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Appendix G: White Paper on Neighborhood Vehicles

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1.0 Background

1.1 SBCOG/SCAG Funded Project

The preparation of this White Paper is made possible through funding from the South Bay Council of Governments and Southern California Association of Governments. This White Paper is a product of the scope of work from the study *"Mixed-Use Centers in the South Bay: How Do They Function and Do They Change Travel Demand?"*

1.2 Objectives

The objectives of this White Paper are to:

- Prepare necessary background information to generally assess the evolution of Neighborhood Electric Vehicles (NEVs).
- Understand NEVs in the context of local transportation.
- Discuss the advantages/disadvantages and costs/benefits of NEVs to support neighborhood/commercial district integration.

1.3 Intended Outcomes

A key outcome of this White Paper is to support grant application(s) for implementing a neighborhood vehicle (NV) demonstration project in the South Bay.

1.4 Overview

NVs, and NEVs in particular have evolved to meet the growing demand for low speed, short distance transportation, usually up to about one mile. NVs and NEVs provide an environmentally friendly alternative to the internal combustion engine (ICE). Through an alternative fuel system such as an electric motor, NVs significantly reduce the number of ICE cold starts that account for the greatest amount of vehicle emissions. According to the National Renewable Energy Laboratory, a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, ICE vehicles contribute between one-third and one-half of the carbon monoxide and hydrocarbon emissions in the United States.

NVs provide transportation in communities:

1. To connect separated land uses, for example residential neighborhoods and commercial shopping districts.
2. To meet the practical needs of daily life such as visiting friends and relatives, running errands, accessing local facilities such as a park or recreational center, and getting to and from nearby jobs.

NVs are defined in this White Paper as auto-mobility solutions in individual or small group vehicles (up to four people). This means that a person or small group of people have self-selection in determining the timing and sequence of their movements between origins and destinations of their choosing. Examples of NVs are human transporters, golf carts, motor scooters, bicycles, tricycles, and neighborhood electric vehicles, among others, as defined below.

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Neighborhood transit services (NTS) are a broad cross section of traditional means of public or group transportation operated by third parties such as public agencies or professional transportation companies in order to relieve the congestion of mass transportation or to meet government mandated special needs transportation programs. NTS usually includes vans, mini-vans, mini-buses, and special vehicles. There are two types of NTS:

1. Individually directed services such as taxicabs and paratransit (usually associated with the disabled and/or elderly transportation services such as dial-a-ride). Trips are usually curb-to-curb or door-to-door services. While operated by a third party, the transportation consumer selects the origin and destination.
2. Group directed services such as local mini-buses and shuttles. Trips are usually part of a fixed route system with predetermined stops.

1.5 Exclusions

This White Paper focuses on NEVs within the context of NVs. Specifically excluded are the following types of vehicles which are either not NVs per se or are not auto-mobility solutions (that is, they are dependent upon a third-party providers and the individual does not select the origin or destination):

- Full size vehicles including electric and hybrid vehicles.
- City-sized vehicles such as those made by the now defunct Ford Th!nk.
- Three-wheeler electric vehicles which exceed 25 miles per hour such as the Sparrow, Twike, Gizmo, and Tango
- Motorcycles.
- Personal rapid transit (PRT) (fixed guide-way “cab-cars”) that require large infrastructure investment.
- Off-road vehicles and electric go-karts which are primarily recreational vehicles.
- Power-assisted wheelchairs.
- Light electric vehicle kits which frequently exceed 25 miles per hour and/or are for recreational purposes and hobbyists.
- Human transporters such as Segway.
- Taxis, ped-cabs, tuk-tuks and other vehicles which are third-party transaction dependent.

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2.0 Regulatory Framework

2.1 Federal

2.1.1 The Final Rule

In June, 1998, the U.S. Department of Transportation, National Highway Traffic Safety Administration (NHTSA) entered into the Federal Register (63 FR 33913, June 17, 1998) a Final Rule with respect to NVs ("Final Rule"). The Final Rule permits the manufacture and sale of small, 4-wheetled motor vehicles with top speeds of 20 to 25 miles per hour as "low-speed vehicles" ("LSVs"), including NEVs. This new classification distinguishes them from passenger cars or conventional golf cars having a top speed of less than 20 miles per hour.

Low-speed vehicles are subject to a new Federal Motor Vehicle Safety Standard No. 500 (49 CFR 571.500) established by the Final Rule. The safety standard requires low-speed vehicles to be equipped with headlamps, stop lamps, turn signal lamps, tail lamps, reflex reflectors, parking brakes, rearview mirrors, windshields, seat belts, and vehicle identification numbers.

As part of the rule making process, the NHTSA addressed several matters concerning the effect that issuing Standard No. 500 has on state and local laws, as follows:

- The Final Rule does not alter the ability of states and local governments to decide for themselves whether to permit on-road use of golf cars and LSVs.
- State and local governments may supplement Standard No. 500 in some respects. They may do so by requiring the installation of and regulate the performance of safety equipment not required by the standard. However, the states and local governments may not specify performance requirements for the safety equipment that is required by the standard. Today, approximately 45 states have laws permitting NEVs.
- The agency notes that the issuance of Standard No. 500 does not require current owners of speed-modified golf cars having a top speed between 20 to 25 miles per hour to retrofit them with the equipment specified in the standard. The decision whether to require retrofitting of golf cars that are already on the road remains in the domain of state and local law.

As noted in the Final Rule itself, "the rulemaking proceeding was initiated in response to a request by Bombardier, Inc., that the agency make regulatory changes to permit the introduction of a new class of 4-wheeled, passenger-carrying vehicle that is small, relatively slow-moving, and low-cost."

2.1.2 Alternative Fuels

An alternative fuel vehicle (AFV) is a vehicle that can operate on a fuel other than gasoline or petroleum based diesel. Alternative fuels, as defined by the Energy Policy Act of 1992 (EPAct), include ethanol, natural gas, propane, hydrogen, biodiesel, electricity, methanol, and p-series fuels. These fuels are being used in a variety of vehicle applications. Using these alternative fuels in vehicles can generally reduce harmful pollutants and exhaust emissions. In addition, most of these fuels can be domestically produced and derived from renewable sources.

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AFVs range in function and size from small passenger cars to large 18-wheeler trucks or transit buses. Off-road products such as forklifts, and agricultural and construction equipment are also available with alternative fuel systems.

AFV's produce fewer emissions than those powered by gasoline or diesel fuel. Emission reductions of up to 80 percent for pollutants such as carbon monoxide, carbon dioxide, non-methane organic gas, oxides of nitrogen, or particulate matter can be achieved. The amount of emission reductions varies by the alternative fuel type and pollutant.

Using alternative fuels helps reduce the nation's dependence on imported oil. Alternative fuels can be derived from renewable biological feedstock or are a by-product of petroleum production. For example, ethanol can be fermented from corn or wood waste, while natural gas or propane is produced in conjunction with crude oil production. Some alternative fuels can also reduce vehicle maintenance requirements. For example, spark plugs from a propane-fueled vehicle last from 80,000 to 100,000 miles and engines can last 2 to 3 times longer than gasoline- or diesel-fueled engines.

2.2.2 Federal Tax Incentives

Federal and state tax incentives are offered for clean fuel vehicles as follows:

a. Clean Fuel Tax Deduction

Federal Tax code provides a deduction to compensate for the cost of the vehicle components that enable it to use clean fuels (clean-fuel vehicle property) and costs of storing and dispensing the fuel (clean-fuel vehicle refueling property). The latter tax deduction, with a maximum of $100,000 per location, is available for qualified clean fuel refueling properties. The tax deduction for vehicle property can by earned by the purchase of a new qualified clean fuel vehicle or for the conversion of an existing vehicle to use a clean-burning fuel. This incentive is provided to business or personal taxpayers under the Energy Policy Act of 1992 (EPAct), Public Law-102-486, Title XIX-Revenue Provisions, Sec. 179A. The amount of the tax deduction for qualified clean fuel vehicles is based on the gross vehicle weight (gvw), the type of vehicle, and the value of the vehicle's clean fuel vehicle property, as defined in IRS Code Section 179A. Maximum allowable deductions are as follows:

- Buses, with seating capacity of 20+ adults = $50,000
- Truck or van, gvw more than 26,000 lbs = $50,000
- Truck or van, gvw of 10,000-26,000 lbs = $5,000
- All other vehicles, off-road vehicles excluded = $2,000.

The dollar amount for the Clean Fuel Vehicle tax deductions and credits were scheduled to be phased out by December 31, 2004, but have been extended by the Working Families Tax Relief Act of 2004 so that full deduction and credit are now allowed for qualified property placed in service in 2004 and 2005. The deduction will be 25% of the otherwise allowable amount in 2006 and phased out in 2007. For more information about alternative fuel tax provisions, please contact the IRS Office of Associate Chief Counsel, Passthroughs, and Special Industries at 800-876-1715. A pdf version of Publication 535, "Business Expenses", is available at the IRS web site.

b. Electric Vehicle Tax Credit

A tax credit for the purchase of qualified electric vehicles is provided and adjusted under the same legislation that established and extended the Clean-Fuel tax deduction. IRS Form 8834 can be used to

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calculate the credit for qualified electric vehicles placed in service during the year. The size of the credit equals 10% of the cost of the vehicle, with a maximum of $4,000. This credit is scheduled to be reduced by 75% in 2006 and expired in 2007. To qualify for the credit, the vehicle must be powered primarily by an electric motor drawing current from batteries or other portable sources of electric current. All dedicated, plug-in only EVs qualify for the tax credit, which is available for business or personal vehicles. A tax deduction of up to $100,000 per location is available for qualified EV recharging property that is used in a trade or business.

Under IRS Form 8834 a qualified electric vehicle is defined as follows:

- Manufactured primarily for use on public streets, roads, and highways, and has at least four wheels;
- Powered primarily by an electric motor drawing current from rechargeable batteries, fuel cells, or other portable sources of electrical current;
- Originally used by you; and
- Acquired for your own use and not for resale.

IRS exceptions include the following:

- The qualified electric vehicle credit does not apply to vehicles that are:
- Used primarily outside the United States,
- Used by a governmental unit or agency or any foreign person or entity, or
- Used by a tax-exempt organization (other than a section 521 farmers' cooperative) unless the property is used mainly in an unrelated trade or business taxed under section 511.
- See section 50(b) for details and other exceptions that may apply.

c. Hybrid Vehicle Tax Credit

The Federal Clean-Fuel Vehicle tax deduction can be claimed for personal and business hybrid electric vehicles that the IRS has certified as eligible (Model Year 2005 Ford Hybrid Escape, Toyota Prius, Honda Civic Hybrid, Honda Insight, and Honda Accord Hybrid). Owners of hybrids can claim a one-time deduction of $2,000 for before 2006. The incentive will be reduced to $500 in 2006 and phased out in 2007. Hybrid vehicles are not eligible for the electric vehicle tax credit.

d. Ethanol and Biodiesel Tax Credit

The American Jobs Creation Act of 2004 (Public Law 108-357) provides tax incentives for alcohol and biodiesel fuels, available to blenders/retailers beginning in January 2005. The credits are 51 cents per gallon of ethanol at 190 proof or greater, $1.00 per gallon of agri-biodiesel, and 50 cents per gallon of waste-grease biodiesel. If the fuel is used in a mixture, the credit amounts to 0.5 cents per percentage point ethanol or agri-biodiesel used or 1 cent per percentage point of waste-grease biodiesel. More information is available at www.irs.gov/publications/p378/ar01.html

e. E-85 Fuel and Infrastructure Tax Credit

Senators Obama, Talent, and Durbin have introduced the "E-85 Fuel Utilization and Infrastructure Development Incentives Act of 2005" to provide a tax credit of 50% for building an E-85 fuel station and a tax credit of 35 cents per gallon of E-85 fuel. This bill is pending approval by the Senate, and frequent updates can be found at www.e85fuel.com/legislation/s918_frontpage.htm.

