Martha's Vineyard Energy Plan 2020
Transportation Strategy Working Paper

INTRODUCTION

In 2018, transportation uses accounted for approximately 45% of the energy used on Martha's Vineyard. This sector is complex, with many modes, and a wide array of vehicles and vessels. Three specific local attributes cause the mix of transportation use on the Island to differ from national averages:

1. As an island, the Vineyard has a high degree of maritime traffic. With no road connection to the mainland, all commercial and personal interconnection with the rest of the world occurs through either ferries, maritime shipping, or air transport. In addition, as a popular summer vacation destination, the island has a large recreational and charter boating community. Commercial fishing is also a common and traditional occupation.
2. As a rural community, the Vineyard has a relatively small population density, with only three small "downtown" districts. Most of the full-time residents live outside the downtown areas, and primarily drive automobiles to accomplish their daily tasks. The mass-transit system is not heavily used outside the summer tourist season. Agriculture and the building trades are major occupations. The equipment they use produces a significant amount of CO_2 emission.
3. As a popular summer destination, the economy of Martha's Vineyard has an extraordinary degree of seasonality. The year-round population is approximately 17,000, but during the summer it increases to over 100,000. This presents a challenge to planners in that the transportation system must be geared towards a constantly changing set of use cases. Some solutions that work for the three-month tourist season become non-viable when usage scales down. The inverse is also true. Solutions designed for the small full-time population may not scale to fit the busy summer months.

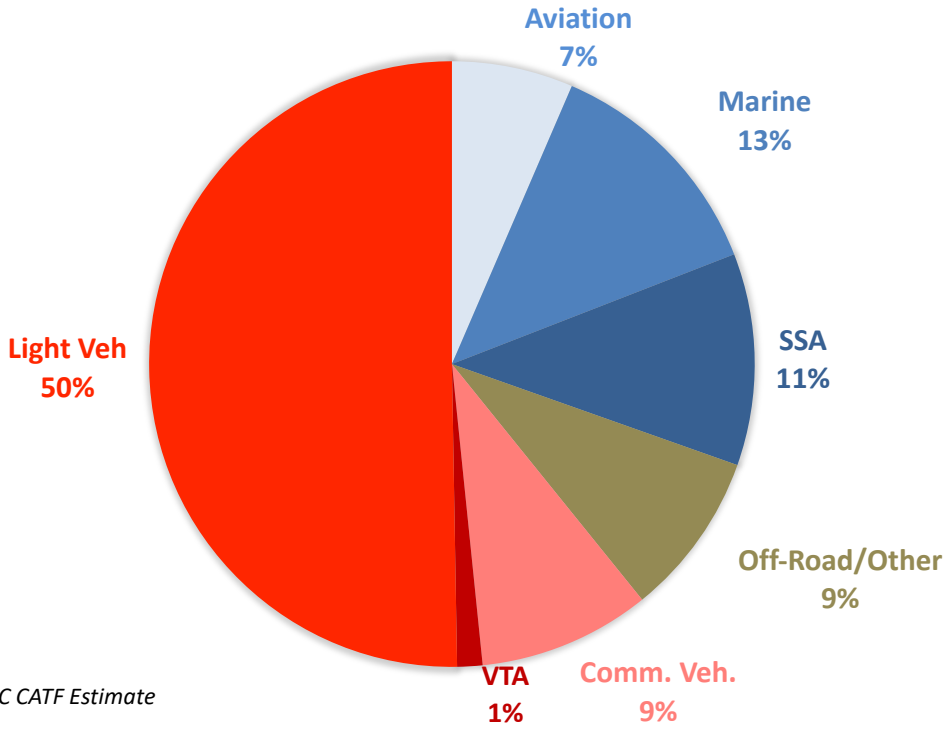
CURRENT STATE IN 2020

The transportation network on Martha's Vineyard is complex and diverse, presenting a variety of challenges in the transition to renewable energy sources.

Based on an energy model of fossil fuel use built by the Martha's Vineyard Climate Action Task Force, transportation accounted for 115,792 metric tonnes of CO_2 emissions in 2018. This includes contributions from the relatively small year-round population, as well as the more extensive energy use during the summer when many seasonal residents and tourists visit. To give a sense of scale, it would take 5 million trees, or about 50,000 acres of forest land to remove that much CO_2 from the air during the same time period.

