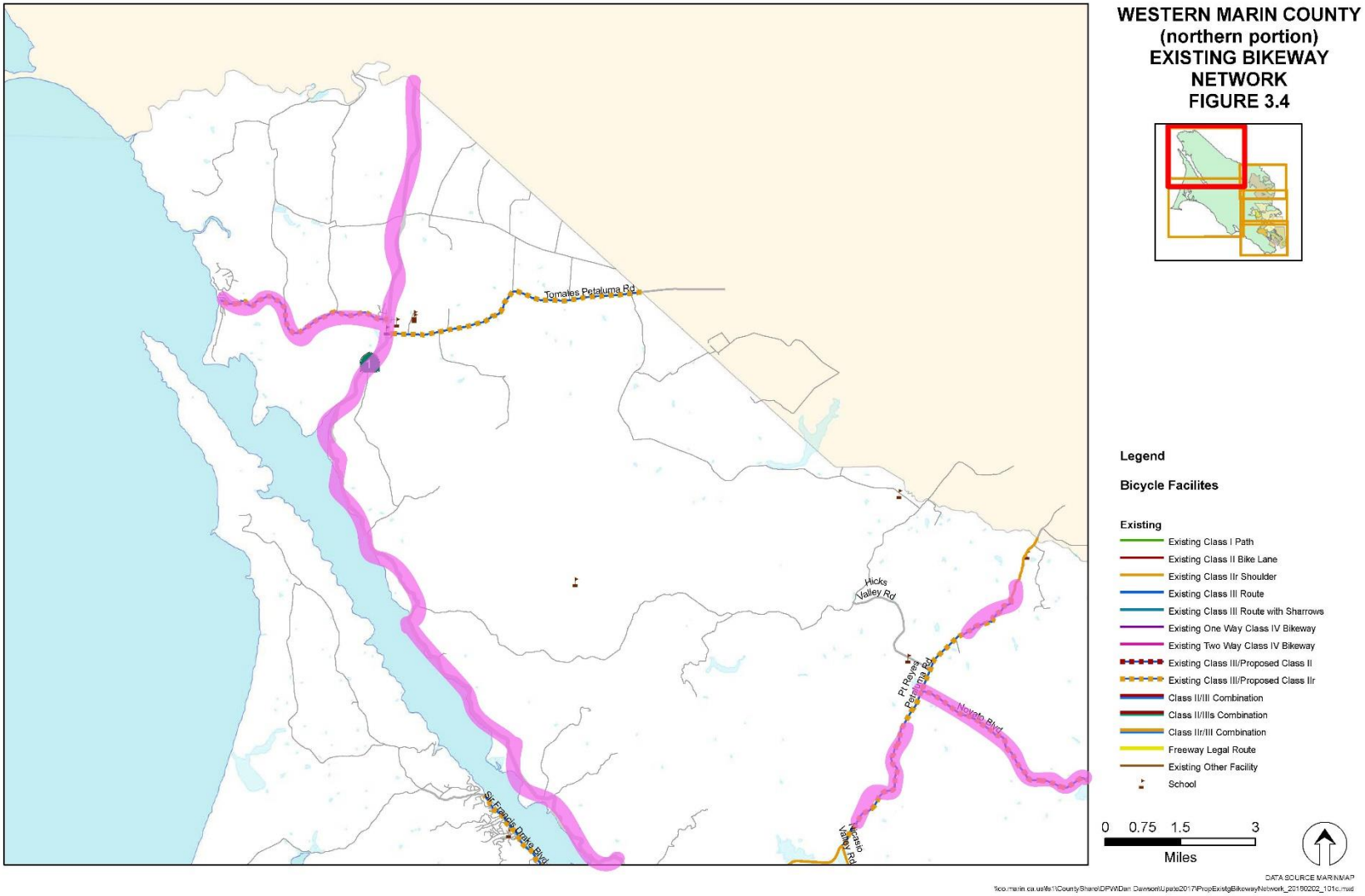
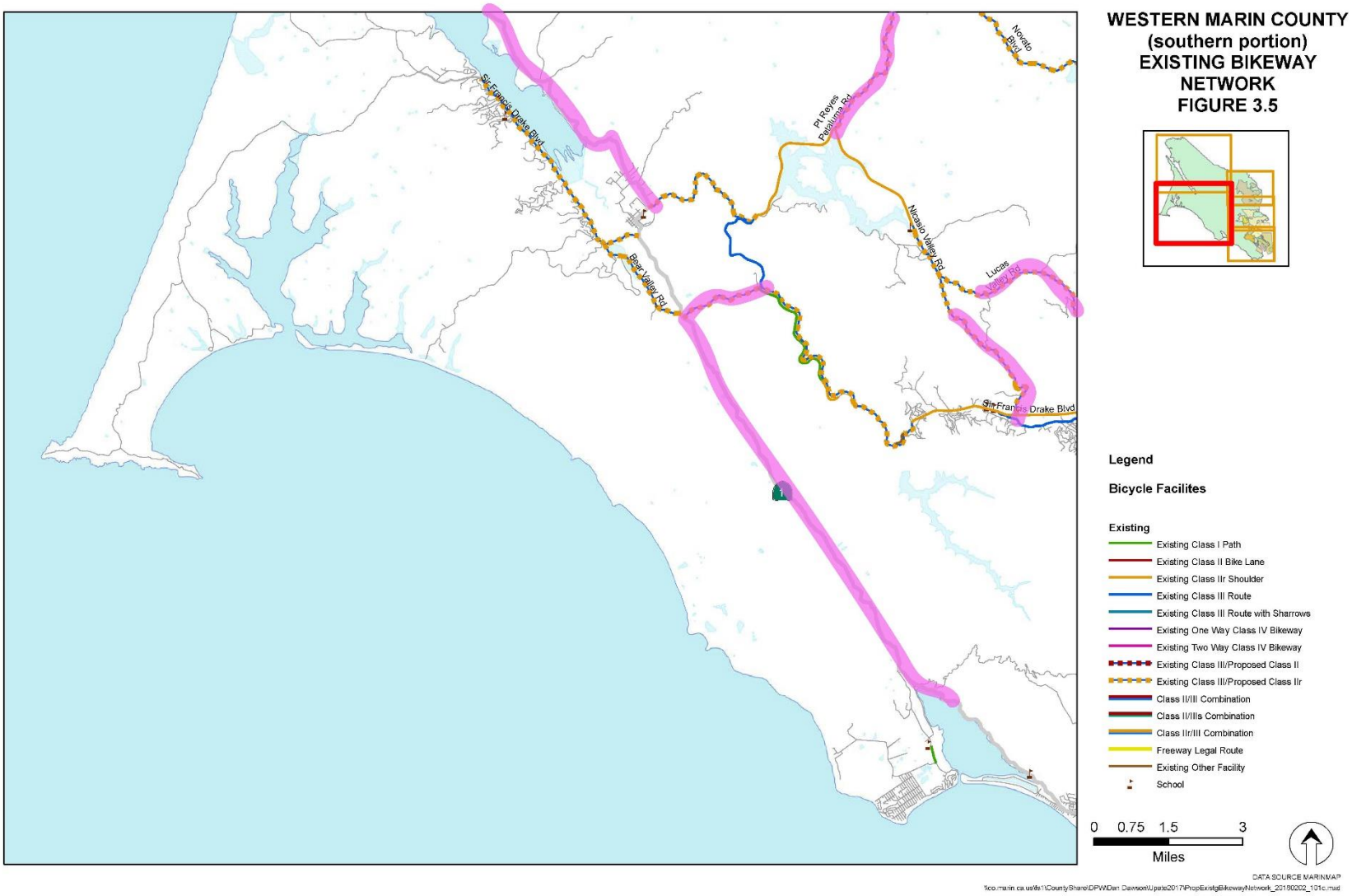