2.2 State of California

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2.2.1 Summary (from the Electric Drive Transportation Association)

The following is an overall summary of low-speed vehicles from the web site of the Electric Drive Transportation Association, a national industry advocacy organization:

"California DMV registers LSVs for on-road use if the vehicle is going to be operated on public streets. LSVs must meet applicable federal safety standards and be certified by the California Air Resources Board as a zero emission vehicle. LSVs are registered as passenger vehicles and issued automobile plates. Owners of registered LSVs must comply with financial responsibility laws and a driver license is needed to operate the vehicle. LSVs are restricted from roadways where the speed limit is greater than 35 mph. Manufacturers are required to affix a decal to the vehicle indicating that the maximum speed is 25 mph and that it may be a hazard on the roadways if it impedes traffic. The dealers are also required to have the new owner sign a statement acknowledging they understand the information on the decal. The dealer retains the original statement and provides the new owner with a copy."

2.2.2 Low-Speed Vehicle Enabling Legislation

The California Vehicle Code section 21250-21266 (Division 11, Chapter 1, Article 5) regulates low-speed vehicles, including NEVs. Key provisions include the following:

- A "low-speed vehicle" is a motor vehicle, other than a motor truck, having four wheels on the ground and an unladen weight of 1,800 pounds or less, that is capable of propelling itself at a minimum speed of 20 miles per hour and a maximum speed of 25 miles per hour, on a paved level surface. A "low-speed vehicle" is not a golf cart, except when operated with respect to an adjacent golf course.
- Generally, a low-speed vehicle is subject to all the provisions applicable to a motor vehicle, and the driver of a low-speed vehicle is subject to all the provisions applicable to the driver of a motor vehicle.
- Low-speed vehicles are not allowed to operate on any roadway with a speed limit in excess of 35 miles per hour.
- Low-speed vehicles also face certain restrictions crossing roadways. A low-speed vehicle may cross a roadway with a speed limit in excess of 35 miles per hour if the crossing begins and ends on a roadway with a speed limit of 35 miles per hour or less, and occurs at an intersection of approximately 90 degrees.
- A low-speed vehicle cannot traverse an uncontrolled intersection with any state highway unless that intersection has been approved and authorized by the agency having primary traffic enforcement responsibilities for that crossing by a low-speed vehicle.
- Local authorities, by ordinance or resolution, may restrict or prohibit the use of low-speed vehicles.
- A law agency with primary traffic enforcement responsibilities or the Department of the California Highway Patrol may prohibit the operation of a low-speed vehicle on any roadway under that agency's or department's jurisdiction when the agency or the department deems the prohibition to be in the best interest of public safety. Any such prohibition shall become effective when appropriate signs giving notice thereof are erected upon the roadway.

2.2.3 Air Pollution Reduction

a. Overview

The California Air Resources Board (ARB) is a part of the California Environmental Protection Agency, an organization which reports directly to the Governor's Office. The mission of the ARB is to promote and

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protect public health, welfare and ecological resources through the effective and efficient reduction of air pollutants while recognizing and considering the effects on the economy of the state.

The California Clean Air Act (CCAA) mandates the ARB to achieve the maximum degree of emission reductions from all on- and off-road mobile sources in order to attain the state ambient air quality standards. The Mobil Sources Program (MSP) develops statewide programs and strategies to reduce the emission of smog-forming pollutants and toxics by mobile sources.

One of the Mobil Sources programs is Zero Emissions Vehicles (ZEV) program. In 1990, ARB adopted the ZEV Mandate to ensure the increasing production and sale of ZEVs into California's market. This new regulation required automakers to gradually increase the percentage of ZEVs in the batch of new cars introduced into California's marketplace each year. The initial mandate was at least 2% by 1998, 5% by 2001 and 10% by 2003. The regulation has been adjusted several times in the last few years but the overall goal has remained the same. Between 1998 and 2003 major automakers placed over 4,000 battery-powered ZEVs in California. In 2003, the ARB directed staff to restart ZEV percentage requirements in the 2005 model year, while allowing manufacturers to earn and bank credits for vehicles produced prior to the 2005 model year.

b. Electric Vehicles

An electric vehicle is a vehicle that is propelled by electric motors or linear motors. Battery Electric Vehicles (BEVs) are the most common of ZEV passenger automobiles as recognized by the ARB. The electrical energy used to power the motors is most commonly obtained from a variety of battery chemistries arranged into battery packs, from onboard hydrogen, fuel cells, and their support systems, and traditional internal combustion engines (ICE) generators or pusher trailers. Batteries used in electric vehicles include Lead-acid, Absorbed Glass Mat, Wet NiCD, Nickel metal hydride, Li-ion, Li-poly, and Zinc-air batteries. The latter Li and Zinc have demonstrated energy densities high enough to deliver range and recharge times comparable to conventional vehicles. Light personal mobility devices include electric wheelchairs, the Segway human transporter, electric scooters, electric assist bicycles, golf carts, and neighborhood electric vehicles. Electric mass transportation vehicles include maglev trains, metros, usually trams, some trains (i.e., for some locomotives and often multiple units), and electric trolleybuses. Working electric vehicles include heavy work equipment, fork lifts, and numerous other service and support vehicles.

c. California Vehicle Emissions

A vehicle's emissions are the result of the combined attributes of fuel type, controls on the engine's operations, and maintenance throughout the life of the vehicle. All new vehicles sold in California must be certified to one of six ARB emissions ratings; however, the criteria to meet these ratings vary depending upon the weight of the vehicle. For example, heavier vehicles like trucks and SUVs, have less stringent criteria than smaller vehicles to receive the same emissions rating. This will phase out by 2008, when SUV size vehicles must match the more stringent criteria currently required for smaller cars. A vehicle's emissions rating is posted on the Vehicle Emissions Control Information Label found under the hood. California's emissions ratings apply to all new vehicles sold in this state, and are the most stringent in the world.

- LEV (Low Emission Vehicle): The least stringent emission standard for all new cars sold in California beyond 2004.
- ULEV (Ultra Low Emission Vehicle): 50% cleaner than the average new 2003 model year vehicle.

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- SULEV (Super Ultra Low Emission Vehicle): 90% cleaner than the average new 2003 model year vehicle.
- PZEV (Partial Zero Emission Vehicle): Meets SULEV tailpipe standards, has a 15-year / 150,000 mile warranty, and zero evaporative emissions (fuel vapors that escape to the outside).
- AT PZEV (Advanced Technology PZEV): Meets PZEV standards and includes ZEV enabling technology.
- ZEV: Zero tailpipe emissions, and 98% cleaner than the average new 2003 model year vehicle.

d. Additional ZEV Information

A ZEV will produce no emissions or pollution from the vehicle when stationary or operating. Emissions of concern include particulates, hydrocarbons, carbon monoxide, and various oxides of nitrogen. (Although not considered an emission by the CARB definition, carbon dioxide is a greenhouse gas implicated in global warming scenarios.)

The only generally available technology considered zero emission is that used in battery electric vehicles. Such vehicles neither emit any of the above pollutants, nor CO2 gasses. Developmental technologies offering zero pollution include:

- Hydrogen utilizing fuel cell powered electric vehicles (Hydrogen cars)
- Compressed air vehicles, typically recharged by slow (home) or fast (road station) electric compressors
- Flywheel energy storage vehicles

"Zero emissions" does not mean that the complete power cycle is non-polluting, except in special cases, since in most cases the energy is provided from fossil fuel plants. This may still be an advantage for urban areas when compared to conventional vehicles. A true zero emission solution would generate electrical energy from only “green” sources such as solar electric or wind generated power. "Zero emissions" also does not include emissions associated with manufacturing such vehicles or components, nor “outgassing” from synthetic materials used in vehicle construction, nor soot-like dust from tire wear, nor potential pollution associated with end-of-life vehicle or vehicle component dismantling, recycling, and reuse.

2.2.4 Strategy to Reduce Petroleum Dependence in California

Assembly Bill 2076 (Chapter 936, Statutes of 2000) requires the California Energy Commission (CEC) and the ARB to develop and submit to the Legislature a strategy to reduce petroleum dependence in California. The statute requires the strategy to include goals for reducing the rate of growth in the demand for petroleum fuels. In addition, the strategy includes recommendations to increase transportation energy efficiency as well as the use of non-petroleum fuels and advanced transportation technologies including alternative fuel vehicles, hybrid vehicles, and high-fuel efficiency vehicles.

- Recommendation 1: The Governor and Legislature should adopt the recommended statewide goal of reducing demand for on-road gasoline and diesel to 15 percent below the 2003 demand level by 2020 and maintaining that level for the foreseeable future. Achieving the goal will reduce California’s dependence on imported oil and petroleum production, moderate price volatility, improve environmental quality, and demonstrate positive leadership in the effort to reduce greenhouse gas emissions.

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- Recommendation 2: The Governor and Legislature should work with the California delegation and other states to establish national fuel economy standards that double the fuel efficiency of new cars, light trucks, and SUVs.
- Recommendation 3: The Governor and Legislature should establish a goal to increase the use of non-petroleum fuels to 20 percent of on-road fuel consumption by 2020 and 30 percent by 2030. The value of this goal is to assure that regardless of how petroleum reduction is achieved, a minimum percentage of the fuel used in California will come from non-petroleum sources. This provides for fuel diversity and helps pave the way towards a sustainable transportation fuel supply.

This report describes a strategy that addresses the three major transportation energy issues facing California:

1. It provides an opportunity for California to demonstrate leadership in reducing greenhouse gases from the transportation sector.
2. It hedges against the risks of future oil and fuel supply disruptions.
3. It will dampen fuel demand and moderate price impacts on the California economy through cost-effective efficiency improvement and use of non-petroleum fuels.

The recommended goal described in this report is presented as a target and not a mandate. It is a performance based goal that can be used to guide decision makers in forming transportation-related policies for the state. A possible “best case” strategy was presented in order to show that the goal can be achieved using a combination of existing and emerging technologies in a cost-effective manner. By improving vehicle fuel efficiency and expanding use of non-petroleum fuels, the state can dramatically reduce the demand for petroleum without additional taxes or fees. Thus, taxes and fees pricing options are not recommended.