MV CO_2 Emissions from Transportation in 2018

*Total = **115,792 Metric Tonnes CO_2***



Source: MVC CATF Estimate

A. Light Vehicles – Current State

Light vehicles are the automobiles and light trucks used for everyday personal and commercial transportation. In 2018, 22,191 automobiles and light trucks were registered on the Martha's Vineyard by the RMV. These light vehicles account for one-half of the CO_2 emitted by all forms of transportation on the Island.

At the beginning of 2020, almost all of the light vehicles on the Island are gasoline or diesel powered. As of January 2020, only 92 battery electric (BEV) or plug-in hybrid electric (PHEV) are registered here. However, in many ways Martha's Vineyard is in an excellent position to be an early adopter community for the transition from fossil fuel to electric vehicles. The limited distances travelled on Martha's Vineyard, and the cost effectiveness of electrical vehicles will make this very viable for residents, particularly for households with multiple vehicles who can designate one or more of them "island cars."

During the months of June through September the population of the island swells from 17,000 to over 100,000. Given the largely rural nature of the island, and the lack of a ubiquitous mass transit system, this results in a manifold increase in road traffic.

Congestion occurs at many choke points, reducing both energy and economic efficiency. The Vineyard Gazette has recently polled its readers to attempt to measure the problem and test some solutions.

The rate of increase in electric vehicles brought to the island by visitors for short periods of time will closely follow the rate of adoption in the Northeast US. However, during the early years of the transition, availability of charging infrastructure (or lack thereof) will modulate the willingness of visitors to conveniently use their electric vehicles on the island. Over time, as more vineyard home owners establish chargers for their own vehicles, as more visitors make a charging station a requirement for rental, and more public charging facilities become available and convenient, this limitation will diminish.

In this transportation segment, conservation of vehicle travel can be a significant source of fuel savings. Bicycle travel is increasing in popularity, both on-island and off, and as more bikers leave their cars behind, fuel will be saved. The wider availability of electrically-assisted bikes will encourage a broader segment of island locals and visitors to travel by bike quickly and quietly from place to place. However, significant improvements in making our roads truly safe for cycling , through a dedicated campaign to educate motorists, cyclists, and law enforcement, as well as dedicated bike paths and lanes, will be needed to support this trend.

B. Mass Transit – Current State

Island public transportations systems, including the Vineyard Transit Authority (VTA) and school buses of the Martha's Vineyard Regional School District (MVRSD), are in the unique position of potentially contributing both in reducing their own rate of consumption of fossil fuels, as well as serving as substitute modes of transportation for other, more CO_2 intensive modes.

The Vineyard Transit Authority (VTA) operates an island-wide network of buses and shuttles for use by the public. Emissions of CO_2 from this fleet represent 1% of the Island's overall transportation emissions.

The VTA has taken an aggressive, pioneering role in transitioning away from diesel buses to electric. In 2019, they began rolling out electric buses on some routes. The VTA's experience to date has shown the electric buses to be more cost effective than diesel, primarily due to their reliability and lower maintenance costs. The VTA presently has 12 electric buses (one-third of the fleet), and plans to be operating a totally electric fleet by 2027. The VTA will also shortly begin building solar canopies coupled with battery power storage at its service yard. The direct use of solar power will significantly reduce the cost of "fueling" its fleet. In addition, the VTA is pioneering the use of high-capacity inductive charging stations at several of its busier stations. This will allow for energy "top-offs" during brief pauses, thus extending the range of the buses during the day.

The Regional School District operates a fleet of 25 school buses and five vans serving all island public schools. These include the Island's five elementary and the MV Regional High School. The district has recently received a grant from the Commonwealth for $500,000 to cover the extra cost of purchasing electric versions of two new school buses as a first step to taking their fleet from diesel to electric.

The Vineyard Transit Authority currently provides fueling and maintenance services for the MV Regional School District's school bus fleet. As the VTA transitions to all-electric mode, it plans to provide charging for electric school buses from the solar canopy system at the VTA service yard.