Figure 5: Southwestern Marin County



E-Bicycle Counts

Counts of bicycles were conducted on the Mill Valley-Sausalito Bicycle Path on a weekday (Thursday, May 21, 2020) and Saturday (May 23, 2020). Table 1 below shows the total hourly volume of bicyclists during a weekday and weekend day peak period. E-bikes and traditional bicycles were also counted. The count shows that approximately 5% of all bicycles were e-bikes on the weekday, and 4% of all bikes were e-bikes on a weekend day. These numbers are lower than but generally conform with the estimates of e-bike sales as a percent of all bicycle sales in the Retailer Survey (10-15%).

Table 1: E-bike Counts on Mill Valley-Sausalito Path

	Thursday, May 21, 2020, 5-6pm	Percent	Saturday, May 23, 2020, 12 - 1pm	Percent
Traditional Bicycles: Total	217	100%	472	100%
Male Rider	149	69%	335	71%
Female Rider	68	31%	137	29%
E-Bike: Total	12	100%	20	100%
Male Rider	11	92%	10	50%
Female Rider	1	8%	10	50%
Total Male Riders	160	70%	345	70%
Total Female Riders	69	30%	147	30%
E-Bike Percent of Total	5.24%		4.07%	
Total Bicycles	229		492	

Table 2: Bike Counts on Mill Valley-Sausalito Path 2008, 2019, 2020

Weekday (Thursday, 5-6pm)		% Change
Thursday, September 25, 2008, 5-6pm	98	
Thursday, May 23, 2019, 5-6pm	55	-44%
Thursday, May 21, 2020, 5-6pm	229	316%
Weekend (Saturday, 12-1pm)		
Saturday, September 27, 2008, 12 - 1pm	302	
Saturday, May 25, 2019, 12 - 1pm	212	-30%
Saturday, May 23, 2020, 12 - 1pm	492	132%

Given these count and survey results, it can be estimated that e-bikes will continue to increase.

E-bike Trends & Opportunities

Consumer Market Trends

According to the Electric Bicycle Market Report: Trends, Forecast, and Competitive Analysis, the "Global Electric Bicycle Market is Expected to Reach an Estimated $21 Billion by 2024 with a cumulative annual growth rate of 12.5% from 2019 to 2024."

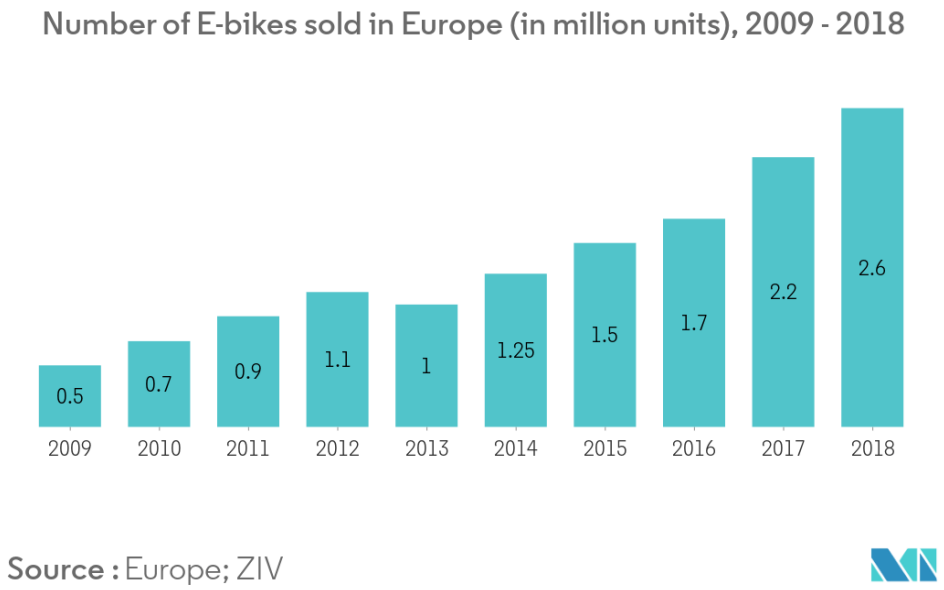
The Global **E-Bike Market** is projected to grow at a CAGR (compound annual growth rate) of 9.01% during the forecast period, to reach USD 38.6 billion by 2025 from an estimated USD 21.1 billion in 2018. Class-I electric bike is estimated to be the largest segment in the global electric bikes market. A class-I electric bike is equipped with a motor that provides assistance only when the rider is pedaling and stops assisting when the bicycle reaches 20 mph.