2.3 Government Information Resources

2.3.1 Federal Government

a. Advanced Vehicle Testing Program

http://avt.inel.gov/
Office of Transportation Technologies, U.S. Department of Energy. This Web site is run by the Idaho National Engineering and Environmental Laboratory (INEEL). It offers EV fact sheets, reports, performance summaries, historical data, and a "Kids' Page." Visitors can also request information online.

b. Alternative Fuels Data Center

http://www.eere.energy.gov/cleancities/
A comprehensive source of information on alternative fuels. Sections include: an interactive map of AFV refueling stations in the U.S.; listings and descriptions of different alternative fuels and AFV vehicles; online periodicals; and resources and documents on AFV programs. The site is part of the National Renewable Energy Laboratory's (NREL) Web site.

c. CALSTART/WestStart

www.calstart.org

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A California-based nonprofit organization dedicated to "transforming transportation for a better world." Visitors can read daily and archived industry news updates and publications, search EV-related databases, and interact with other EV owners in an online forum.

d. International Partnership for The Hydrogen Economy

www.usea.org/iphe.htm
To serve as a mechanism to organize and implement effective, efficient, and focused international research, development, demonstration and commercial utilization activities related to hydrogen and fuel cell technologies. It also provides a forum for advancing policies, and common codes and standards that can accelerate the cost-effective transition to a global hydrogen economy to enhance energy security and environmental protection.

e. Office of Transportation Technologies EPACT & Fleet Regulations

http://www.eere.energy.gov/vehiclesandfuels/epact/
Many public and private fleets are subject to AFV acquisition requirements under the Energy Policy Act (EPAct) regulations. These requirements differ for different types of fleets. Visit this site to obtain information on fleet requirements and the manners in which you can comply with the EPAct regulations.

f. National Renewable Energy Laboratory

www.nrel.gov
The National Renewable Energy Laboratory (NREL) has created a Web site detailing research efforts in renewable energies and alternative transportation technologies. Some key areas include hybrid vehicle development; renewable energy research; and battery technology research.

g. Thomas

www.congress.gov
Acting under the directive of the leadership of the 104th Congress to make federal legislative information freely available to the Internet public, a Library of Congress team brought the THOMAS World Wide Web system online in January 1995. The THOMAS system allows the general public to search for legislation and information regarding the current and past business of the U.S. Congress.

h. US Department of Transportation Advanced Vehicle Technologies Program

http://scitech.dot.gov/partners/nextsur/avp/avp.html
The homepage includes links to the seven regional members of the Advanced Vehicle Program (AVP):

2.3.2 State and Community Related EV Sites

a. California Air Resource Board (CARB)

www.arb.ca.gov
This site provides access to information on a variety of topics about California air quality and emissions. The site has general information on all types of alternative fueled vehicle programs and demonstrations. The CARB's mission is to promote and protect public health, welfare and ecological resources through the effective and efficient reduction of air pollutants while recognizing and considering the effects on the economy of the state.

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b. California Energy Commission

www.energy.ca.gov
This site gives viewers access to information on a variety of topics about California's energy system. The site dedicates a page to electric vehicles, where it has general information on electric transportation, lists sellers of EDs in California, outlines state and federal government incentives for AFVs, and includes a database of contacts in the electric transportation industry.

c. Driveclearn

Driveclean.ca.gov
California Air Resources Board's Guide to zero and near zero emission vehicles.

d. Mobile Source Air Pollution Reduction Review Committee (MSRC)

www.msrc-cleanair.org
The MSRC was formed in 1990 by the California legislature. The MSRC Web site offers information on a variety of topics regarding California air quality and programs underway to improve it, including a number of EV-related programs and incentives.

2.3.3 General Information Sites

Many web sites disseminate information on EVs or report industry news and developments. A few of these, with "house" specific EV-related information, are provided below.

a. Advanced Transportation Technology Institute

www.atti-info.org
The Advanced Transportation Technology Institute (ATTI), a nonprofit organization, promotes the design, production and use of battery-powered electric and hybrid-electric vehicles. The organization supports individuals and organizations interested in learning more about electric and hybrid-electric vehicles, particularly electric buses.

b. California Fuel Cell Partnership

www.cafcp.org
Introduced in April 1999 and comprised of the world's largest automakers, energy providers, fuel cell manufacturers, and government agencies, the California Fuel Cell Partnership (CaFCP) evaluates fuel cell vehicles in real-world driving conditions, explores ways to bring fuel cell vehicles to market, and educates the public on the benefits of the technology. The CaFCP primary goals aim to demonstrate vehicle technology by operating and testing the vehicles under real-world conditions in California; demonstrate the viability of alternative fuel infrastructure technology, including hydrogen and methanol stations; explore the path to commercialization, from identifying potential problems to developing solutions; and increase public awareness and enhance opinion about fuel cell electric vehicles, preparing the market for commercialization.

c. Fuel Cells 2003

www.fuelcells.org
The online Fuel Cell Information Center.

d. Hydrogen Now

www.hydrogennow.org

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The mission of Hydrogen Now! is to educate and motivate the public to seek and use hydrogen and renewable energy technologies for greater energy independence and improved air quality.

e. National Hydrogen Association

www.hydrogenus.org
The National Hydrogen Association is a membership organization founded by a group of ten industry, university, research, and small business members in 1989. Today the NHA's membership has grown to nearly 70 members, including representatives from the automobile industry; aerospace; federal, state, and local government; energy providers; and many other industry stakeholders. The NHA serves as a catalyst for information exchange and cooperative projects and provides the setting for mutual support among industry, government, and research/academic organizations.

f. ZEV Information

www.zevinfo.com
Designed by the California ZEV Education and Outreach Group, which was established under the California Air Resources Board's (CARB) ZEV Program. The basis of the Website is to serve as a "one-stop-shop" for information on electric drive products in California. Moreover, and websites' goal is to inform the public of the benefits and availability of advanced electric drive technologies, from early deployment and on into the future.

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3.0 Electric Vehicle Technology Basics

3.1 Electric Vehicle Technology

In an electric vehicle, many of the components normally found in an internal combustion engine vehicle are not needed such as the gasoline engine, catalytic converter, fuel lines, exhaust pipes, coolant hoses, intake manifold, spark plugs, and many other features.

The electric motor (or motors) that turns the wheels are powered by a large bank of batteries inside the car which need to be recharged frequently--usually on a daily basis. Generally speaking, there are four components that make an electric vehicle unique:

3.1.1 Electric Motor

Electric cars can use AC or DC motors. Because the top speed of a NEV is 25 miles per hour and it is not intended for lengthy trips (range over 30 miles), its motor is limited in terms of power output, or voltage. Therefore, most NEVs utilize a Direct Current (DC) motor (compared to an Alternating Current or AC motor).

3.1.2 Controller

The controller is the brains of the electric vehicle. It regulates the flow of electricity from the battery pack to the electric motor, and monitors everything from the speed of the vehicle, the regenerative braking process, and the charge in the batteries. The controller takes the signal received from the accelerator pedal and instructs the batteries on how much energy to deliver to the motor: zero power when the car is stopped; full power when the driver floors the accelerator pedal; and every power level in between. The controller regulates the flow of the electricity to keep the ride smooth and comfortable.

3.1.2 Rechargeable Batteries

The batteries are the key component in an electric vehicle. In the GEM, for example, the motor is powered by a battery pack comprised of six deep cycle 12-volt batters that delivers 72-volts, corresponding with the voltage requirements of the electric motor.

As mentioned above there are a range of battery types that can be used in an electric vehicle including Lead-acid, Absorbed Glass Mat, Wet NiCD, Nickel metal hydride, Li-ion, Li-poly, and Zinc-air batteries. The latter Li and Zinc have demonstrated energy densities high enough to deliver range and recharge times comparable to conventional vehicles. Because of their limited capacity they need to be recharged after use by plugging them into a conventional 110 volt receptacle found in just about any home across the country. An alternative method for recharging is a regenerative system in which the free motion of the wheels or the energy created by applying the brakes to the wheels is converted to recharge the battery.

3.1.4 Charging System

The charging system recharges the batteries. The charging system has two goals:

- To pump electricity into the batteries as quickly as the batteries will allow.
- To monitor the batteries and avoid damaging them during the charging process.

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Most charging systems monitor battery voltage, current flow, and battery temperature to minimize charging time. The charger sends as much current as it can without raising battery temperature too much. The normal household charging system has the advantage of convenience -- anywhere you can find an outlet, you can recharge. The disadvantage is charging time. A normal household outlet typically limits the amount of electricity flow (e.g., 15-amp circuit breaker). Most NEV's take between eight and ten hours to fully recharge.

3.1.5 Battery Alternative on the Horizon: Fuel Cells

The electric vehicle industry is working to improve battery quality, range, and regeneration. A parallel effort that is underway is to replace batteries altogether by using a different technology: fuel cells. Fuel cells are an electrochemical device similar to a battery, but the fuel cell is designed to continuously replenish the reactants consumed. The fuel cell produces electricity from an external fuel supply as opposed to the limited internal energy storage capacity of a battery. Typical reactants used in a fuel cell are hydrogen and oxygen (a hydrogen cell). In contrast, conventional batteries consume solid reactants and, once these reactants are depleted, must be discarded, recharged with electricity by running the chemical reaction backwards, or, at least in theory, by having their electrodes replaced. Typically in fuel cells, reactants flow in (hydrogen, for example) and reaction products flow out (electricity), and continuous long-term operation is feasible virtually as long as these flows are maintained. The use of hyrdogen fuel cells is therefore attractive because it is naturally plentiful element.

3.2 Continuum of Electric Vehicle Types

The following table provides a description of electric vehicle types:

Table 1 - Continuum of Vehicle Technology

Vehicle Type	Description

Human transporter (HT)
 
	• The Segway HT intuitively balances the way humans do—moving forward and backward, responding to changes in your body's position.
	• There is no accelerator and no brakes. Lean forward and you move forward. Straighten up and you stop. Lean back, and you move back.
	• To turn, rotate the steering grip under your wrist in either direction.
	• Utilizes dynamic stabilization to enable self-balancing.
	  • Works like a human's sense of balance with solid-state gyroscopes, tilt sensors, high-speed microprocessors, and powerful electric motors.
	  • Instantaneously assess the riders balance and makes minute adjustments one hundred times a second.
	  • Balances whether you're traveling at 10 mph, carrying a heavy load, slowly maneuvering in tight spaces, or standing perfectly still.
	• Four models segmented for personal and business use
	• Maximum speeds between 10 and 12.5 mph
	• Up to 24 mile range

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Vehicle Type	Description
Scooters (electric) 	• Two wheel standup configuration. • Speeds between 10 and 15+ mph. • Electric motor and rechargeable battery located under the floor board. • Speed control switch and bicycle-type hand brakes mounted on the handlebar • Range varies up to about 20 miles. • Salient features of the California motor vehicle code section 407.5: • “A "motorized scooter" is any two-wheeled device that has handlebars, has a floorboard that is designed to be stood upon when riding, and is powered by an electric motor. This device may also have a driver seat that does not interfere with the ability of the rider to stand and ride and may also be designed to be powered by human propulsion. For purposes of this section, a motorcycle, as defined in Section 400, a motor-driven cycle, as defined in Section 405, or a motorized bicycle or moped, as defined in Section 406, is not a motorized scooter.”

