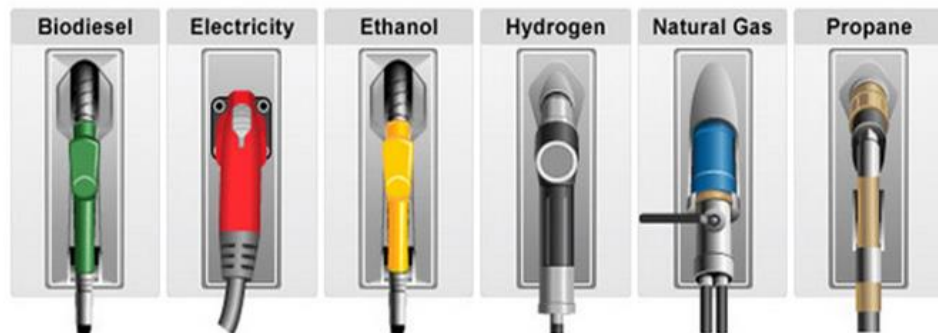


refuel



Alternative Fuels for Fleets

This toolkit was developed as part of the San Diego Regional Alternative Fuel Readiness Plan with support from the San Diego Regional Alternative Fuel Coordinating Council (Refuel), which seeks to reduce barriers to alternative fuel adoption in the region.

What is the value of alternative fuels?

Alternative fuel vehicles offer long-time cost savings and can have the same performance quality of conventional vehicles, but without the air pollution that comes with them.

Policies for the acquisition of alternative fuel vehicles may already be in your organization's larger long-term energy or Climate Action Plan. A majority of municipalities and public agencies throughout the San Diego region have already referenced the increased procurement of alternative fuel vehicles as a way to reduce

greenhouse gas (GHG) emissions and to support the State's climate goals.

Not only are local governments thinking about alternative fuels, there are several state-level policies and strategies that promote the increased use of them.

How do I use this toolkit?

This toolkit includes resources identified by fleet managers for further training and assistance in the transition to alternative fuel vehicles. The toolkit includes the following resources:

- Guidance on the available funding for alternative fuel vehicles and infrastructure installation projects
- Fact sheets or reference guides on general information about alternative fuels
- Case studies of fleets that use alternative fuel



Biodiesel

FACTS ABOUT BIODIESEL

What is biodiesel?

Biodiesel is a non-petroleum-based diesel that is made from vegetable oil, recycled restaurant grease, or animal fats. Pure biodiesel is renewable and a clean-burning form of diesel.

Typically, biodiesel can be blended with petroleum diesel. Biodiesel blends range from B2 (2% biodiesel, 98% petroleum diesel) to B99 (99% biodiesel, 1% petroleum diesel). B20 is the most common biodiesel blend in the United States.

Renewable diesel has been growing in popularity. Renewable diesel is also made from biomass feedstocks, but is processed in a different way that makes it more chemically similar to diesel than biodiesel.

How many public stations are in the San Diego region?

There is currently one public Biodiesel station in the San Diego region; however, there are many private fleets that have B20 delivered to their own facilities.

How much does it cost to fuel my vehicle?

Biodiesel is generally less expensive than diesel. Below are the 24-month averages of both fuels.

24-month average*	
Diesel	\$3.44
B20	\$3.15
Savings	\$0.31

*June 2013-June 2015

- Biodiesel is biodegradable, nontoxic, and safe for handling
- Biodiesel is produced from co-products and byproducts of crops already being grown. It also can be produced with used cooking oil
- B20 provides similar fuel economy, horsepower, and torque as diesel fuel
- Between 2004 and 2014, 8.2 billion gallons of biodiesel have been used in the U.S. Carbon emissions were reduced by 75.5 million metric tons. This is equivalent to removing 15.9 million cars off the road.
- Biodiesel reduces lifecycle carbon emissions by up to 86%

What types of vehicles can use biodiesel?