Sales of Speed Pedelecs that can go up to 45 Km/hr (28 mph) are declining "primarily because of the infrastructural issue, as they have to share roadways with cars." They are not allowed in bike lanes except with local approval.

The e-bike market in North America is projected to be the fastest-growing market. It is estimated to grow at a CAGR of 19.77%, by value, during the forecast period. The demand for e-bikes has increased tremendously in Europe and North America due to increased urbanization and consumer desire to move away from cars to alternative mobility such as e-bikes. Pedal-assist dominates the market with 88.32% of all sales.

As the e-bike market grows, there will be a broader range of e-bike types and styles appearing on the street. E-bikes are no longer just utilitarian machines to give a helping hand on hills or around town; there is an e-bike to suit everyone's needs and desires.

There are practical e-bikes that can carry luggage, children, pets, and many other items. There are also e-bikes, like the VanMoof or Cowboy, that stylishly integrate hardware to appeal to the more aesthetically conscious rider. There are even lightweight race machines with inconspicuous electrical assistance for the racer that might need the safety of a get out of jail free card. Consumer choice in the industry is getting better and better every month. The chart below illustrates the growth of electric bicycles in Europe between 2009-2018.



Technical Trends

Some of the key technical trends for e-bikes include:

- More integration of technology and accessories on bikes
- More niche products
- More high-quality options available
- More integration with the "internet of things"
- More speed bikes available
- More internal hubs/electronic shifting
- More high-quality bikes at lower prices

Bike Share Opportunities

E-Bike sharing is a new model of public and private transportation that has rapidly emerged in recent years. It offers a healthy, sustainable, and alternative transportation choice, particularly for short trips. The new trend in the cycling world is an e-bike, and this trend is now changing the bike-sharing industry. It has multiple benefits over traditional bicycles.

A Gotcha bike share e-bike in Richmond.

Currently, there are approximately 40,000 shared e-bikes present globally, and approximately half of them are in China. Electric bikes (e-bikes) can provide a higher level of service compared to regular bike share systems. Electric bicycles reduce the effort required by the rider, promoting

greater travel distances and easier use over hilly terrain. While the high price of e-bikes is a major concern for a rider, sharing electric bikes can overcome price barriers by dividing the cost between many users. Unlike the traditional bike-sharing system, e-bike companies have introduced dockless e-bike sharing, which benefits both the rider and service provider. Also, many countries, such as the US, China, and Germany, are introducing e-bikes in public bike-sharing programs. These bike-sharing programs can help tremendously in the growth of the e-bike market.

Currently TAM and the Sonoma County Transportation Authority are coordinating to deliver an e-bike share program with Gotcha Mobility as the selected operator in the future serving SMART stations and offering an important end-of-trip connection for the public.

Infrastructure Opportunities

Like any mode of transportation, e-bikes have specific infrastructure requirements that both foster new users and trips and improves the experience of riders. While many infrastructure components are shared between traditional and electric bikes (parking, on- and off-road facilities, end-of-trip facilities, etc.), there are some unique needs for e-bikes.

- Wider paths/lanes: Wider dedicated paths and lanes allow for room to pass, which is especially important in mixed-modal paths or high-density areas with higher volumes of bicycle trips.
- Universal chargers: Similar to the increasing presence of electric vehicle charging areas in both public and commercial locations, universal e-bike chargers can extend the range of e-bikes and allow more trips (and trip-chaining) to be completed; increasing the effectiveness and practical-ness of e-bikes as an everyday mode of transportation.

E-bike Incentive Programs

Incentive Opportunities

Why incentivize?

Despite the trend lines showing future growth in the United States and high usage levels in Europe and Asia, E-bikes remain a small share of bicycling. Barriers to growth have been documented in this report and include the higher cost of e-bikes, lack of secure bike parking, limitations on range for the upper end of trip lengths and durations, and concerns about safety on busy roadways.

E-bikes have demonstrated their ability to extend the range of trips on bicycles by 80% over traditional bicycles, potentially diverting trips that would be made in vehicles. E-bikes have the clear potential to change the dynamics of travel within communities, and even between communities. The main barrier to E-bikes in the United States remains the high cost compared to traditional bicycles, though the price differential is expected to be reduced as the technology matures. Incentive programs coupled with effective outreach and promotion both by the industry itself, bicycle advocacy groups, public agencies, and employers is a potential pathway to overcoming the cost barrier.

Types of Incentives

One of the most effective ways to lower the cost barrier is through a subsidy program. Traditional bicycles have been subsidized in the form of publicly-funded bike share programs, bike loaner programs, and on some corporate campuses and military bases, free fleets of bicycles. E-bike subsidies would be a reasonable extension of these types of programs.

According to John MacArthur of the Transportation Research and Education Center (TREC) at Portland State University, "There are five different types of such programs:

1. Partial purchase subsidy from government or utilities
2. Vendor funded discount (a discount from the e-bike store or manufacturer)
3. Employer sponsor programs (where the employer provides an e-bike, perhaps as part of their compensation packages or as a component of a larger TDM program)
4. Government-sponsored loans
5. Public promotions/outreach

Government and Utility

Locally, Marin and Sonoma Counties have joined forces to fund and manage an e-bike share system, to be operated by Gotcha and based at select SMART stations. This investment represents a direct subsidy of e-bikes which will help extend the range of SMART and local bus transit, and open up access on routes with topography and lack of bike lanes as described earlier.

Public utility companies and agencies in California, New York State, Austin, Texas, Vermont, and Utah have taken steps towards E-bike incentives and research. BAAQMD currently provides ebike rebates in its clean cars for all program eligible for income restricted households in the bay area. In Marin County, electric vehicle rebate programs offered by agencies such as TAM support ebikes through through rebates up to $1,000 to public agencies. Local agencies could invest in a fleet of E-bikes for employees to borrow as part of their commute trips. Local agencies could provide incentives or requirements for employers over a specific size to include E-bikes as part of the TDM programs.