Bicycles (electric)
 
	• Battery powered electric motor assists pedaling.
	• Two power system types:
	  • Power on demand activated by a handlebar switch.
	  • “Ped-elec” assists the user pedal with adjustable power output.
	• Standard bicycle hand brakes and gearing.
	• Two basic designs:
	  • Adaptive: starts with a bicycle and adds a drive system.
	  • Purpose-built: designed with a motor from the ground up.
	• Benefits: easy acceleration, hill climbing, and cutting through headwinds.
	• Rechargeable batteries provide power for the electric drive motor.
	• 12 to 20 mph.
	• 8-20 mile range.
	• Salient features of the California motor vehicle code section 406:
	  • “A "motorized bicycle" or "moped" is any two-wheeled or three-wheeled device having fully operative pedals for propulsion by human power, or having no pedals if powered solely by electrical energy, and an automatic transmission and a motor which produces less than 2 gross brake horsepower and is capable of propelling the device at a maximum speed of not more than 30 miles per hour on level ground. A "motorized bicycle" is also a device that has fully operative pedals for propulsion by human power and has an electric motor that meets all of the following requirements:
	  • (1) Has a power output of not more than 1,000 watts.
	  • (2) Is incapable of propelling the device at a speed of more than 20 miles per hour on ground level.
	  • (3) Is incapable of further increasing the speed of the device when human power is used to propel the motorized bicycle faster than 20 miles per hour.”

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Vehicle Type	Description

Recumbent Bicycles (tricycle or quadricycle)
 
	• Recumbent cycles enable one to ride in a natural sitting position without twisting one's spine, straining one's neck, or putting undue pressure on wrists or crotch.
	• Adult three-wheelers don't require balancing like bicycles.
	• Although stable when stopped or when ridden straight ahead, tricycles may tip when turning at "high" speeds.
	  • To avoid tipping, electric trike speeds are usually limited to about half of e-bike speeds.
	  • Added stability is available with certain model design, and recumbent quads with two wheels in front may also be used.
	• Enhanced safety (in a collision, one's feet being in front prevents the head-first fall over the handle bars).
	• Long frame allows for additional batteries to increase riding range.
	• 10 to 30 mph.
	• 15 to 25 mile range.
	• Salient features of the California motor vehicle code section 407:
	  • "A "motorized quadricycle" is a four-wheeled device, and a "motorized tricycle" is a three-wheeled device, designed to carry not more than two persons, including the driver, and having either an electric motor or a motor with an automatic transmission developing less than two gross brake horsepower and capable of propelling the device at a maximum speed of not more than 30 miles per hour on level ground. The device shall be utilized only by a person who by reason of physical disability is otherwise unable to move about as a pedestrian or by a senior citizen as defined in Section 13000."

Motorscooter 	• A type of motorcycle with a step-through frame in which the rider sits without straddling any part of the engine. • Most utilize continuously variable transmissions. • Wheels smaller in diameter than regular motorcycles. • Engine usually located near the rear wheel or axle and is typically smaller than engines on other motorcycles. • More storage space than a motorcycle. • Legal distinctions vary by state but usually refer to motorcycles with an engine displacement of 50 cc (cubic centimeters) or less as being in the moped class. • The word *moped* is a Swedish short form of the word *motorvelociped*. *Velociped* is an older Swedish word for bicycle, imported from the French word *vélocipède* formed from the Latin *velocispedis* meaning "fast foot". However, it is also likely that the term is merely an abbreviated combination of the two key elements of a moped - a MOtor and PEDals. • Maximum speed of 25 mph. • Range of 25 to 30 miles some models up to 50 miles. • Standard equipment includes maintenance-free batteries, built-in charger, economy and performance modes, helmet storage, and luggage rack. • Other equipment may include variable grip throttle, suspension, front and rear brakes, head lamps and brake lights, turn signals, horn, full instrumentation, padded seat, and rear cargo rack.
NEVs	• Speed limited battery electric vehicle designed to conform to Federal Motor Vehicle Safety Standard No. 500 (49 CFR 571.500).

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Vehicle Type	Description
	• Maximum speed of 25 miles per hour. • Operationally restricted to roads with speed limits not exceeding 35 mph • Incorporates other safety features such as three point seat belts, windshields and windshield wipers, running lights, headlights, brake lights, reflectors, rear view mirrors, and turn signals, among others. • Doors may be optional. • Crash protection from other standard vehicles is almost non-existent. • Charges with household 110-volt outlet. A single charge will provide a 30 mile range depending upon temperature, terrain, and driving style. • NEVs either purpose built or modified golf carts. • NEVs frequently used in master planned communities, golf-oriented communities, senior citizen communities, destination resorts, industrial complexes, and universities, among others. • NEVs also used in traditional neighborhoods in which traffic can be accommodated under conditions to meet the requirements of low speed vehicles. • NEVs range in price from about $6,500 to $12,000. Most NEVs are in the $6,500 to $9,000 range.
Pedicabs or cycle rickshaw   	• A vehicle for hire usually with one or two seats for carrying passengers in addition to the driver. • Powered by the driver pedalling as one would a bicycle, though some rare configurations also have an electric assist motor. • Usually a tricycle, quadricycles, or bicycles with trailer • Used througout Asia, particularly Cambodia, Vietnam, India, Bangladesh, Singapore, and Indonesia. • While criticized for causing congestion, cycle rickshaws are also environmentally-friendly and inexpensive mode • Also provides essential employment for poor men and recent immigrants from rural areas. • Use in European and North American cities usually limited to tourist attractions. • American and European manufacturers often incorporate advanced features such as hydraulic disc brakes and lightweight fibreglass bodies. • An American missionary to Japan named Jonathan Scobie invented rickshaws around 1869 to transport his invalid wife through the streets of Yokohama. The word "rickshaw" comes from the Japanese *jinrikisha* which literally means "human-powered vehicle".
Golf carts	• Small vehicle designed originally to carry two golfers and their golf clubs around a golf course faster and with less effort than walking. • Golf carts now come in a wide range of formats and are more generally used to convey small numbers of passengers short distances at relatively slow speeds. • While some golf carts come with small gas engines the majority are electrically powered; they are the first mass-produced electric vehicles for private consumer use. • Under federal rules (see above), golf carts have evolved as purpose-built vehicles for general transportation as NEVs.

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Vehicle Type	Description
	• Attractive in communities that value lack of emissions, lack of noise, and slow speeds • Salient features of the California motor vehicle code section 345: • A "golf cart" is a motor vehicle having not less than three wheels in contact with the ground, having an unladen weight less than 1,300 pounds, which is designed to be and is operated at not more than 15 miles per hour and designed to carry golf equipment and not more than two persons, including the driver.
Auto rickshaw 	• Vehicle for hire that is one of the chief modes of transport in India, Pakistan, Nepal, Bangladesh, Thailand, Vitenam, Indonesia, Philippines, and Sri Lanka. • A motorized version of the traditional rickshaw, a small two- or three-wheeled cart pulled by a person. • Usually a tin, sheet metal, or iron body resting on three small wheels (one in front, two on the rear), a small cabin for the driver in the front and seating for three in the rear. • Generally fitted with a motorcycle version of a two-stroke engine with a handlebar for control instead of a steering wheel, effectively making them a three-wheeler motorcycle carrying passengers on the rear seat. • Can be quite powerful and go faster than taxis, particularly in heavy traffic.

3.3 Operating Cost

Operating a NEV is generally compared to the cost of operating a conventional ICE car; and the cost of electricity per kilowatt-hour usually compares favorably to that of gasoline, but varies depending upon the location.

A reliable national source for fuel comparison prices is the *Alternative Fuel Price Report (AFPR)* (http://eeredev.nrel.gov/afdc/resources/pricereport/price_report.html), sponsored by the Clean Cities program of the Energy Efficiency and Renewable Energy division of the U.S. Department of Energy. The AFPR is published quarterly. The AFPR only calculates the fuel cost per year for a conventionally sized automobile but not for a NEV. Nevertheless, looking at the price comparison for a conventionally sized automobile will at least demonstrate the order of magnitude cost savings of an electric vehicle versus a traditional gasoline powered vehicle.

Fuel costs per year were calculated based upon EPA-published fuel economy ratings for a Ford Ranger at 24 miles per gallon and for an electric version of the Ranger at 0.4 kilowatt-ours per mile. Each vehicle was assumed to drive 12,000 miles per year. Electric vehicle fuel costs were calculated from a range of prices from $0.5 per kilowatt-hour to $0.15 per kilowatt-hour, as set forth in Table 2, Annual Electric Vehicle Fuel Cost Comparison. At the national average gasoline price of $2.109 per gallon for the week of March 21, 2005, the fuel cost of an electric Ranger is less than that of its conventional counterpart for electricity price up to $0.22 per kilowatt-hour. As depicted in Table 2, the conventional Ranger gasoline cost is $1,050 while the electric version averages at cost of $490 at $0.10 per kilowatt-hour. As depicted in Figure 3-1, if gasoline costs $1.00 per gallon, the electric vehicle will not have a lower fuel cost than its conventional counterpart unless the electricity price is under $0.11 per kilowatt-hour.

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Table 2 - Annual Electric Vehicle Fuel Cost Comparison

	Electric Vehicle (5¢/kWh)	Electric Vehicle (7.5¢/kWh)	Electric Vehicle (10¢/kWh)	Electric Vehicle (12.5¢/kWh)	Electric Vehicle (15¢/kWh)	Gasoline Vehicle
Ford Ranger	$240	$360	$490	$610	$730	$1,050
Toyota Rav4	$180	$270	$360	$450	$540	$970

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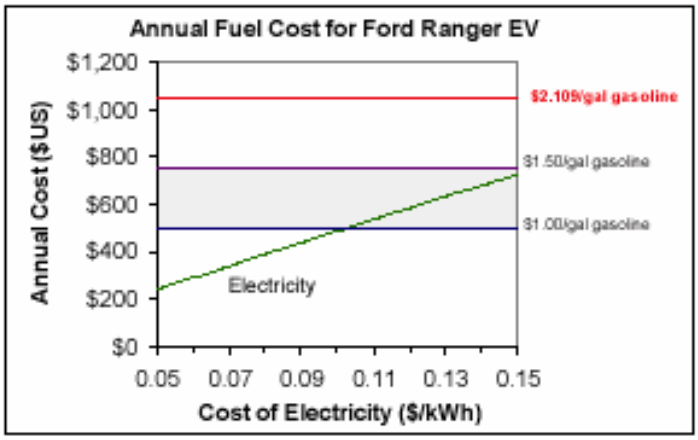
Table 3 -Comparison of Electric and Gasoline Fuel Cost for a Ford Ranger



GEM also provides a calculator at http://www.gemcar.com/asp/cost_calc.asp. Using the GEM calculator, the following example shows that the comparable annual fuel cost for a NEV is $168.00 versus $937.78 for a compact car, a savings of $769.78. Using the GEM calculator, the NEV is priced at $0.10 per kilowatt-hour and compared to a compact car at 27 miles per gallon at $2.11 per gallon of gasoline (national average price the week of March 21, 2005). Both cars are assumed to travel 12,000 miles per year. According to the GEM calculator, the cost for operating the NEV is $168.00 annually compared to $937.78 for the compact car, representing a savings of $769.68. The annual operating cost of the NEV is $0.014 cents per mile, compared to $0.078 cents per mile for the compact, a savings of over 550 percent. (Calculations and energy usage may vary slightly by GEM model and use of the vehicle. These calculations are taken on average energy usage on a base model GEM in a study conducted by the United States Department of Energy.)