Any vehicle that runs on diesel can also use biodiesel, including, but not limited to:

- Passenger vehicle
- Vanpool – shuttle
- School bus
- Refuse hauler
- Sweeper
- Construction equipment
- Other medium/heavy-duty vehicles



Did you know...

Many light-duty diesel vehicles can also take low percentage blends of biodiesel. 85% of all manufacturers will allow B20 in newer model vehicles. Visit the National Biodiesel Board for more information:

<http://www.biodiesel.org/using-biodiesel/oem-information>



Where can I learn more?

- Alternative Fuel Data Center - www.afdc.energy.gov/fuels/biodiesel.html
- National Biodiesel Board – www.biodiesel.org
- Biodiesel Education Network – www.askben.info
- Drive Biodiesel – www.drivebiodiesel.net
- National Biodiesel Foundation – www.biodieselfoundation.org

Is Biodiesel Right for your Fleet?

You may not be sure whether or not using biodiesel is the right for your fleet. The following tools and resources are available to help guide you through the decision-making process.

Case Studies

Fleet Put Biodiesel to the Test: Recent studies and experiences have shown that using biodiesel in lieu of petroleum diesel has resulted in no significant differences in performance, maintenance, or fuel efficiency. Read more at: <http://www.greenfleetmagazine.com/channel/biofuels/article/story/2009/04/fleets-put-biodiesel-to-the-test-grn.aspx>.

Biodiesel Helps Cut a City's Carbon Footprint: The City of Asheville, NC cut its carbon footprint by 4.5% from the prior year by switching from B5 to B20. The increase biodiesel use accounted for 40% of the carbon footprint improvement. Read more at <http://www.government-fleet.com/channel/green-fleet/news/story/2015/02/biodiesel-use-helps-city-meet-carbon-reduction-goals.aspx>.

Essential Baking Co. Uses Biodiesel: The Department of Energy's Clean Cities Program newsletter, Clean Cities Now Vol. 16, No. 2 offers an in-depth case study of Essential Baking Co.'s partnership with California-based Propel Fuels for its biodiesel needs. Read more at http://www.afdc.energy.gov/uploads/publication/ccn_16_2.pdf (page 4).

Several fleets in the San Diego region already using biodiesel:



City of Chula Vista

The City of Chula Vista installed their own biodiesel fueling station thanks to the federal Energy Efficiency & Conservation Block Grant, of which the City received nearly \$2.0 million. A 12,000 gallon biodiesel tank sits at its Public Works Corporate Yard and is used to fuel the City's 146 biodiesel vehicles, which include heavy-duty fleet vehicles such as fire engines, dump trucks, and excavators.

This installation was completed in October 2010 and had made a vast improvement in their overall greenhouse gas (GHG) emissions. Originally, the City had two small tanks that held 1,500 gallons total, which required costly daily fuel deliveries. With this larger capacity tank, fuel deliveries only happen once every two months, which lowers costs.

With the larger capacity, the City expects they have saved over 145,000 gallons of diesel fuel each year.

Since then, three 1,000 gallon underground biodiesel tanks have been added at various fire stations.

For more information, contact Steve Dorsey, CFPF, Fleet Manager at sdorsey@chulavistaca.gov.



Biodiesel: Comparing Costs

You've decided that it makes sense to consider using biodiesel for your fleet vehicles. These tools are intended to help you better understand the financial benefits of adopting biodiesel and the costs associated with their procurement.

Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool

The AFLEET tool is developed by the Department of Energy's Clean Cities Program (Clean Cities). It estimates the environmental and economic costs of adopting alternative fuel vehicles into your fleet. It takes into consideration fuel costs, fuel types, and vehicle purchase price. Before getting started with this tool, having the following data available will strengthen the estimates returned:

- Vehicle class your fleet would likely adopt
- Annual vehicle miles of a single vehicle
- Vehicle purchase price
- Useful life of fleet vehicle(s)
- Financing terms if a loan is needed

Take advantage of this tool here: <https://greet.es.anl.gov/afleet>.