The California Bicycle Coalition is asking the California Air Resources Board to expand its incentive programs to include the cleanest vehicle of all: *the bicycle.* The ARB funds the Clean Vehicle Rebate Program and similar state programs to help people replace high-polluting cars with electric cars to reduce greenhouse gas emissions. Still, they don't have any programs to encourage bicycle riding. CalBike proposes to change that with a $10 million Bicycle Purchase Incentive Pilot Program. The program will provide incentives in the form of vouchers for half of the cost of bikes that are commonly used for transportation, up to a maximum value of $500, or $1000 for electric bicycles. Bike share programs and bicycle repair services may also be supported, in addition to vouchers to incentivize the purchase of cargo bikes, electric bikes, folding bikes, and other utilitarian bicycles used for everyday transportation. No funding would be taken from existing bicycle-related sources.

In another example, the TREC white paper showed, "In 2017, BikeSGV was awarded $70,000 in a competitive grant process through the City of El Monte, CA, to begin an e-bike subsidy program. The funding for the program came from the revenue of newly added toll lanes on I-10. This toll revenue was required by law to be reinvested along the I-10 corridor, of which 40% was earmarked for active transportation initiatives such as the grant received by BikeSGV. Through this grant, BikeSGV funded 100 e-bike incentives of $700 each. To be eligible, applicants were required to take a bike safety course and live within three miles of I-10."

A government loan program to purchase e-bikes could help overcome the barrier of cost, where the bicycle is either financed over time in a revolving loan program or the bicycles can be rented to the public at lower costs. This may be an effective way to get people to try an e-bike.

Market Forces

As with any newer technology, the initial marketing of e-bikes can be difficult because of a lack of resources and a wide variety of manufacturers. The biggest challenge in e-bike marketing is simply to get a person to try them. Riding an e-bike itself is the best form of marketing. Most people are probably not aware of a bicycle on the road in front of them is an e-bike. Where people have an interest in health and the environment, e-bikes are a natural fit for many local trips.

The cost of E-bikes may be lowered through natural competition and increased scale of sales by vendors and manufacturers, who could also increase the promotion of their equipment in various media. These entities could also expand their programs to let people 'test drive' an e-bike for at least 24 hours, if not longer. Bike shops may also develop e-bike rental fleets that allow people to try out the bike on their regular local trips.

Employer Subsidies

Employers could underwrite some or all of the cost of E-bikes for employees, or, provide a fleet of E-bikes to be used for commute purposes by staff. Employers already offer subsidies to transit use and other programs to reduce SOV trips.

Incentive Case Studies

Implementing many of the changes above will indirectly promote the use of electric bikes. However, if TAM or local municipalities or agencies have a desire to promote e-bikes directly, there are many methods available for them to do so.

Case Study: Contra Costa County Transportation Authority (2020)

Residents of Contra Costa County can now receive cash rebates for new electric bicycles (e-bikes) through a pilot program launched by 511 Contra Costa (511CC).

A limited number of $150 rebates ($300 for low income residents) are available for residents of each Contra Costa city to assist in the purchase of e-bikes, e-bike conversion kits, and electric mopeds (with a maximum

speed less than 30 mph). E-bikes are clean fuel vehicles that provide riders with an excellent alternative to driving when traveling short to medium distances on local streets.

"We're proud to partner with 511 Contra Costa on this effort", states Contra Costa Transportation Authority Executive Director Randell Iwasaki. "E-bikes offer several key benefits as an alternative to driving - they reduce congestion, reduce greenhouse gas emissions, eliminate parking dilemmas, and can help bridge those first and last mile trips to transit – plus they are just really cool."

Post purchase rebates are available for county residents who purchase e-bikes on or after October 1, 2020, and will be distributed on a first come, first served basis.

"One of our goals is to introduce Contra Costa residents to this energy efficient mode of transportation by helping to reduce costs and raising awareness about the benefits of e-bikes in their communities," said Kirsten Riker, Project Manager, 511CC.

The Contra Costa Transportation Authority's local Measure J sales tax is the funding source for this program and others like it to encourage alternatives to the single occupant vehicle. To learn more, visit 511CC.org/rebate for information about rules, resources, and current rebate availability by city.

Case Study: MyGo-Pasadena (2007)

In 2007, the City of Pasadena and CALSTART partnered to create the "MyGo-Pasadena" program. This program offered financial incentives for those who rode their electric bike to local light rail stations. How many times a week, participants biked to a rail station (2, 3, or 4 times a week) determined what the financial reward was. That incentive would go towards the purchase of a transit pass or fare. The table below breaks down to incentive structure.

Commuting Level	Usage Performance	Amount Awarded
Bronze	Use e-bike to commute to a Gold Line station 2 times a week from date of initial purchase until December 31, 2007	$10 per month
Silver	Use e-bike to commute to a Gold Line station 3 times a week from date of initial purchase until December 31, 2007	$20 per month
Gold	Use e-bike to commute to a Gold Line station 4 times a week from date of initial purchase until December 31, 2007	$30 per month

Table 1: MyGo-Pasadena membership levels

Funding for this program came from the Los Angeles County Metropolitan Transportation Authority (Metro), the City of Pasadena, Pasadena Water, and Power, and the Federal Transit Administration.

Several studies and focus groups were done as a part of this program, and the results provide key insights into the mindset and opinions of program participants. Before the creation of the My-Go Pasadena program,

a survey was conducted on the Metro Gold Line (at the time which ran from Sierra Madre Villa to Union Station. The survey found the following were perceived barriers to people using e-bikes:

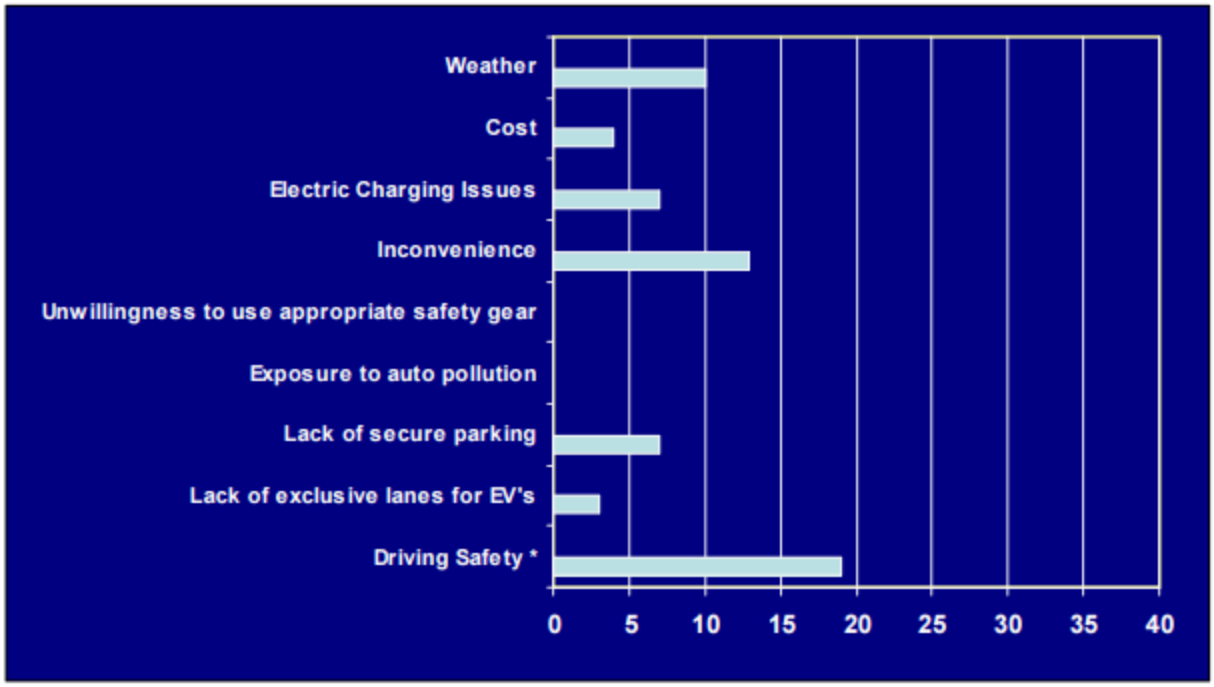


Figure 1: Perceived barriers of survey respondents to EV usage

In a follow-up focus group of a select group of riders, the following positives about such a program were found:

- Reduction of traffic congestion
- Saving money
- Helping the environment
- Health benefits
- Splitting lanes
- Increased sociality

The following concerns were found:

- Safety
- Lack of familiarity (many had not ridden a bike in decades)
- Cosmetic issues (sweat, helmet hair, etc.)
- Theft & security
- Parking & storage Lack of available bike facilities/routes
- Lack of dual-passenger or storage capability (children, groceries, other items)

Nighttime riding (safety and visibility)

- Cost
- Weather (both rain and when it's too hot) the need for a special license
- Maintenance issue/locations

With the 41 program participants, two surveys were conducted, and the following results were found:

- Only 42% of participants were using the Gold Line before the program (survey 1)
- 88% used their bikes outside of their regular commute (survey 1) and 81% planned to continue using their e-bikes as a part of their commute after the program had ended (survey 2)
- On average the bike-transit combination added 10-15 minutes per trip to individuals commute time (survey 1)
- 46% of participants had *never* ridden a bicycle before joining the program. 73% now said that they now ride "far more often" since joining the program (survey 2)

Case Study: Santa Cruz County Electric Bike Commuter Incentive Program

Santa Cruz's Electric Bike Commuter Incentive Program ran from 2000 to 2007 and had over 1,000 participants. This program was funded by the Monterey Bay Unified Air Pollution Control District, Santa Cruz County Department of Public Works, and Ecology Action of Santa Cruz (lead). This program provided a subsidy for electric bikes between $145-$300. To gain the subsidy, all participants had to do was attend a safety training course (and be at least 16) and purchase the bikes from one of two local vendors (prices and terms were pre-negotiated).

UC Santa Cruz bike paths – Jim

- Sal Saladin, a "fifty-something" UC Santa Cruz employee who journeys over the hills of campus on his electric bike, agrees. "[The program] keeps me on the bike," said Saladin, a West Side resident. "I'm not sure if I'd be riding a regular bike if it wasn't for the electric motor. I arrive at work warmed up, yet I don't need to change and shower.
- A 2006 survey of 879 of the 1,211 participants (at the time) found that 62% of participants had switched from driving exclusively in a single-occupancy vehicle to riding an e-bike for an average of 24-28 miles per week.

<u>Potential Local Agency Implementation</u>

Type:	Subsidy Program
Implementation:	Private companies, local agencies, state or federal tax incentives
Cost:	Ranges from $0 (private implementation) to $2,000-$4,000/e-bike
Impact:	Could have a beneficial impact in increasing e-bike usage for transportation trips, reducing local traffic congestion.

Infrastructure Opportunities

Additional Network Planning Work

While cost has been identified as perhaps the most significant barrier to riding an e-bike, concerns about riding on busy roadways with little or no separation from vehicular traffic may be a major factor as well. Marin County local agencies have done an excellent job of developing a bikeway network through the completion of bicycle master plans and investments in bike lanes and multiuse pathways. Yet some major corridors have sections where bicyclists must ride in travel lanes shared by vehicles moving 35 mph or faster or narrow winding two-lane roadways with limited or no shoulders. Some intersections remain challenging for bicyclists. The quality of any transportation facility is measured by conditions at its most challenging location. A high-quality corridor with bike lanes that ends in a narrow, high-traffic segment with no bike lanes will discourage many bicyclists from using the route again. These challenging locations are often the last to be improved because they are the most constrained and costly to fix.

In addition to increasing physical separation between bicycles and motor vehicles, providing wider bicycle facilities increased the use and more comfortable use of bicycle facilities. Wider facilities allow faster bicycles to more easily pass slower bikes, scooters, or other lane users. Wider lanes can also facilitate side-by-side riding, which can be a more comfortable experience for some riders.

Some of the challenging segments in Marin County are shown in Figures 1-5, including those routes which e-bikes offer the greatest potential to overcome, including routes with steep terrain.

<u>Potential Local Agency Implementation</u>

Type:	Bicycle planning including e-bikes
Implementation:	TAM, local agencies
Cost:	Plan updates range from $10,000 - $50,000 per jurisdiction
Impact:	Would ensure that updated plans and policies reflect the unique characteristics of e-bikes.