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4.0 Benefits

The extent to which the benefits from a NEV are tangible to the consumer will be the measure of their market adoption and of the societal benefits they offer. The following are four classes of benefits offered by NEVs:

4.1 Air pollution

Reduced air pollution is a tangible benefit from the use of NVs and NEVs. As stated above, ICE vehicles contribute between one-third and one-half of the carbon monoxide and hydrocarbon emissions in the United States. 60 percent to 80 percent of the toxic air emissions from automobiles occur during the "cold-start" period, which is the first minute or two of engine use before the catalytic converter warms up (operating temperature is about 300 degrees centigrade). Replacement of the ICE to reduce air pollution is the idea behind alternative fuel vehicles such as ZEVs, LEVs, ULEVs, SULEVs, PZEVs, and AT PZEVs.

4.2 Energy

NVs and NEVs, due to their lighter weight and lower speeds, burn less energy per trip than traditional cars. Energy savings from the use of NEVs and other alternative fuel vehicles is significant, when compared with ICE technologies. Some critics complain however that the vehicle energy reductions do not account for pollution at coal burning or nuclear power plants that generate the electricity. While a fair criticism, it should be pointed out that not all electricity generation is from "dirty" sources. "Green" electricity, both at power plants and home-generated from photovoltaic cells can power NEVs with little spill-over energy waste.

4.3 Congestion

Due to the smaller size of NVs and NEVs, these vehicles can help reduce the need for roadway space and parking spaces, thereby decreasing congestion.

4.4 Economics

NEVs can reduce both the capital outlay for a personal mobility solution and the operating expenses on a per mile basis. The capital cost for purchasing a NEV is between about $6,000 to $9,000 compared to a subcompact between $12,000 to $14,000. As depicted in section 3.3 Operating Cost, the side by side comparison for a gas powered car is about 550 times more expensive than operating a comparable NEV (the gas powered vehicle costs about $0.078 cents per mile versus about $0.014 cents per mile for the NEV).

4.1 Fit with Smart Growth

NVs and NEVs are a good fit with smart growth principles which emphasize the provision of transportation choices, small scale walkable neighborhoods, and local balance between jobs and housing. Most NEV solutions are in master planned communities that strive to implement Smart Growth principles such as Celebration, Florida, Otay Mesa, California, and Playa Vista, California. Master planned communities have a better chance at controlling street and vehicle speeds which is necessary for making commercial districts accessible using a NEV.

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5.0 Demand Side

5.1 Consumer Types

The consumer market is segmented into three primary consumer types who drive demand. The following briefly describes their interest in NVs and NEVs:

5.1.1 Individuals and households

Individuals and households are most likely to obtain NVs and NEVs for use in local neighborhoods including shopping, taking kids to and from school, accessing local jobs, visiting friends and relatives, and accessing regional transit, among others.

- Apartment complexes
- Condo complexes
- Master planned communities
- Mobile home parks

5.1.2 Companies and corporations

Companies and corporations are most likely to obtain NVs and NEVs for local fleet use to replace or supplement conventional automobiles. Applications are numerous, and are organized into the following categories:

- Industrial
  - Airports
  - Boatyards
  - Business parks
  - Construction sites
  - Dairies
  - Distribution centers
  - Electric and gas meter checking
  - Factories
  - Farms
  - Hospitals
  - Industrial complexes
  - Lumberyards & mills
  - Movie studios
  - Prisons
  - Ranches
  - Refineries
  - Warehouses
- Commercial
  - Auto dealerships
  - Commercial districts
  - Convention centers and exhibition centers
  - Nurseries and orchards
  - Shopping centers and malls
  - Harbors

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- Entertainment and Sports
  - Amusement parks
  - Arenas
  - Athletic complexes
  - Beaches
  - Botanical gardens
  - Campgrounds
  - Docks and marinas
  - Fairgrounds
  - Golf courses
  - Hotels
  - Olympic complexes
  - Parades
  - Parks and national parks
  - Race tracks
  - Resorts
  - Sports complexes
  - Stables
  - Stadiums
  - Zoos
- Campuses
  - Cemeteries
  - Colleges and universities
  - Schools

5.1.3 Government

Government agencies are most likely to obtain NVs and NEVs for fleet use to replace conventional automobiles. Uses may include the following:

- Land management (national parks)
- Police
- Military
- Traffic control

5.2 Exchange Models

There are three ways in which NV's and NEVs can be obtained by consumers:

- **Purchase:** individuals/households, companies/corporations, and government agencies purchase NVs and NEVs. The purchase model is widely used by all market segments. A current trend in some consumer oriented settings such as master planned residential communities (the town of Bay Harbor, Michigan and the Saguaro Ranch residential development, Tucson, Arizona) is for the project's developer to purchase NEVs and include them in as a feature in the development, bundling their cost into the price of the home.

- **Leasing:** leasing is a model that has not been adopted in the NV/NEV industry but could be useful to overcome consumer resistance (e.g., either perceiving NVs and NEVs as an added capital cost or unsure of their usefulness and safety). Providing favorable short term leasing (six months to one year) with purchase options could offer consumers a reasonable trial period to test the vehicles and to ease into a payment schedule upon purchase.

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- **Rental:** rental is a model used by resort property owners and in a city's downtown (San Luis Obispo; see case study below). In this model NVs and NEVs can be made available to consumers across a range of environments (resorts and entertainment locales such as beaches, national parks, etc.; and urban environments such as downtowns, master planned communities, and neighborhood districts), for use on an as needed or short term basis. Several conditions must be in place for this to make financial sense from an operator's point of view such as sufficiently large market size to provide potential demand, marketing campaign to establish credibility and market awareness in a local area, and road safety signage in place, among others.

5.3 Why Consumers Purchase/Use NVs

There are a number of reasons why consumers (individuals/households, companies, and government) purchase NVs or NEVs:

- **Appropriate technology:** NEVs apply an appropriate level of technology to solve the problem of local trips.
- **Environmental benefits:** zero emissions including eliminating the cold start emission contributes to a clean environment.
- **Convenient:** NEVs are easy to drive and maneuver, have sufficient storage space to accommodate local trips (e.g., grocery bags, dry cleaning), and carry a second passenger.
- **Low maintenance:** NEV's require less service than ICE vehicles. NEV's don't require tuneups, oil changes, timing belts, water pumps, radiators, fuel injectors, or tailpipes. However, they require battery maintenance. Electric batteries have a limited number of charging cycles (the number of times a battery can be charged and discharged) and will typically need to be replaced within 3-6 years. Different types of batteries (such as lead-acid, nickel-metal hydride, and lithium-ion) are available depending on the manufacturer and the vehicle.
- **Congestion reducing effects:** NEVs don't take up much road space and they are easier to maneuver in congested urban locales.
- **Quiet:** due to the electric motor technology, NEVs run quietly.
- Affordable: compared to the purchase price of a second or third car, NEVs are affordable (notwithstanding a counter argument provided below).
- **Ample power:** NEVs provide the driver with ample power from a high-torque electric motor.
- **Easy on-board charging system:** NEVs utilize a 110-volt household current for recharging; most can be completely recharged in about eight hours.
- **Range:** most NEVs can easily travel 30 miles on a single charge, which is easily sufficient for local trips.
- **Eligible for federal tax credit:** see above.
- **Manufacturer supported:** depending upon the company from whom the NEV is purchased, manufacturer support for service and warranty rivals conventional automobiles.

5.4 Perceived Problems with NEVs

The following are perceived problems with NVs that inhibit their adoption:

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5.4.1 Safety

Because NEVs are smaller, usually don't have doors, and are significantly differently from conventional cars, people may not consider them to be safe, especially if it in an accident. NEVs are required by federal regulation to be driven on slower streets (35 miles per hour and under) and are required to have the following key safety features: head lights, tail lights, directional signals, parking brake, side view mirror, rear view mirror, horn, driver and passenger, seat belts, high-mounted brake, light, windshield, and windshield wiper. In addition to these mandated features, many NEV manufacturers are providing doors, which add to a sense of enclosure and an enhanced perception of safety.

The perceptions of a lack of safety must be overcome if NEVs are to gain full credibility and a fully competitive place in the market. Possible solutions are to deliver a clear marketing message about safety, provide empirical studies demonstrating safety in specific use settings, and provide education for other drivers. Education can be provided in the environment in which NEVs have been introduced, especially traditional neighborhoods and communities. Education may include multi-media and direct mail marketing campaigns and the addition of safety signage, among others.

5.4.2 Added Capital Cost

NEVs are more likely to be perceived as an added capital cost by individual and household consumers rather than government, corporate, or other organization buyers. Because NEVs are designed for local, short-haul trips, they are not designed to replace the automobile used for commuting or driving longer distances, or for driving on streets which have speed limits in excess of 35 miles per hour. The perception of the NEV as an additional capital cost is likely to be true, especially when the NEV competes to displace the purchase of a second or third car in a home that needs two or three cars for long distance driving. In today's market, the NEV will most likely be purchased after the second or third car, if at all. The additional capital cost is likely to make the NEV seem like a luxury item, and the payment on a $6,000 to $9,000 NEV loan would be a significant challenge to most households already paying for two or three cars.

Nevertheless, three arguments can be made for purchasing a NEV: 1) a NEV has a significantly lower operating cost than a conventional car for local, short-haul trips; 2) that the capital cost for the NEV will in turn reduce use in the conventional car thereby prolonging its useful life; and 3) tax incentives or other financial assistance may reduce the capital expense.

The first two points above have the weakness of not decreasing the monthly loan payment for a NEV; the cost is still an out of pocket expense. The third point has the problem that tax incentives are limited and are not offered as tax credits so have a reduced benefit.

5.4.3 NEV Stereotypes

Stereotypes about NEVs abound; frequent ones are set forth in the following table. Arguments to confront and overcome these and similar misperceptions can be developed and applied. A key is to strike first in marketing a message that confronts the stereotype with both facts and wit that turns the stereotype into an embarrassment for those thinking it.

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Table 4 - NEV Stereotypes

Stereotype	Factual Arguments Against Stereotypes
It's not a real car.	It is legally defined as a low speed vehicle and is regulated by federal and state law with safety features to operate with cars on public streets.
It's not really an electric car.	It is electrically powered and saves a bundle of money over the internal combustion engine.
It's a glorified golf cart.	Its origins do derive from golf carts but recent designs and engineering have moved it past being a golf cart into its own category.
No one really uses them.	Over 10,000 are operational nationwide; California is the largest market.
It's a toy, not a mobility tool.	Driving at 25 miles per hour on city streets is not for a toy. Testimonials can demonstrate mobility benefits.
It's more fun than functional.	There is no denying that it is fun to undertake functional trips in a NEV.
They're good for gated communities and golf courses, but not for where real people live.	Demonstrations can depict operational use in real neighborhoods.

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6.0 Supply Side

6.1 Manufacturers

The following table is a partial list of the NEV manufacturers. Because most NEV manufacturers also make golf cars, those companies that make both products are included in this table. Table X: Golf Car Manufacturers displays companies that make only golf cars which could be converted to NEVs; and Table 6-1: Utility Vehicles displays companies making utility vehicles that may be converted to NEVs.