The Steamship Authority also maintains a fleet of 28 buses to provide transportation from its parking facilities. About 20 of these serve the Vineyard passenger terminal in Woods Hole. In 2019, the SSA received $875,000 in grant funds to offset the price differential between diesel and electric versions of two new buses. Present construction plans for the new passenger terminal include solar canopies to charge these buses. Although there is no plan at present to electrify all of the SSA's buses, we may expect that the Steamship's fleet will be all-electric within the next decade.

C. Commercial Vehicles – Current State

Commercial vehicles are the medium-duty and heavy-duty trucks used in hauling cargo from source to user. These include a wide range of vehicles from delivery vans and trucks, to larger tractor/trailers, to dump trucks and refuse trucks. This mode of transportation produces approximately 9% of the CO_2 emitted on the island. Most of these vehicles can be considered "island vehicles" with consistent, limited range requirements either on the island, or coming to and from southeastern Massachusetts.

While today there is almost no use of electric commercial trucks on Martha's Vineyard, electric medium-duty trucks are in early stages of commercial adaptation, primarily in urban environments in Europe and Asia. A number of established manufacturers like Daimler, Volvo, and Mack have vehicles in operation in the field. Newer entrants like Lion and BYD are also well into commercial production. Carriers like Amazon, UPS, FedEx, and DHL are running early deployments to test performance and experience the benefits and challenges first hand.

For longer ranges and heavier loads, electric tractor/trailers are either in production or planned for delivery in the 2020-21 timeframe from Daimler Freightliner, Volvo, Tesla, and a number of other manufacturers. Initially, these trucks will be used for local or regional transportation with routes in the several hundred-mile range. These are exactly the use cases for the tractor trailers travelling to and from the Vineyard.

D. Off-Road Vehicles – Current State

Off-road vehicles include a distinctive collection of machines that move materials from place to place without the need for road travel. On Martha's Vineyard, construction, landscaping, and farming are principal activities that use off-road vehicles. Excavators are typically tracked vehicles with buckets or scoops that dig and/or transport earth materials. Wheel loaders have similar duties, but move on wheels that are steered much like road vehicles. Farm tractors are also wheeled vehicles, but accomplish a variety of tasks by towing, pushing, or carrying accessory devices to cultivate, mow, fertilize, harvest, or just transport materials from place to place on the farm.

Four-wheeled utility vehicles (UTVs) carry a passenger and driver with a box or bed behind, much like a small pickup, but with high clearance and low gearing needed for overland travel. Smaller, lighter garden tractors, designed primarily for mowing, can also do snowplowing, light grading, and hauling. All-terrain vehicles (ATVs) are steered with handlebars and have three or four wheels, and used primarily for recreational and sporting applications.

All of these categories of off-road vehicles are presently available in battery electric versions, which will eventually supplant fuel-fired versions. As with cars and pickups, electric versions of these transporters will prove much less costly to operate and maintain. The largest versions of excavators and wheel loaders are presently diesel-driven, but as batteries become lighter and more powerful, we may expect these to become electric vehicles as well.

At present, it is difficult to track the fuel consumption of off-road vehicles. In the 2018 baseline island energy budget, we estimate their fuel use as the remainder needed to close the balance between fuel imported and fuel used by other consumption.

E. Maritime – Current State

As an island, Martha's Vineyard is a community which is inextricably linked to maritime activities. We estimate that one-quarter of the current use of fossil fuels for transportation comes from various maritime uses.

Almost one-half of that is used by the Steamship Authority, the Vineyard's primary link to the rest of the world. The SSA operates a fleet of 10 ferries of various displacements and types, used in service between from the mainland to both Martha's Vineyard and Nantucket. In 2018, the SSA carried 2,435,308 passengers, 417,931 automobiles, and 137,635 trucks between the Vineyard and Woods Hole. These boats consumed 1.29 million gallons of diesel fuel on the Martha's Vineyard route.