The [Alternative Fuel Data Center's Vehicle Cost Calculator](http://www.afdc.energy.gov/calculator) shows the total cost of ownership and emissions for a large variety of makes and models of most vehicles, including alternative fuel vehicles. You can also create your own custom vehicle if you cannot find the model you want. The tool is available at: <http://www.afdc.energy.gov/calculator>.

According to the Alternative Fuel Data Center, biodiesel users save, on average, \$300-\$400 annually per vehicle.

Vehicle Manufacturers

These are just a few of the manufacturers of diesel vehicles. Look through the National Biodiesel Board's handbook *Biodiesel and the U.S. Diesel Vehicle Market: 2015* for a detailed list of light-, medium-, and heavy-duty diesel vehicles available on the market.¹



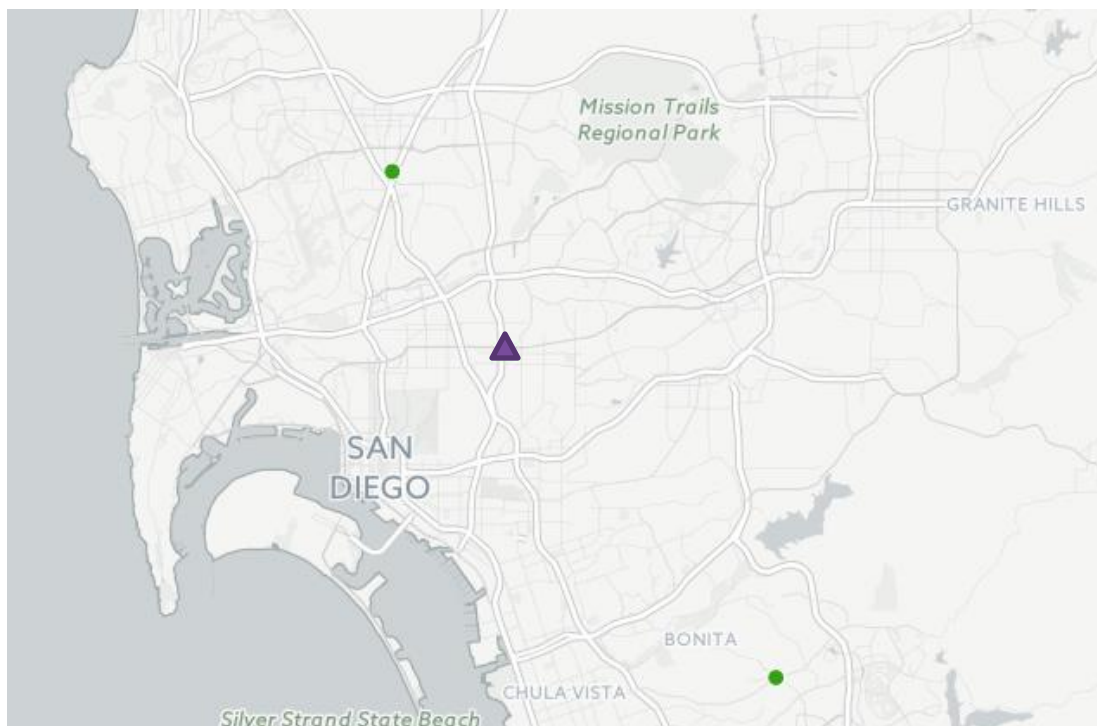
¹ http://biodiesel.org/docs/default-source/ffs-engine_manufacturers/2013-diesel-vehicle-list.pdf

Fueling Stations

Using Fueling Stations

Fleets that want to incorporate biodiesel into their fleet operations can either rely on public fueling stations or install their own, private, fueling station.