Table 5 - NEV Manufacturers

Name	Company Information	Product Offering(s)
Bombardier http://www.brp.com/en-CA/	Bombardier is a Canadian corporation engaged in design, development, manufacturing and marketing activities in the fields of transportation equipment, civil and military aerospace, motorized consumer products and services related to its core competencies. The Montreal-based corporation operates plants worldwide employing 40,000 people. Bombardier's business volume totals C$7.1 billion, and more than 85 percent of the Corporation's revenues are made in markets outside Canada.	No product information is available on their website.
Barton Investment Group www.bigmanev.com	No corporate information was available online at the time of publication. Targeted for use at airports, theme parks, zoos/aquariums, rental operations, recreational resorts, colleges/universities, military installations.	• BIG Man offers two lines of LSV vehicles: • Passenger vehicle: five passenger vehicle.  • Utility vehicle: three passenger vehicle with utility bed.

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Name	Company Information	Product Offering(s)
		 • 75 mile range. • 10 hour charging time. • Features include key controlled fully automatic transmission, illuminated instrument panel, rack and pinion automotive steering, and all-wheel braking system, among others.
California Roadster http://www.californiaroadster.com/index.html	American Custom Golf Cars has been involved in the design and construction of Custom Cars including movie cars, one-off custom cars, and high quality automotive accessories since 1976. The California Roadster is the newest luxury production golf car/NEV to hit the fairways and roadways. Vehicle range is 70 miles.	Models include: • Four passenger car  • Six passenger limo 
Cart-Rite http://www.car	No corporate information was available online at the time of publication.	Three models available: • Transporter: Two Passenger "golf-ready" with 20 mph top speed and 36 mile range.

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Name	Company Information	Product Offering(s)
t-rite.com/home.html		 • Peoplemover 1: Four passenger seats features an advanced steering and suspension system, AM/FM stereo, street package, seatbelts available, top speed 20 mph, and 50 mile range.  • Peoplemover 2: Six passenger seats features an advanced steering and suspension system, AM/FM stereo, street package, seatbelts available, top speed 20 mph, and 50 mile range. 

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Name	Company Information	Product Offering(s)

Columbia Par Car
 	
http://www.parcar.com/
	Columbia ParCar Corp. is a Wisconsin based manufacturer of gasoline and electric powered golf cars, utility, industrial, commercial and passenger vehicles that are distributed through an international network of independent dealers.
	
	Columbia ParCar Corporation, the successor to Harley-Davidson Golf Car Company, began August 17, 1984. Today, Columbia produces the broadest line of electric and gas-powered golf, industrial, and low speed vehicles on the market.
	
	Columbia ParCar is a member of the Nordic Group of Companies, a family-owned management and manufacturing business headquartered in Baraboo, Wisconsin with manufacturing operations extending throughout the United States, Mexico, and Europe.
		Columbia offers two lines of vehicles:
		• Eagle
		  • Golf car configured for use as an NEV.
		  • Available in configurations for two or four passengers.
		 
		• Summit
		  • Available in configurations for two or four passengers.
		  • Builds on Eagle line with advanced technology features:
		  • Pedal proportional braking
		  • Programmable controller
		  • Regenerative braking
		  • Advanced opportunity charging
		  • Premiere battery manufacturer
		  • An integral tubular steel frame and solid roof
		  • Standard adjustable seats
		 

Dynasty Electric Car Corporation http://www.itiselectric.com/	Dynasty designs, manufactures, and markets zero emission, electric low speed vehicles (LSV's) for urban, recreational, and light commercial markets such as planned and gated communities, destination resorts, industrial complexes, and universities. Dynasty Motorcars, based in British Columbia, Canada, launched their Innovative Transportation (IT) line of NEV amid much fanfare. They built a small number of these	• Innovative styling and advanced engineering design. • Optional packages include an enclosed driver compartment. • Models include: • Van: two passenger, five door cargo van

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Name	Company Information	Product Offering(s)
	vehicles and started to put together a dealer network, but unfortunately ran out of cash and were forced to shutdown operations. They were subsequently bought out by Commercial Body Builders, a Vancouver based company who has restarted production. After a successful electric vehicle conference in December 2002, the company has returned to production and distribution of its IT line.	 • Sport: four passenger, five door  • Utility: two door, two passenger with open cargo bay  • Tropic: four passenger, no doors  • Coming soon: convertible: our passenger, four door 

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Name	Company Information	Product Offering(s)
		• 30 mile range.
Feel Good Cars http://www.feelgoodcars.com/	As a leading developer, manufacturer, and supplier of electrically powered vehicles, Feel Good Cars provides drivers with choices they can feel good about. Working with internationally respected partners, Feel Good Cars brings zero-emission vehicles to tries to "set a new standard for what electric vehicles can be." The company provides the only "luxury" NEV on the market. Feel Good Cars continually explores new avenues of technology—such as new approaches to interior climate control and safety air bags—to outfit vehicles with outstanding features that drivers will love.	Models include: • ZENN (Zero emissions no noise) Unlike other neighborhood electric vehicles, ZENN has the form and features of a "real car": fully-enclosed, three-door hatchback with a performance-proven, steel-reinforced body. That translates into a tremendous safety advantage. ZENN not only looks like a car; it performs like one, too. Equipped with front-wheel drive, brisk acceleration and capable of achieving a regulated maximum speed of 25 mph, it keeps pace with traffic on local streets to get you where you're going safely and in good time. And ZENN's battery efficiency enables 30 to 40 miles per charge. 
Global Electric Motorcars http://www.gemcar.com/index.asp	Global Electric Motorcars, LLC, a DaimlerChrysler company, is in its 7th year of operation and is headquartered in Fargo, N.D. The company has produced nearly 28,000 vehicles to date. The GEM traces its roots back to Livonia, Mich., where a group of automotive engineers designed and debuted this unique electric vehicle in 1992. A North Dakota businessman purchased the company and moved it to Fargo in December 1997. DaimlerChrysler acquired GEM in December 2000. GEM vehicles are available through select Chrysler, Dodge, and Jeep dealerships. GEMs provide transportation in locations such as master planned communities, college and university campuses, military bases, airports, state and national parks, city centers and industrial and commercial campuses. Beginning in 2000, GEM began a national	• Four models available: • e2: two seats.  • e4: four seats targeted at families.

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Name	Company Information	Product Offering(s)
	marketing campaign to position itself as the leader in LSV and ZEV vehicle technologies. As part of the campaign, the GEM was placed at the center of a lifestyle theme called "GEM Town." GEM Town is positioned as a resource and an interactive community for creating better neighborhoods with electric vehicles. GEM Town was created for customers and stakeholders to share ideas, talk with other GEM owners, learn about model GEM communities, and work together to create better communities through innovative transportation solutions.	 • eS: two seat mini-hauler.  • eL; two seat with extended load bed for additional hauling capacity.  • 30 mile range. • Plugs into a regular 110 volt outlet. • Charges in 8 hours. • Unique features include choice of canvas or hard doors, front-wheel drive, stability and steering with wide track suspension, regenerative braking system, four wheel hydraulic brakes, safety glass windshield with wiper, three-point anchored seatbelts, five horsepower 72-volt GE electric motor, GE custom motor controller, sealed electronics, Delta Q charger, LCD driver information display, and power and signal distribution module.

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Name	Company Information	Product Offering(s)
Lafayette County Car No web site available	Lafayette County Car Company has three models the LC3 II is a two-seater, the LC3 IV is a four-seater, and they also offer a truck option. The vehicles look somewhat similar to the GEM. All are powered by a 72V lead Acid battery pack that gives it a quoted range of 30 - 45 miles and a top speed of 25 mph.	Models include: • LC3 IV  • No other information available.
MDEK Electric Cars http://www.mdek.com/index.html	MDEK manufactures electric vehicles for the physically impaired and senior citizens who cannot handle steering wheels or pedals. Vehicles include golf cars, utility, and shuttles. Instead of a steering wheel, tiller, handle bars, brake pedal, accelerator or reversing switch, vehicles are equipped with a console mounted multimode controller to perform all key operator functions using just one hand.	Models include: • MDE-A Utility Sprint  • MDE-A Golf Cart  • MDE-A Sprint Shuttle

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Name	Company Information	Product Offering(s)
		
Sport Electric Vehicles http://www.sportelectricvehicles.com/	Sport Electric Vehicles Sport Truck and Cadillac escalade targets luxury and custom golf cart needs. Luxury cart was inspired by our own mud splashing past. You may not have known it, but as Ranchers by trade we've always been a shade ahead of popular culture.	Models include: • Escalade includes two forward and two rear facing seats.  • Escalade Limo includes four forward and two rear facing seats.  • LS Sport includes two forward facing seats and golf/storage in the back.

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Name	Company Information	Product Offering(s)
		 • LS Sport Limo includes four forward facing seats and golf/storage in the back. 
Western Golf Car (Lido) http://westerngolfcar.com/index.html	For over 20 years, Western Golf Car has been a leading manufacturer in golf course transportation. Western has now extended their golf car line to NEVs. Every Western Golf Car is handmade. All vehicles use the highest quality components from companies like Textron, Dana and Goodyear. Custom fiberglass bodies are designed and engineered to provide uncommon style and many years of trouble-free enjoyment.	• Models include: • The Anthem has the look and feel of a golf car but qualifies as an NEV. Two passenger vehicle with options for rear of vehicle including a three passenger bench, golf club stand, and utility bed.

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Name	Company Information	Product Offering(s)
		 • The Coupe is a two passenger vehicle with a rear storage compartment and a golf package optional.  • The Sedan is a four passenger vehicle with a small rear storage space for groceries.  • The Runabout is a two passenger vehicle with a utility bed.

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Name	Company Information	Product Offering(s)
		 • 40 mile range. • Features include 13" wheels and tires, adjustable front seats, automotive style lighting, front license plate bracket, grab handles, locking front trunk, rack-and pinion steering, regenerative braking, reverse warning indicator, 3 point anchored front seat belts, and tail lights, among others

6.2 Other Low Speed Vehicle Manufacturers

The following are other low speed vehicle manufacturers that do NOT produce vehicles specifically for neighborhood use. These vehicles tend to be used for golf, utility, or specialized conditions.

1. Bad Boy Buggies

http://badboybuggieshillcountry.com/
Bad Boy Buggies manufacturers electric vehicles for the hunting market.

2. Club Car

http://www.clubcar.com/
Club Car, part of Ingersoll Rand, manufactures a wide range of golf (fleet, turf utility, beverage, ADA compliant), utility, rough terrain, and specialty (ambulance, security) vehicles with applications in golf course, grounds maintenance, industrial, academic and commercial markets are available.

3. Cushman

http://www.cushmanco.com/
Cushman, a part of Textron, claims to have the broadest line of gasoline and electric utility vehicles on the market. Cushman offers a complete range of heavy-duty industrial burden carriers, comfortable personnel carriers, and specialty (security, maintanence, ambulance) vehicles.

4. E-Car

http://www.e-caramerica.com/default.htm
E-Car makes specialized e-vehicles including an electric golf cart for the disabled, electric recreational vehicles for visiting parks and outdoor sites, an electric golf caddy, and an electric buggy.

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5. E-Z-Go

http://www.ezgo.com/
E-Z-GO, part of Textron (a global, multi-industry company with market leading operations in aircraft, automotive, industrial, and finance) claims to be the world's largest manufacturer of golf cars and utility vehicles including fleet golf cars, turf maintenance vehicles, shuttle personnel carriers, refreshment vehicles, industrial utility vehicles, personal golf cars, trail utility vehicles, and a sporting clay shooter car.