In many regards, the Woods Hole to Martha's Vineyard route is an excellent place to begin deployment of battery-powered ferries, due to the short route length (7 miles) and the large capacity needed for the Steamship's vessels. The maritime transportation

industry is now beginning to deploy electric-powered ferries for similar routes on a rapidly expanding scale. Most of the pioneering work is being done in Northern Europe, where such ships are now deployed with displacements and routes in the same general ranges as the SSA ferries serving the Vineyard. In 2019, the Washington State Ferries system committed to a migration of its Puget Sound fleet to hybrid propulsion systems, where batteries charged at the dock will provide the main source of energy. The hybrid ferries will have diesel engines aboard for backup or range extension. The first of these hybrid ferries is scheduled to begin service in 2022, with a commitment to operate 22 of 26 ferries as hybrids by 2040. While there are some differences in routes and conditions, these early deployments of battery and hybrid ferries are existence proofs for the potential for the SSA to greatly reduce its carbon footprint by 2040.

Other maritime activities, both commercial and recreational, account for the other 13% of Martha's Vineyard's transportation-based CO_2 emissions. These uses will be among the most difficult to convert from fossil fuels to renewable energy. The heavy drag inherent in marine propulsion makes it a very energy intensive application. Typically, the fuel efficiency of a recreational motorboat is in the very low single digits of miles per gallon. Additionally, these boats typically require a much longer operating range than the Martha's Vineyard ferries. Lastly, many recreational and commercial boats are based on moorings, which present huge barriers to the ability to charge overnight.

As a result, the commercial and recreational maritime industry is not very far along in developing viable solutions for renewable energy-based propulsion. Some special purpose vessels, and very small electric engines are available, but they exist today only for fringe applications rather than the mainstream.

F. Aviation – Current State

Air transportation accounts for roughly 7% of the CO_2 emitted by transportation systems on Martha's Vineyard. The vast majority of this comes from jet fuel, consumed primarily during the summer months when visitor traffic is high. Several airlines have in-season flights daily from Boston, New York, Washington D.C., Philadelphia and other large cities. In addition, there are a significant number of private jet arrivals and departures during the summer months.

Roughly 15% of the fuel used for aviation on the Vineyard is aviation gasoline for smaller, propeller-driven aircraft. Cape Air operates multiple daily roundtrip flights to the Vineyard on a year-round basis. There are also many private small aircraft using MVY, primarily in the summer tourist season.

In 2020, the aviation transport on Martha's Vineyard is powered entirely by fossil fuels. There are a very small number of electric airplanes in use around the world, primarily in prototype or experimental applications. There are no electric planes in commercial use

today. Industry efforts toward sustainability focus mainly on engine and aircraft fuel efficiency, and research into alternative hydrocarbons fuels such as biofuels or synthetics.

In 2019 Cape Air signed a Memorandum of Understanding with the Israeli manufacturer Eviation to be the launch customer for "Alice", a 9-seat electric aircraft with a range of 620 miles. Delivery is planned in 2024. However, once the concept is proven, reduced fuel and maintenance costs will tend to drive adoptions in this market.

PLANNING ASSUMPTIONS FOR 2020 - 2040

Key Planning assumptions used in this rough analysis include:

- Population growth of 0.6% per year, driving transportation demand by a similar percentage.
- Constant transportation miles travelled per capita per year.
- Continued global industrialization of electric vehicles/vessels for all modes of transportation.
- Commitments by governments to continue or accelerate tax incentives for some period of transition time.
- No significant breakthrough in electric aviation for large commercial passenger airplanes.
- The ability of the local electricity distribution utility to evolve the Martha's Vineyard electrical grid to support growth and changing demand as the transportation infrastructure evolves to become electrically powered.
- Continually increasing availability of electrical capacity from renewable sources, including offshore wind and Island-based solar.

In addition, most of the work behind this strategy was conducted during the winter of 2019-20, before the COVID-19 pandemic and its subsequent economic disruptions occurred. As of this writing (May 2020) the extent and duration of those disruptions are still unknown, and so have not been considered in our present analysis.

VISION FOR 2020-2040

A. Light Vehicles 2020 - 2040

During the 2020-2025 period, global automobile manufacturers will mainstream electric vehicles, bringing to market models with capacity and range rivaling current generation gasoline cars. By the later part of the decade, we expect the rate of new electric cars and light trucks purchased in the United States will approach or exceed that of gasoline-

fueled cars. The rate of adoption will be primarily driven by the rate of deployment of charging infrastructure, both public and private, and therefore the alleviation of "range anxiety." Improvements in battery technology will increase range while reducing price. Wider deployment of direct-current chargers will reduce charging time, as will new charging technologies, such as inductive charging.