Map of Public Biodiesel and Renewable Diesel Fueling Stations in San Diego Region



*Triangle indicates biodiesel station; circles indicate renewable diesel station
(Map updated as of September 2015)

http://www.afdc.energy.gov/fuels/biodiesel_locations.html

Installing Biodiesel Equipment

Installing biodiesel fueling equipment is very similar to installing conventional gasoline equipment. These are considerations when adding a private fueling station:

- **Determine fueling specifications** – How much fuel storage is needed for your fleet? Ensure to store enough fuel of reasonable size. If there are other fleets nearby, it may be possible to share transport loads. Speak with a fuel provider to make sure you get the appropriate-sized tank.
- **Is there an existing tank to be repurposed for biodiesel?** – If so, ensure that the tank is properly cleaned out and that it is compatible with holding biodiesel blends.
 - **Underground tank:** It may be necessary for the existing underground storage tank's manufacturer to provide a statement of compatibility of their product with certain biofuel blends. All tank manufacturers have issued statements of compatibility with blends up to 100%. Read more in the EPA's guidance for the storage of biofuel blends in existing tanks here: <http://www.epa.gov/oust/altfuels/biofuelsguidance.htm>
 - **Above-ground tank:** Above-ground manufacturers have provided statements of compatibility with all biodiesel blends.

- **Dispensers:** It is preferred to install UL-certified B20 and B100 dispensing equipment.

Read more about the proper handling, storing, and dispensing of biodiesel:

<http://www.nrel.gov/transportation/pdfs/43672.pdf>.

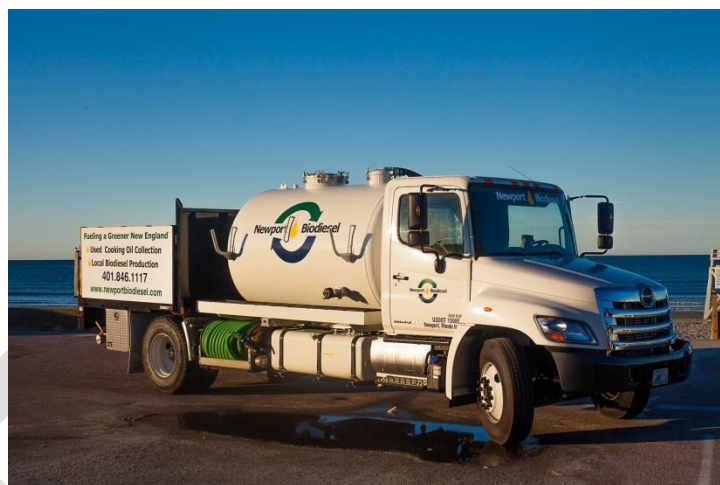
How to Buy Fuel

When buying fuel for bulk use, it is recommended that the biodiesel purchased meets American Society for Testing and Materials (ASTM) benchmark standards (for B6-B20, ASTM D7467-13; for B100, ASTM D6751-12).

To ensure quality product, take the necessary steps to make sure that your storage tanks are free from contamination. You can obtain fuel from a BQ-9000 accredited producer or certified fuel marketer.

Read more about these troubleshooting tips, visit:

http://www.biodiesel.org/docs/default-source/ffs-performance_usage/fuel-quality-and-performance-guide.pdf.



Pre-Buy Considerations²

- Secure a reliable and trustworthy fuel distributor
- Obtain certificate of analysis assuring the fuel is meets ASTM specifications
- Ensure that delivery personnel “stick” (i.e., measure) your storage vessel before and after the drop noting water accumulation on the delivery slip

Post-Buy Considerations³

- Make a company employee “stick” the storage tank before and after the drop, seeing if there are discrepancies with the deliver personnel notes
- Hold two (2) quart container running samples off the truck prior to off-loading into the storage vessel for possible analysis if fuel quality issues arise
- If there is accumulated water, remove it immediately, bulk storage, saddle tanks, and water fuel separators
- Keep a log of all inbound shipments and water accumulation where appropriate

More guidance on inventory control for underground storage tanks can be found in this EPA document:

<http://www.epa.gov/oust/pubs/inventory.pdf>.