6. Gorilla

http://www.gorillavehicles.com/

Gorilla manufactures electric tractors and all terrain vehicles. Vehicles meet all federal requirements for a NEV including an electric work vehicle, airport ground support vehicle, an electric sport vehicle.

7. Melex

http://www.melex.pl/
Melex, located in Mielec, Poland is the fourth largest manufacturer of electric vehicles in the world. The company makes a wide range of vehicles including golf cars, utility vehicles, shuttles, and specialty vehicles such as ambulances.

8. Taylor-Dunn

http://www.taylor-dunn.com/
Taylor-Dunn manufactures a complete line of commercial and industrial gasoline and electric vehicles including burden carriers (material handling needs), personnel carriers (shuttles for up to 33 people), utility vehicles, custom vehicles, and tractors.

9. Tiger Truck

http://www.tigertruck.com/index-e.html

Tiger manufactures a range of gasoline, electric, and hybrid vehicles including closed cab trucks and utility vehicles and shuttles.

10. ULB Corporation

http://www.ulbcorp.com/index.htm
ULB Corporation, located in Seoul, Korea, manufacturers and exports electric all terrain vehicles (ATV) including golf cars, utility vehicles, shuttles, and a remote controlled car.
11. Yamaha
http://www.yamahagolfcar.com/
Yamaha, a part of the Japanese conglomerate, manufactures gas and electric golf cars, shuttles, utility, and specialty vehicles. Custom vehicles include beverage cars, ambulances, ADA compliant cars, bell captain service, and laundry and food service.

6.3 Advocacy and Trade Organizations

The following organizations, either non-profit or for-profit, advocate or provide industry support or information for NVs. While these organizations may receive funding from manufacturers or other industry-related companies, they are not a subsidiary of an NEV manufacturer.

6.2.1 Green Car Institute

http://www.greencars.org/index.htm

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GCI is a 501©(3) nonprofit research organization and think tank. GCI encourages the development and widespread use of alternative and clean fuel vehicles. The Institute's goal is to be a leader in environmental vehicle education and outreach, leading to greater public understanding of the relationship between low emission/clean fuel vehicles and the environment. GCI also places emphasis on related areas such as energy efficiency, recycling, and environmentally conscious manufacturing to promote understanding of these important and interconnected issues.

The Institute's projects and programs include focus on partnering auto industry and utility/ energy company clean fuel technology and research opportunities with public education programs. These include any of the following or other creative collaborations:

- Research projects
- Seminars and conferences
- Mass-market communication projects and presentations
- Consumer-oriented educational materials and events
- School automotive technology demonstrations

6.2.2 Electric Drive Transportation Association

http://www.electricdrive.org/
EDTA is the preeminent industry association dedicated to advancing electric drive as a core technology on the road to sustainable mobility. As an advocate for the adoption of electric drive technologies, EDTA serves as the unified voice for the industry and is the primary source of information and education related to electric drive. Our membership includes a diverse representation of vehicle and equipment manufacturers, energy providers, component suppliers, and end users.

EDTA is a respected voice for the electric drive industry on Capitol Hill and works with its diverse membership to educate federal policy makers on the benefits of electric drive and the most effective ways to promote electric drive technologies. EDTA testifies before key Congressional committees, works with the Executive Branch and participates in advanced transportation coalitions to ensure that the opportunities the industry offers, including increased energy security and enhanced environmental quality, are understood in Washington. EDTA also monitors key state and local actions affecting the industry.

The EDTA Conference and Exposition series has quickly established itself as the leader in electric drive events. The EDTA Conference is a comprehensive and hands-on forum for information exchange, business venture development, and market forecasting, featuring industry experts, policy leaders and academia from around the globe. The conference focuses on market, policy, and commercialization issues, and features the key decision makers who can ensure that the market is mobilized to embrace sustainable transportation.

6.2.3 Electric Auto Association

http://eaaev.org/eaalinks.html
The Electric Auto Association (EAA) was formed in 1967 in San Jose, California. The EAA is a non-profit educational organization that promotes the advancement and widespread adoption of Electric Vehicles (EVs). EVs are a clean, quiet alternative to conventional automobiles, which are powered by petroleum derivatives that, when burned, emit noxious gases into the environment. EVs not only keep our Earth cleaner, their use preserves the earth's natural resources. EVs are a smart and efficient choice for personal transportation. The EAA's mission is "to act as a public source of information about developments in electric vehicle technology, to encourage experimentation in the building of electric vehicles, and to organize public exhibits and events of electric vehicles to educate the public on the progress and benefits of electric vehicle technology.

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7.0 Empirical Studies

7.1 Use Snapshots

Due to a lack of readily available information the following examples of NEV use in practice is sketchy and is given the form of snapshots.

7.1.1 San Luis Obispo, CA

In March 2003 a new type of GEM rental service was deployed called NEVSHARE. The service was stationed in downtown San Luis Obispo for users to get around conveniently without having to take their cars out of local parking structures.

7.1.2 Otay Ranch, CA

Otay Ranch, located in the City of Chula Vista south of San Diego and only six miles north of the U.S./Mexico border, is the largest master planned community in California currently being built out. Toay Ranch is planned to be the home of 60,000 residents. The vision for Otay Ranch includes the use of NEVs as a central component for local transportation circulating through neighborhood streets as well as providing NEV-exclusive pathways.

The Green Car Institute undertook a study of NEV use in Otay Ranch. The objective was to analyze how GEMs fit into the real world environment as daily transportation vehicles of 28 participants who live and work within a “village” of Otay Ranch. The study found that, given a choice of travel modes for short trips, participants chose a NEV over their private cars 90 percent of the time. Study results also showed that more than half of the trips taken in NEVs, some 53 percent were for purposes defined as “business” or “delivery,” meaning trips of necessity. One-third of the trips, some 33 percent were classified as “leisure,” while 14 percent were designated as “other.”

7.1.3 Bay Harbor, MI

Bay Harbor is a gated community located along Lake Michigan coastline near the town ofCharlevoix. Bay Harbor is home-away-from-home for many auto executives and entrepreneurs who dock their boats at the Bay Harbor Yacht Club and park their golf carts at the 27-hole Bay Harbor Golf Club.

The standard mode of transportation around Bay Harbor is the GEM, not luxury cars. It was in Bay Harbor that Daimler Chrysler exeuctives were first exposed to this NEV which led to the eventual purchase of the company. Approximately half the people who live at Bay Harbor own GEMs.

7.1.4 Celebration

Celebration is a master planned community developed by Disney in Orlando, Florida. The town has approximately 4,000 full-time residents. Celebration is designed with a NEV infrastructure and GEMS are driven on a daily basis. NEV rentals are available from local hotels.

7.1.5 Playa Vista

Playa Vista in Los Angeles is working with GEM to develop a personal mobility solution to reduce the use of traditional cars to relieve traffic congestion, reduce air pollution, and cut down on the capital cost of building parking spaces.

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7.1.6 Skyharbor International Airport, Phoenix, Arizona

GEMTown reports that AmericaWest Airlines purchased 80 GEMs to move ground personnel and supplies around the airport. GEM reports that because the speeds of GEM are twice as fast as golf carts, combined with a range of body types, meets the diverse needs of the airlines.

7.1.7 Palm Desert, California

A portion of the Coachella Valley along Highway 111 includes the cities of Palm Springs, Cathedral City, Rancho Mirage, Palm Desert, and Indian Wells, among others. All these places share residential communities oriented around golf courses and tennis clubs. Over the last ten years the use of golf carts and then NEVs on city streets as a normal way of getting around town has blossomed.

7.2 Usage Study: Study of NEV User Behavior in California, July 2003

7.2.1 Authorship

This study was conducted by the Green Car Institute in partnership with the Access Research Group, principals of whom are staff researchers at the U.C. Davis Institute of Transportation Studies.

7.2.2 Purpose and Methodology

This survey was conducted to develop a statistical portrait of the travel behavior and mobility preferences of NEV owners in California. The study estimates that there are approximately 15,000 NEVs in service in California as of July 2003.

The report believes that this volume of NEVs represents the largest single geographic concentration of electric vehicles anywhere in the world. The aim of the study was to determine why NEV owners acquired a NEV, how they use a NEV in their daily routines, and how this travel behavior fits into the larger context of California emissions, traffic congestion, land use patterns and other factors.

260 NEV owners/users were interviewed by phone for approximately 10-15 minutes each. The names of the respondents were randomly selected from a database of nearly 10,000 GEM vehicles in service in California. Data were collected over two one-week periods (M-F, July 14-18 and M-F, July 21-25, 2003) from 9 a.m. to 5 p.m. PST.

Of the 260 people interviewed, 162 were "household" users (retail customers, individual owners), and 98 were "small fleet" operators (business or institutional customers). The sample size of 260 provides a statistically accurate representation of the overall NEV travel behavior of the users of the conservatively estimated 15,000 NEVs in service in California today. This sample size provides a margin or error of 6-8 percent. In order to provide unassailable data, all statistical extrapolations used in the narrative of this study are based on the assumption of a total population of 10,000 NEVs. The remaining 5,000 NEVs estimated to be in service in California are not counted in this study nor represented by statistical extrapolation.

7.2.3 Significant Findings

As quoted in the study, "…this study found the NEV is used as a daily replacement for an internal combustion engine vehicle more than two-thirds of the time. It is used for far more purposes than anyone might have imagined, usually in trips characterized as "trips of necessity." The functionality of the NEV is underscored by users' reports of the high incidence of employing their NEV to carry goods or do errands. The NEV is viewed by its owners as a viable tool in the toolbox of transportation options available to them. Most NEV users own more than two internal combustion engine vehicles, but the NEV still replaces

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two-thirds of daily short-distance trips formerly taken with either of those vehicles. While one of five NEV trips may be on the golf course, even there the NEV is often a replacement for a gasoline-powered cart.

“Moreover, NEVs are in use in a wide variety of land use settings. It isn’t possible to characterize a single “typical” setting. The survey showed that NEVs are in use in relatively equal numbers in small, medium, and large urban centers, in suburbs, master-planned communities, rural areas, gated golf communities, mobile home parks, apartment complexes and numerous other surroundings. This finding graphically demonstrates the fallacy of the stereotype that NEVs are limited in their utility to gated communities and golf courses.

“As may be obvious from the high usage rates, NEVs do not appear to be encountering significant obstacles to their use in many, varied communities. One surprising finding of the study is that NEVs are much more likely than a typical car to be carrying more than one person. While standard vehicles in California typically carry a single driver with no passengers more than 70% of the time, NEV users have a completely opposite occupancy rate: 75.4% of all NEV trips carry more than one person. Thus, NEVs are having an impact on congestion and carry an even greater positive environmental benefit than might be measured by simply counting vehicle cold-starts eliminated, trips taken and vehicle miles traveled (VMT).”

7.2.4 Statistical Findings

Other selected statistical findings include the following:

- State wide, an average of 7.56 trips per day are taken in a NEV.
- The average annual NEV mileage in California is 1,258 miles.
- Among all NEV users in California:
  - 39.2% usually travel less than 1 mile for a one-way trip.
  - 35.7% travel 1-3 miles.
  - 18.2% travel 3-5 miles.
  - 03.1% travel 5-7 miles.
  - 03.9% travel 7 or more miles.