Shared E-bike Systems beyond Bike Share

Two of the greatest constraints to using bike share, especially in lower density communities such as Marin County, is the fact that many bicycle trips can end in less-traveled places like office complexes where the next rider might not appear for hours, and the concern that a bike might not be available nearby when you're ready to return home. One way to eliminate this issue is to offer the ability to pay for the exclusive use of a bicycle for any selected period (an hour, day, month) and have that e-bike available exactly when you need it and where you left it. While this might partially defeat the purpose of the 'share' in bike share, it might be of interest in a place like Marin County where there is still demand for bike share; the model just has to fit the level of demand. This hybrid <u>'rent/share'</u> approach would greatly lower the entry cost to an e-bike, match the travel patterns of those desiring to share a bike versus those who want the assurance an e-bike is waiting for them, while also giving people a feeling of ownership and exclusive use of an e-bike. This

model could be developed and executed by an e-bike retailer, a local organization, a local agency, a bike share operator, and/or a larger employer.

A variation of this approach would be a subscription-based service where people join a service and pay a base monthly fee, have exclusive access to an e-bike, and pay for the e-bike on a per-mile basis. Included in the subscription membership would be maintenance, access to the latest e-bikes, access to different types of e-bikes, and pick-up/delivery of an e-bike upon request.

Potential Local Agency Implementation

Type:	Lease or Subscriptiuon Option
Implementation:	Private companies, local agencies, state or federal tax incentives
Cost:	Ranges from $0 (private implementation) to $2,000-$4,000/e-bike, Net Cost to local agencies could be zero over time
Impact:	Could have a beneficial impact in increasing e-bike usage for transportation trips, reducing local traffic congestion.

New Charging Opportunities

The implementation of public e-bike charging stations would help foster increased acceptance and use of e-bikes. A network of charging stations would improve the public perception of e-bikes, providing users greater confidence that they will be able to complete their longer journeys or have enough power for their return trip. One of the current pitfalls of implementing a network of public e-bike charging stations is the lack of standardization. There currently is no standard for public e-bike charging equipment. Individual manufacturers can install the plug/socket/adaptor of their choice and have unique voltage requirements. Without a universal charging standard or readily available adaptors, implementing a system useable for a variety of bikes will be challenging.

Swiftmile and Kuhmute offer publically-available universal chargers for e-bikes and scooters including both privately-owned and those that are part of a bike/scooter share system. These chargers are typically 'free' to public agencies and include a monitor that shows both advertising and public information such as bikeway maps or transit routes/schedules. Local public signage/advertising regulations that limit or control public signage/advertising will impact the financial viability of the 'free' chargers.

Some shared e-bike (and other modes like e-mopeds) rely on a system of shared battery chargers. Users travel to a battery station, remove the battery from their bike, insert it into the charging machine, and are given a fully charged battery to install in their bike. Similar to the above model; however, this requires at least some level of battery standardization. While multiple types of batteries can live within this type of ecosystem, it cannot be an infinite number as the market currently has. These types of systems also would not work for e-bikes with integrated, non-removable (or at least non-easily-removable batteries).

Associating charging stations with a low-cost membership program (like BikeLink lockers, for example) is one possible way to generate some income for the system and also increase accountability and security for users of the system.

Potential Local Agency Implementation

Type:	Public Charging Facilities
Implementation:	Local Agencies
Cost:	Ranges from $0 (stations with digital ads) upwards
Impact:	Could reduce parking revenue if placed in existing parking space. Could impact sidewalks if placed in this location. Could have a beneficial impact in increasing e-bike usage for transportation trips, reducing local traffic congestion.

Coordination with Public Transit Systems

As was stated earlier in this report, transit agencies that operate within Marin County have varying policies in terms of e-bikes. E-bikes are allowed on SMART trains but are not permitted on GGBHTD or Marin Transit vehicles due to weight restrictions. These limited options for e-bikes, reinforce the need for secure bike parking at transit stations and hubs. Secure parking in the form of lockers and cages provide the most protection and provide users with the most confidence about leaving their bike for extended periods.

Potential Local Agency Implementation

Type:	Consistent Access Policies
Implementation:	Local agencies
Cost:	Consistent policies could be developed at no additional cost if done through a master plan process. Cost of secure bike parking at transit stations or new bus racks would need to be determined.
Impact:	Could have a beneficial impact in increasing e-bike usage for transportation trips, reducing local traffic congestion.

Parking

Bike parking is a critical component to supporting bicycles of all types, electric and traditional. Parking can be accomplished in a number of forms, including bike racks, corrals, cages, lockers, etc. Having a mix of both short-term (bike racks) and long-term (corrals, cages, etc.) parking options will provide riders with secure parking options that fit the specific needs of that trip. Bike rack design should follow best practices allowing for multiple points of contact and be placed in well-traveled, lit locations. As e-bikes are typically more valuable and potentially more of a target for theft, providing secure parking is critical to ensuring bicyclists have confidence in parking their bicycles. Without that confidence, they are less likely to make that trip on a bike.

Potential Local Agency Implementation

Type:	E-bike parking
Implementation:	Local agencies
Cost:	Ranges from $2,500 to $5,000 per secure bike rack. Special racks may be needed for e-bikes.
Impact:	Could reduce parking and parking revenue iof placed in parking spaces. Could impact sidewalks if located there. Could have a beneficial impact in increasing e-bike usage for transportation trips, reducing local traffic congestion.

Safety

Safety is a concern for both traditional bicycles and e-bikes. Since e-bikes generally travel at a higher speed than traditional bicycles, and also weigh more, the safety risk also changes. For example, e-bikes may move at the same speed as vehicle traffic and accelerate out of intersections faster, thereby reducing potential coflicts. However, they may also allow bicyclists to speed on multi-use paths or mix with much faster moving vehicle traffic. Local agencies already have policies in place for different classes of e-bikes. Communicating these policies and restrictions through signage and website information would help increase compliance.

Potential Local Agency Implementation

Type:	E-bike safety
Implementation:	Local agencies
Cost:	Cost of signage where needed, and related website information
Impact:	Would improve compliance with local agency policies and regulations.