As the support infrastructure for electric vehicles becomes more established in the Northeast United States, the limitation to Vineyarders using them only as island cars will become less relevant. In the 2025-2030 timeframe we expect to see Islander's purchases of electric light vehicles increase rapidly.

By 2030 we expect to see virtually all Vineyard municipal, county, state, etc. light vehicles converted to electric.

By the 2030-2040 time period we expect global adoption of light electric vehicles to become the norm. Private and public charging infrastructure will be ubiquitous in all but the most remote regions of the United States. The elimination of range anxiety and the inherent economic advantages of electric vehicles will tilt the marketplace completely in favor of EVs. By the end of this decade, production of fossil-fueled light EVs will effectively cease, and replacement of the existing fleet with EVs will be largely complete. During the latter half of the decade, many gasoline stations will either convert to public charging stations, or close entirely, thus accelerating the replacement of older gasoline and diesel-powered vehicles in the fleet.

Conservation will also supplement the energy savings due to electrification. Trips saved by biking and walking will continue to increase throughout our time interval, as the infrastructure for these activities grows with time.

<u>Light Vehicle Strategies</u>

1. Encourage all island municipalities to adopt goal of 100% Light EV usage by 2030.
2. Assess the likely demand for public charging facilities 2020-2040, and develop a plan to encourage development.
3. Consider requiring a Class 2 charging station (or a charging-ready 240V garage/outdoor circuit) for new builds in all town building codes.
4. Consider incentives for Island visitors to bring EVs, for example dedicated or free parking availability, or a reduced EV rate for the ferries.
5. Consider offering reductions in excise taxes on locally registered EVs to incent Vineyard residents.
6. Encourage more trip conservation by continued investment in infrastructure supporting biking and walking.

B. Mass Transit 2020 - 2040

Under its current plan, by 2027 the VTA will be operating a fleet 100% powered by electricity.

VTA could also potentially alleviate the need for some consumer vehicle use (addressing both the carbon output and traffic congestion problems), by expanding its coverage. In particular they could concentrate on expanding down-island availability of public transport, by looking at more thorough local route coverage in VH, OB, and EDG, and more frequent trunk trips connecting those towns. An added benefit of doing so would be reduction of traffic on some of the most congested routes on the Island. The economics of doing so should be explored, and sources of capital and operating funds need to be identified.

Following the VTA model, the Regional School District school bus system and the SSA shuttle system should be able to reach 100% electric power by 2030. It is likely that the VTA and school bus system will share assets in terms of charging facilities and maintenance, and even potentially vehicles for some usages. Plans should be fully developed for both MV schools and SSA including the financial cases.

Mass Transit Strategies

1. Work with School System and SSA to plan for full conversion to electric buses by 2030. Help identify sources of funding for the investment.
2. Explore with the VTA the possibility of expanding system coverage in the higher density areas, including impact on rates/subsidies.

C. Commercial Vehicles 2020-2040

While deployment of larger electric commercial vehicles to the market is just beginning in 2020, this segment has the possibility to take on a much faster acceptance rate than electric cars and pickups. Commercial vehicles usually are driven hard, rapidly building up miles, and so are replaced more frequently. Operators will find the life-cycle cost savings (particularly for diesel trucks) very attractive. The ability for commercial owners to rapidly depreciate their newly purchased vehicles will somewhat ease the investment burden.

If action is taken to jump-start the market on Martha's Vineyard, we expect to see significant presence of electric commercial vehicles by 2030. The earliest vehicles to convert will likely be box trucks used as delivery and contractor vehicles. Even for larger vehicles in this category, like tractor trailers and dump trucks, the limited distances travelled on the island closely match their early target applications.

For commercial vehicles owned by larger businesses and operated as fleets, building charging facilities to handle multiple vehicles will be a large investment. As we have

seen with the VTA, some remote capability to give a quick charge boost may be necessary for vehicles with long daily routes. As fleet vehicles, the charging challenge can be simplified through concentrated charging/storage facilities at the fleet's home locations.