- Of all NEV users:
  - 24.6% usually drive alone.
  - 50.8% usually have one passenger.
  - 8.8% usually have two passengers.
  - 15.8% usually have three passengers.
  - 65.3% usually transport cargo in their NEVs.

- Of all NEV trips taken in California:
  - 64.7% replaced personal or company-provided internal combustion engine
  - vehicles.
  - 20.1% replaced electric or gasoline powered golf carts. (In other words, one in five NEV trips is for golfing.)
  - 5.0% of NEV trips were “new” or “additional” trips not replacing any other mode of travel.
  - 10.1% replaced modes such as walking, biking, public transportation and other.

- Of all household NEV users:
  - 48.1% own three or more personal internal combustion engine vehicles.
  - 28.1% own two.

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- 22.5% own one.
- 01.3% own no other vehicle in addition to their NEV.

- Of the household users:
  - 60.0 % are older than 55 years.
  - 22.8 % are 46 to 55.
  - 11.1 % are 36 to 45.
  - 04.9 % are 26 to 35.
  - 01.2 % are under 25.

- The most common reasons given for why NEV users perceive their communities to be suitable for NEV travel were:
  1. Short distances between destinations.
  2. The presence of 35 mph or less streets in their communities.
  3. The weather is fair most of the time.

- The most common types of trips taken in NEVs in California were:
  1. To run local errands,
  2. For personal recreation,
  3. To visit friends and family, and, interestingly,
  4. To deliver or transport goods for businesses or personal reasons.

- Households and small fleets are more likely than not to use their NEVs to transport cargo:
  - 65.3% of respondents use their NEVs to transport something other than people.

- The most common reasons why households acquired a NEV were:
  1. The NEV fit their lifestyle.
  2. They wanted to “have fun” getting around their communities.
  3. They thought the NEV was “cool.”
  4. They wanted to “save on gasoline” or provide cheap transportation.
  5. They wanted “a more environmentally friendly mode of travel” or wanted a car that fit their travel patterns.

- The most common reasons why businesses acquired a NEV were:
  1. They wanted a car that fit their company’s travel needs.
  2. They wanted “a more environmentally friendly mode of travel.”
  3. They wanted to “save on gasoline.”
  4. They wanted an affordable fleet vehicle.
  5. They wanted an air quality regulatory compliance tool.

7.3 Usage Study: Field Operations Program – Neighborhood Electric Vehicle Fleet Use, July 2001

7.3.1 Authorship

This study was conducted by the Idaho National Engineering and Environmental Laboratory, Transportation Technologies and Infrastructure Department, Idaho Falls, Idaho. Principal authors were J. Francfort and M. Carroll. The report is dated July 2001. It is prepared for the U.S. Department of Energy,

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Assistant Secretary for Energy Efficiency and Renewable Entergy under DOE Idaho Operations Office Contract DE-AC087-99ID13727.

7.3.2 Purpose and Methodology

To better understand fleet use of neighborhood electric vehicles (NEVs), the Field Operations Program conducted a study of fifteen fleets that were known to be using NEVs. Personnel from the Idaho National Engineering and Environmental Laboratory contacted the fifteen fleets by telephone and asked about 20 questions. The individual responses for the fifteen fleets are available in the report at http://avt.inel.gov/pdf/nev/nevstudy.pdf. The study was not intended as a scientific sample, rather, as an informal analysis of NEV use and experience.

7.3.3 Significant Findings

This report summarizes a study of 15 automotive fleets that operate NEVs in the United States. The information was obtained to help Field Operations Program personnel understand how NEVs are being used, how many miles they are being driven, and if they are being used to replace other types of fleet vehicles or as additions to fleets.

The models of NEVs used by the fleets includes 306 GEMs in ten fleets, 27 Bombardiers in three fleets, 4 Nissan Hyperminis in one fleet, and 11 NEVs of unknown manufacturers in two fleets. Included in this total was one fleet with a mix of 69 GEM and 13 Bombardiers.

The fifteen fleets operate a total of 348 NEVs in a variety of missions. The fleets include military, commercial, municipal, rental, and transportation organizations. The NEV fleets range in size from 2 to 82 NEVs with an average (mean) of 23 and a median size of 10. Thirty percent of the 348 NEVs were purchased as replacement vehicles. Fifty-six percent of the NEVs are used on private roads, 32% are used on public roads, and 12% are used on both public and private roads. The fleets reported that 91% of the 348 NEVs did not have any problems; 14 of the NEVs have had their battery packs replaced. The fleets are charging 99% of their NEVs at 110 volts.

The NEVs' contribution to petroleum avoidance and cleaner air can be estimated based on the miles driven and by assuming gasoline use and air emissions values for the vehicles being replaced. Gasoline and emissions data for a Honda Civic are used as the Civic has the best fuel use for a gasoline-powered vehicle and very clean emissions. Based on these conservative assumptions, the 348 NEVs are being driven a total of about 1.2 million miles per year. This equates to an average of 3,409 miles per NEV annually or 9 miles per day. It is estimated that 29,195 gallons of petroleum use is avoided annually by the 348 NEVs. This equates to 87 gallons of petroleum use avoided per NEV, per year.

Using the 348 NEVs avoids the generation of at least 775 pounds of smog-forming emissions annually. Based on the comments received, the fifteen fleets have had positive experiences with their NEVs.

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8.0 Key Professional Studies

8.1 Green Car Institute

Green Car Institute conducted a study measuring the potential for NEVs with a focus on their primary consumer market, master planned communities.

The Market Potential of Neighborhood Electric Vehicles in Planned Communities quantifies current market size and estimates and forecasts demand for this class of vehicle. The study costs $3,000. In addition, the study explores price and feature expectations of consumers. In its analysis of the results, GCI draws on the experience of Green Car Marketing & Communications' recognized leadership in this area to present a thorough definition of the potential for, and obstacles to, this developing market.

Study objectives include the following:

1. Purchasing Plans and Decision Process: Specific consumer intentions for acquiring NEVs and key factors in the decision process are covered in this study.

2. Consumer Profile: The study provides insight about consumers' travel behaviors, income profiles, product awareness, and NEV purchase price thresholds.

3. Product Requirements: One of the most important topics in this study, the research program identifies and defines the specific product functionality required for a NEV to successfully meet consumer needs.

4. Product Utilization: What is the extent of current penetration of NEVs in these communities? How are those NEVs being used?

The study focuses on master planned communities in select states and regions, providing insight into the evolving and expanding NEV market. Leading experts in the advanced transportation vehicle field have designed this study's survey instrument and have performed detailed data analysis.

8.2 InfoShop

The InfoShop prepared a report entitled "Electric Vehicles" published in February 2005 at a cost of $4,450. The report provides broad based coverage on a range of electric vehicles from full sized cars and SUVs to NEVs and trains. Contents include market snapshots, industry overview, global market scenarios, product overview, environmental and regulatory scenario, major structural elements of the EVs Market, other alternative fuel vehicles, research and technological developments, EV related technological developments, product launches, recent industry activity, focus on select global players, global market perspective including country studies on the U.S., Japan, Canada, Europe, Asia-Pacific, and the rest of the world, competition, and a world directory of manufacturers.

The Infoshop is a division of Global Information, Inc. (GII), Tokyo, Japan. GII is an aggregator of premium business intelligence and market research products worldwide with offices in Korea, Singapore, Taiwan, Brussels, and the United States. Through partnerships with over two hundred of the world's leading market research publishers and analysts, GII offers a wide range of products. Two key products are 1) in depth market research reports for business planning and strategic analysis, and annual information services with up-to-date with the information to make informed decisions regarding changing markets and industry trends.

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9.0 Findings

9.1 Moving to Mainstream

NVs and NEVs are ready for full market adoption. The technology is proven, the costs (both capital and operating) are reasonable, the regulatory framework is in place, the benefits, for both individuals and society are good, and the functionality (making short trips) is well matched to the vehicle.

Yet, NVs and NEVs are not mainstream.

NVs and NEVs may never become mainstream, and may continue to operate on the fringes of the majority adopter market. If NVs and NEVs never become mainstream, then government agencies will have to continue to subsidize the market to stimulate social policy objectives.

We believe there are two key problems that inhibit NEVs from becoming mainstream:

1. Individuals see the purchase of a NEV as a luxury purchase and not a replacement for their conventional car. This approach may be quietly supported by the major car manufacturers (with the exception of DaimlerChrysler, the only “major” manufacturing NEVs) who stand to lose revenue if consumers substitute a cheaper NEV purchase for a more expensive traditional gasoline powered vehicle.

2. Individuals do not trust the safety of the NEV when driving in a mixed environment on city streets with conventional cars. This is also related to the cost of adapting the physical environment by local city’s including signage, production of driving maps, and other safety features.

Overcoming these perceived problems will be very difficult as it is hard to disprove a negative. Perhaps the best approach is a positive marketing campaign to simultaneously attempt to disprove these stereotypes while communicating a compelling value proposition about owning/using a NEV. Unfortunately, implementation of such a marketing campaign is unlikely because there are no large manufacturers (except DaimlerChrysler) or interest groups that have the kind of budget to undertake such a program.

Ultimately, to move NEVs into the mainstream will require one of two things: 1) a more compelling value proposition for consumers and businesses to purchase NVs and NEVs than already exists; or, 2) a marketing message that successfully communicates that the value propositions are already there, but not recognized.

To a large extent DaimlerChrysler has already begun to do try to mainstream their GEM car with the overarching concept of GEMTown, described above. GEMTown is targeted at socially and environmentally progressive people who are the target market and want to identify with such a national movement.

However, mainstreaming NEVs will need to attract a much larger target market.

9.2 Demonstration Projects

The biggest problem with the applications NEV applications nationally is the lack of “real world” case studies. Most large scale NEV applications are in planned communities or other “closed” environments such as golf courses or gated communities. Applying NEVs in and around traditional, “open”

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neighborhood centers such as Riviera Village in Redondo Beach, Old Town in Torrance, and Downtown Inglewood will provide a unique value that we do not believe has otherwise been applied in the U.S.

Utilizing these three neighborhood centers would provide valuable toward mainstreaming NEVs. Among other things, such a study would be useful to: 1) determine what it will take to improve local road conditions with signage and other safety features; 2) test marketing messages to residents and business users; 3) test how readily people are willing to use NVs/NEVs for different trip purposes, and how willing they are to use the NV/NEV in place of their conventional car; and 4) obtain information over a prolonged period (one year) about the communities changing perception of NVs/NEVs.

8.3 Use by Residents and Commercial Users

In reviewing the range of functions and activities to which NVs/NEVs can be applied, it occurs that commercial users and businesses may be better placed than individual consumers to mainstream NVs/NEVs. By putting these vehicles to work across a range of activities and locations in a community (see section 5.1.2 above) may offer greater sales and visibility thereby further helping to drive residential interest. The use of NVs/NEVs by commercial retail businesses in demonstration projects at the three neighborhood centers described above could make vehicles available for use by residents who walk in from their local neighborhood but need a lift back home with the goods that they purchased (groceries) or services that they paid for (dry cleaning). After dropping off the items, the consumer borrowing the NEV could return it and then walk home. Other innovative forms of sharing NVs/NEVs are possible.

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