Conclusion

The data collected in this report confirms the rapid rise of e-bikes as part of the transportation systems in our communities. E-bikes conclusively show that they appeal to a broader range of users than traditional bicycles, and also offer greater range and access. E-bike usage in the United States has lagged behind patterns in Europe and Asia, but current sales trends show it is catching up. E-bikes could transform bicycling in places like Marin County, where steep gradient and narrow roads that inhibit bicycling could be mitigated. E-bikes could also help extend the range and accessibility of SMART and bus transit systems, providing an important boost in ridership. Local government agencies and private employers could play a role in subsidizing the purchase of e-bikes, as well as providing important infrastructure improvements including secure bike parking.

APPENDIX A

Local Bicycle Retailers E-bike Survey – May 2020

Bike lockers & a bike cage at Milpitas

Bicycle retail shops that sell e-bikes were sent copies of survey questions and interviewed via phone during May 2020. The specific shops contacted and the people interviewed are shown below. The responses are aggregated to protect confidential sales information.

- Mikes Bikes (Sam Bolster, San Rafael shop General Manager)
- The New Wheel (Brett Thurber, Larkspur shop, Co-Owner)
- Four retail outlets pending responses

E-bike Sales and Usage Trends

Question 1: What are the trends in e-bike sales in your shop (e-bikes sold, dollars spent, percent increase) over the past two years? What is the approximate percent of e-bikes of total current bike sales (units sold, dollars spent)? Do you think e-bike sales have come mostly from current bike owners, or not?

Responses:

- Eight months ago e-bikes constituted 5-10% of bikes sold and about 10% of sales dollars; today they constitute 10-15% of bikes sold and 20-35% of sales dollars
- 50% of people coming into the store are interested in e-bikes
- Most e-bike purchasers already have traditional bikes
- 70% of street/pavement e-bikes sold are Class I, 30% Class III
- 20% growth in e-bike sales in last year
- $5.5 million in e-bike sales in 2018; $6.5 million in e-bike sales in 2019
- Recent growth (since March 2020) has led to record-breaking monthly growth (40% higher month to month, 2019-2020)

Question 2: What are the reasons people mention why they are purchasing an e-bike? Use primarily for recreation, commuting, school, etc.? Want to be able to ride longer distances, more often, ride over steep hills, etc.?

Responses:

- Most e-bike purchasers are doing so for commuting purposes
- Purchasing e-bikes to get over the 'big hill'
- Some stigma to 'cheating' especially for e-mountain bikes
- Recent growth has come from people who formerly took transit to work

Question 3: Do you think e-bikes are replacing vehicle (car) trips?

Responses:

- Based on the sale of accessories such as cargo racks, the answer would be 'yes'
- E-bikes allow commuting into San Francisco from communities such as Larkspur and Corte Madera that formerly involved two major hills to overcome and a long distance

Question 4: Any general information on who is buying e-bikes (i.e., men v women, age group)?

Responses:

- E-mountain bikes are typically 60-40 men/women
- E-street bikes are closer to 50-50 men/women
- E-bike sales used to be primarily to older people, but now younger families are a growth area
- There are different types of e-bike buyers, some seeking something safe and comfortable, others, carrying capacity, others, distance/range.

Question 5: Do you have a feel for a Five and Ten-Year projection of e-bikes sales and usage in Marin? Would you point to Europe or Asia as examples of longer-term e-bike trends?

Responses:

- Unlikely that Marin will ever become like Europe or Asia in terms of e-bike usage
- E-bikes may constitute 50% of sales dollars by the end of this year
- E-bikes will constitute 90% of bicycle sales dollars in 10 years if supportive policies in place

Question 6: Where within Marin do e-bikes provide benefits over traditional bikes, considering topography, demographics, and commute behaviors?

Responses:

- Any route that involves major hills or trip over five or so miles

Question 7: What are the main barriers to people riding e-bikes more often? Battery life? Safe places to park? More room to ride on the road?

Responses:

- Range is a major factor, especially concern about battery life on the return trip if no opportunity to charge
- Each bike has a different battery type/range
- A publicly-accessible charger would be a benefit
- Range is not a major factor in Marin: most people can ride within the County on the available charge which lasts 3-5 hours
- Lack of infrastructure a major constraint; most people not comfortable riding on busy roads

Question 8: Where do e-bike gaps in the network occur (i.e., on ferries, weight limits on bus bike racks)?

Responses:

- Where current regulations prohibit e-bikes (such as roads in GGNRA, Pt. Reyes)

- Weight makes putting on ferries and buses difficult if not impossible

Question 9: How will e-bikes influence overall mode split in Marin (will they replace existing bikes or replace automobile trips)?

Responses:

- It partially depends on how the current crisis impacts people's decision to recreate near home as they're doing now during the COVID crisis, versus recreating elsewhere
- An estimated 40% of e-bikes are being sold primarily for work or school commute
- Young families are also buying e-bikes and using them to carry children to school, shopping, etc.

Facts About E-bikes

Question 10: What is the Average cost range for e-bikes? Do you see this coming down in the future?

Responses:

- $1,500 to $17,000, most in the $3,000-$6,000 range
- Consolidation in the industry will help bring costs down—but current 'value' of e-bikes justifies the cost
- Some direct-sellers like RadPower sell e-bikes for as little as $1,300

Question 11: Are limits on battery charges limiting the use of e-bikes? Do you think that quick-charge public e-bike chargers would be used? Would a universal proximity charger work on the e-bikes you sell?

Responses:

- Battery range is an area of concern
- Yes on universal charger question
- Public chargers could be a major asset in places where e-bike touring is popular, such as the wine country

Safety & Regulations

Question 12: How would you describe the state of knowledge of e-bike purchasers of relevant laws, rules of the road, use of sidewalks, pathways, and trails, etc.? Do you think e-bikes should be treated like vehicles, i.e., license, insurance, registration, etc.? Allowed on all bike paths? Off-road trails? Ever on sidewalks?

Responses:

- Very unlikely that cyclists can maintain or exceed the Class III power rating of 28mph
- E-bike speeds allow users to be more predictable when sharing roadways with traffic
- Crowded bike paths and speed differential between bikes and pedestrians a safety issue

Recommendations/Thoughts

Question 13: What type of policies, changes in laws, and infrastructure (such as universal public chargers, secure racks, etc.) are most needed to support e-bikes?