Also, by working with a relatively small number of fleet owners, the challenges of owner education and development of economic cases will be greatly simplified. To the extent these fleet owners are regional or national players (FedEx, UPS, USPS, etc.), it may be possible to encourage them to think of Martha's Vineyard as a test bed for larger rollouts.

With early action to educate the owners of commercial vehicles, we believe that the significant operating cost advantages of using electrical power for these heavily worked vehicles will encourage accelerated migration to EVs. In this scenario, it is possible that the migration may be close to complete by 2040.

Commercial Vehicle Strategies

1. Work with local representatives of large national companies (UPS, FedEx, Coca-Cola) to understand their strategies and encourage early adoption on MV.
2. Bring Commercial EV manufacturers to MV for forums to educate the marketplace. Work with them to develop models for fleet conversion, including charging infrastructure investment.
3. Assess the need for public charging stations on the Island to remove range as a barrier to rapid adoption.
4. Consider offering reductions in excise taxes on locally registered EVs to incent Vineyard businesses.

D. Off-road Vehicles 2020-2040

Development of battery electric off-road vehicles is somewhat behind that of light vehicles and trucks, but there are still choices on the market in 2020. Equipment manufacturers like Bobcat, Volvo, and Takeuchi are beginning to sell light excavators in the American market. European manufacturers Schaeffer, Kramer, and also Volvo are providing wheel loaders in Europe. German manufacturer Fendt has added an electric model to its large line of farm tractors. John Deere has produced some prototypes, and American manufacturer Soletrak is bringing an all-electric line of light tractors to market especially for smaller and organic farms, like those on the Vineyard.

As the 2020-2030 decade progresses, we may expect more electric off-road models, and as battery technology improves, more powerful and longer-working machines will enter the market. On the island, most of our excavators, loaders, and tractors are smaller

models for which there will be readily available electric replacements. As with all electric vehicles, the conversion will be driven by lower maintenance and fuel costs, as well as future lower prices. However, many off-road vehicles have long lifetimes and replacement rates will be a factor.

Although the market segment for electric off-road vehicles will lag behind electric light and commercial vehicles, we may anticipate that the goal of 100% electrification will be approached in the mid-2030's and reached by our 2040 target.

Off-Road Vehicle Strategies

1. Reach out to construction workers and landscapers about new electric utility vehicles, stressing amortization and cost savings.
2. Partner with dealers for local events and demonstrations.
3. Seek out federal and state incentives for these less-common vehicles and lobby for their inclusion in broader programs.
4. Consider offering reductions in excise taxes for off-road EVs registered locally.

E. Maritime Vessels 2020 - 2040

By 2030, we fully expect that the SSA will have a well-developed plan for converting its entire fleet. We also expect the first hybrid ferry should be either in service, or at least undergoing conversion/construction. While there will be significant technical and operational challenges, the most difficult issue will be securing the capital required to convert the vessels and build out the charging infrastructure.

During the 2030s, we expect the conversion of the SSA fleet to hybrid or electric vessels to be well underway. Port facilities for the new vessels will have been completed by 2030. Also, we expect that, by 2030 or before, the operating costs of hybrid vessels will be lower than the existing diesel boats. The rate at which the fleet will adopt the hybrid or battery-powered vessels will depend on the SSA's ability to raise capital to convert them or acquire new vessels. It is possible that the fleet could be completely refreshed by 2040, but this will require a breakthrough in financing for the SSA.

During the 2020s, we do not expect to see much progress in the commercial and recreational maritime fleets. It is likely that at the very smallest end, tenders, launches, and other harbor craft with low range requirements will begin switching to battery power.

We expect that the maritime industries will have development work underway toward new vessels and powerplant refits for more mainstream applications, with expectation of early deployments in the next decade. As this happens, we expect the maritime community on the Vineyard to begin plans for facility rearrangements to accommodate

electric-powered boats and their charging systems when they eventually become a commercial reality.

During the 2030s, we may see adoption of electric power for some vessels in the Martha's Vineyard fleet. The rate at which this occurs will mostly be driven by the ability of the marine power industry to develop propulsion systems for vessels of all sizes. In the case of recreational vessels, it will also depend on the ability to develop charging systems able to support a widely distributed fleet based on water, and in many cases at moorings with no land connections. Finally, given the very long lifetime of boats, changing the fleet will occur over a three- to four-decade period from the first availability of practical electric boat solutions.

Maritime Vessel Strategies

1. Work with the SSA to formulate a 20-year plan for converting the fleet to hybrid or battery-driven vessels.
2. Convene a group from the commercial and residential maritime interests to plan for the long-term conversion to renewable energy and the associated modifications to waterfront and marina facilities.

F. Aviation 2020 - 2040

By 2030, we expect to see some Cape Air flights to the Vineyard making use of the new Alice aircraft for regular service. If these aircraft are delivered on time and their demonstrated performance meets expectation, it is possible that all Cape Air service to the Island might be electric.

We expect little change to the commercial and private jet fleets servicing the Vineyard, with the exception of a gradual shift toward better fuel efficiency. We may see a few private small electric aircraft on the Vineyard during the 2020s, and will certainly see some by 2040, but the change is likely to be very gradual. Private light aircraft have useful lifetimes spanning 30-50 years. We expect the change-over of the light private aviation fleet to be very gradual.

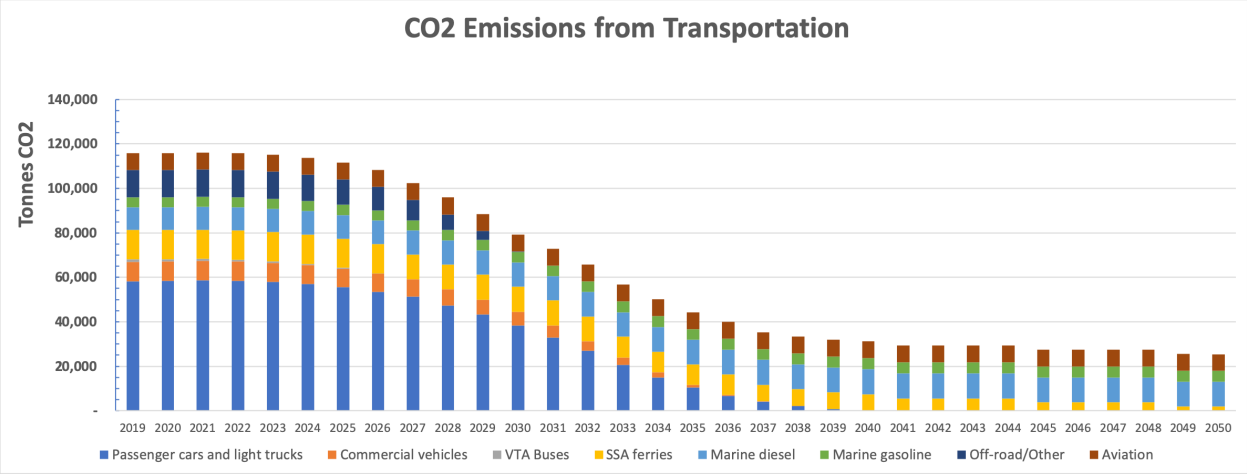
As with other modes of transport, charging infrastructure will be an essential requirement for battery-powered aircraft serving the Island. Cape Air's charging facilities will most likely be located at its hubs, which include Boston. However, as electric light aircraft become more plentiful, a charging facility at MVY might be practical and useful in the late 2030s.