Responses:

- Secure, publicly accessible bike parking/chargers
- Enhanced bike lanes, paths, other infrastructure
- Lack of secure bicycle parking is a major barrier to e-bike usage: the cost and weight of the bicycle make owners reluctant to park them and eat, shop, work, etc.

Question 14: Marin County is considering an e-bike share system. What do you think are the future Ownership Models (i.e., shared models, private ownership)?

Responses:

- A leasing system whereby e-bikes are leased to individuals or employers (fleet programs) would be a good way to overcome the price barrier, especially if there were some subsidies. This is popular in Europe (Germany) where the lease cost includes the cost of insurance, employees can purchase e-bikes with pretax dollars, and employers can offer this benefit as a retention incentive
- An e-bike rental/subscription system might be met with marginal success given the fact that people want specific e-bikes with specific features rather than a 'generic' e-bike

Question 15: How do Covid-19 impacts and regulations change any of the e-bike mobility findings in this report?

Responses:

- Local recreation trip making (versus traveling) as a result of Covid-19 has accounted for much of the recent rapid growth in bicycling

National E-bike User Survey

This data comes from "A North American Survey of Electric Bicycle Owners" by the National Institute for Transportation and Communities (NITC), led by John MacArthur of Portland State University and published in March of 2018.

Some key findings of this survey include:

Gender of E-bike Owner:

Men:	70%
Women:	30%

Age of E-bike Owner:

Over 45 years:	67%
Over 65 years:	19%

Family Size of E-bike Owner:

1+ child at home:	64%

Traditional Bicycles owned by E-bike Owner:

1+ traditional bicycles at home:	97%

Weekly Mode of Travel of E-bike Owner (all trips):

Car:	50%
E-bike:	34%
Traditional bicycle:	5%
Transit:	4%
Walk:	5%

Trip Type of E-bike Owner:

Work/school:	34%
Recreation:	44%

Barriers to Riding Traditional Bikes More Often (by rank):

1. Hills
2. Distance
3. Desire to not arrive sweaty
4. To slow
5. Physical limitations

Reasons Owners Converted to E-bikes (by rank):

1. Replace car trip
2. Ride with less effort
3. Recreational purposes
4. Hilly area
5. Increase physical fitness

E-bike versus Traditional Bicycle Use (frequency):

E-bikes: 49% daily	42% weekly	
Traditional bicycles:	25% daily	30% weekly

Three Most Recent E-bike Trips:

Commute:	33%	
Recreation/Exercise:	36%	
Errands:		20%

Do You Feel Safe Riding Your Bicycle?

E-bike user (infrequent rider):	75% yes
Traditional bike user (infrequent rider):	49% yes

These survey results indicate that e-bikes trips replace significantly more vehicle trips than traditional bicycles, and most e-bike trips are for work, school, or utilitarian purposes. The survey results clearly show that e-bike trips greatly expand the range of destinations, especially in hilly areas, and extend the average length of trips as well.

In early 2018 Electric Bike Report showed the results of a study conducted by the National Institute for Transportation and Communities (NITC). We reported that the National Electric Bike Owner Survey found, "Before the advent of e-bikes people would have used their cars for trips of five miles and more, but the range seems to have been extended by 80% on e-bikes. In car-mad America, this is a significant finding

APPENDIX B

Quantifying the Transportation Benefits of E-bikes

An estimate of the existing and future usage of e-bikes and their related benefits in terms of reduced vehicle trips (VT) and vehicle miles traveled (VMT) is shown in Table 3. The model is based on the Marin County

Demand Model created as part of the Non-Motorized Transportation Pilot Project (NTPP), e-bike research, e-bike shop interviews, and counts conducted in May of 2020. The NTPP model was used as part of the Report to Congress in April of 2012,

Table 3: Estimate of Existing and Potential E-Bike Trips
Marin 2020

		Input	*Calculated Totals*
Work Commute Trips			
a. Population /1		258,826	
b. Employed Persons /2		101,361	
c. Bicycle Commute Share /3		1.80%	
d. Bicycle Commuters	commuters x2 = trips	1,824	3,649
College Commute Trips			
e. College Population /4		12,098	
f. Bicycle Commute Share /5		1.80%	
g. Bicycle College Commuters	commuters x2 = trips	218	436
Utilitarian (non-work or school) Trips			
h. percent of work bicycle trips /6		100%	
i. estimated bicycle utility trips			3,649
Recreational/Discretionary Trips			
j. ratio of recreational/discretionary trips to work trips /7		367%	
k. estimated bicycle rec/disc trips			13,380
Total Estimated Daily Bicycle Trips			**21,113**
Average One-Way Travel Length (Miles)			
Adults/College Students /8		3.5	
Replaced vehicle trips /9			
Utilitarian/work/school		60%	
Nonutilitarian (recreation, personal business)		25%	
Reduced Daily Vehicle Trips			**7,985**
Reduced Daily Vehicle Miles /10			**27,948**
Reduced Daily Vehicle Trips (E-bikes)		5.6%	**1,182**
Average One-Way Travel Length (Miles)			
Adults/College Students /12		6	
Reduced Daily Vehicle Miles (E-bikes) /13			**7,094**
Reduced Daily Vehicle Miles (E-bikes) - 1 Year			**2,589,319**

Reduced Daily Vehicle Miles (E-bikes) - 5 Years /14			**4,170,124**
Reduced Daily Vehicle Miles (E-bikes) - 10 Years /14			**6,105,479**

overseen by the Volpe National Transportation Systems Center. The effort included extensive counts and surveys of bicyclists in Marin County over several years.

As can be seen in Table 3, bicyclists, in general, are projected to be reducing 7,985 vehicle trips/day, and 27,113 vehicle miles traveled per day. E-bikes are estimated to consist of 5.6% of the bicycle fleet as of June 2020.

E-bikes are projected to reduce 1,182 vehicle trips per day, and 7,094 vehicle miles traveled/day. The projections for 1, 5, and 10 years is shown below. A conservative estimate of a 10% annual growth rate is used, although the current growth rate is much higher. These figures show that e-bikes can play a small but important role in helping to reduce traffic congestion and air pollution in Marin County, in addition to providing health benefits.