Aviation Strategies

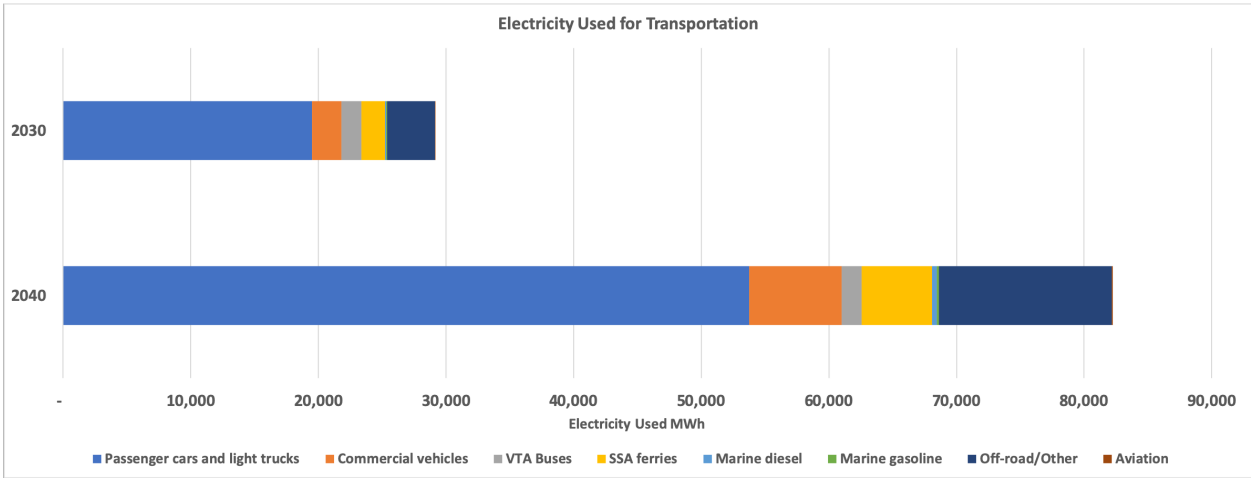
1. To encourage electric aircraft, offer incentives, such as reduced landing fees, preferential hangar or mooring space.
2. Adopt noise restrictions that favor quieter electric aircraft over internal combustion engines.
3. Assess the cost and timing of building a common-use charging capability for smaller electric aircraft at MVY airport, and develop a long-range planning recommendation.

2030 AND 2040 EXPECTED RESULTS

By 2030 we will begin to see strong acceptance of EVs in passenger, commercial, and off-road applications and the complete conversion of the VTA and school bus networks to EVs. This will result in a one-third reduction in CO_2 emissions from the 2018 baseline view. With the complete migration to EVs for land-based transportation systems, and substantial progress toward converting the SSA fleet to hybrid or battery power, CO_2 emissions will be reduced by three-fourths from the 2018 level.



Correspondingly, we see additional requirement of 29 GWh of additional electricity in 2030, and 82 GWh in 2040 to propel the new, renewably-powered fleets of vehicles and vessels.



CONCLUSION

The residents of Martha's Vineyard have a promising opportunity to transform our Island's transportation infrastructure over the next 20 years, and in doing so dramatically reduce the amount of greenhouse gases emitted. The scenario detailed in this working paper should be considered an "optimistic" outlook, which assumes steady progress on all fronts. It demonstrates there is a clear path to virtually eliminate CO_2 emissions from land-based transportation, which today account for three-fourths of all transportation-generated emissions.

Forecasting 20 years ahead is inherently uncertain. The rate at which fossil fuel consumption will actually be reduced will be driven by a few critical global trends that are beyond the control of the people of Martha's Vineyard. These include (1) the level of commitment by governments and industries to reduce greenhouse gas emissions, (2) the degree of progress on the development of economically competitive electric vehicles and vessels, and the necessary support infrastructure, (3) the global price of crude oil, and (4) the rate at which the global economy recovers from the unprecedented economic disruption resulting from the Covid-19 pandemic.

Locally however, Vineyarders can determine whether we are leading or trailing the rest of the world through our actions in the following areas:

1. Launching intensive education and awareness programs to keep our residents informed of the latest developments and opportunities to convert to EVs.
2. Providing local incentives to residents and visitors for EV usage.
3. Development of a strategy for public EV charging stations.
4. A commitment to invest in mass transit.

Eliminating the remaining emissions will be more challenging. It will be technically possible to convert the SSA ferry system and eliminate its dependence on fossil fuels by 2040, but the

necessary investment will require a large, creative infusion of capital far beyond the historical norm. The picture is cloudier for the other maritime and aviation transportation applications. Scalable solutions for these are undeveloped, and are still many years in the future. Near term progress will continue to depend on more efficient vessel/aircraft design, and use of greener fuels.

The window for action is short. While solutions are at hand, the lifetimes of our vehicles, vessels, and aircraft are long. Adopting renewable solutions and overhauling the entire network will take time. The work ahead is daunting. We must start now, today, planning our strategies and investing the effort to take us to a fossil-fuel free future.