² Federal Transit Administration. *Biodiesel Fuel Management Best Practices for Transit*. 2007. http://biodiesel.org/reports/20071127_tra-56t.pdf

³ Ibid.

Codes and Standards

When installing a fueling station, it is important to adhere to the necessary codes and standards. This guidance document provides a thorough list of codes and standards when developing biodiesel infrastructure:

<http://www.afdc.energy.gov/pdfs/48603.pdf>.

The general standards for the dispensing and storage of biodiesel falls under the National Fire Protection Association (NFPA) 30 Flammable and Combustible Liquids Code.⁴ It covers fire and explosion prevention, storage of liquid in containers, storage systems, and processing facilities. More specific codes and standards for other aspects of biofuel stations are found in the following table. Many of these codes and standards also apply to conventional gasoline fueling stations.

Fueling Station Aspect	Pertinent Codes and Standards
Containers	NFPA 30 ASTM Standards for Containers American National Standards Institute (ANSI)/ Underwriters Laboratory (UL) Standards for Containers US Department of Transportation (DOT) 10CFR49
Dispensing Operations	NFPA 30 NFPA 30A NFPA 385 NFPA 10
Storage of Liquids	UL 2245, 2080, 2085 NFPA 91, 30A Steel Tank Institute (STI) Corrosion Control Standards

⁴ <http://www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=30>



Electric Vehicles

WHAT IS CHARGING?

What is a PEV?

A plug-in electric vehicle (PEV) is a vehicle in which there is an onboard battery that is powered by energy delivered from the electricity grid. It is commonly referred to as just an electric vehicle (EV). There are two types of plug-in electric vehicles: a battery electric vehicle (BEV) and a plug-in hybrid electric vehicle (PHEV). BEVs run exclusively on the power from their onboard battery. PHEVs have both an onboard battery and a gasoline tank that is used when the car's battery is depleted.

There are upwards of 17,500 PEVs in the San Diego region (as of Summer 2015).

How many stations are in the San Diego region?

Currently there are over 600 public charging stations in the San Diego region.

How much does it cost to fuel my vehicle?

It generally costs less than half as much to drive an electric vehicle as an internal combustion engine

24-month average*	
Gasoline	\$3.35
Electricity**	\$1.22
Savings	\$2.13

*June 2013-June 2015

**Gasoline gallon equivalent at \$0.12/kWh



Level 1 Charging

Level 1 charging uses 120 volts AC. An PEV can be charged with just a standard wall outlet.

Level 2 Charging

Level 2 charging uses 240 volts AC. This is the same type of voltage as an outlet used for a dryer or washing machine.

DC Fast Charging

DC fast charging is very quick. Some PEVs can charge up to 80% of its battery in 30 minutes

What types of vehicles can use electricity?

Electric vehicles come in all shapes and sizes. They are not limited to light-duty passenger vehicles (of which there are over 25 models!) anymore.

- Passenger vehicles
- Vanpool shuttles
- Pickup trucks
- Medium-duty vehicles
- Transit buses
- Forklifts
- Low-speed vehicles (like a golf cart)



TYPES OF PLUG-IN ELECTRIC VEHICLES

Battery Electric Vehicle (BEV): Battery electric vehicles run entirely on the energy stored on an onboard battery. The vehicle is charged by electricity from the grid. On average, the vehicle's range is upwards of 80 miles on a single charge.

Plug-in Hybrid Electric Vehicle (PHEV): A plug-in hybrid electric vehicle runs on electricity and a gasoline as well. The onboard battery is charged using electricity from the grid, and when the battery is depleted, the gasoline engine is used.

Where can I learn more about electric vehicles?

You can learn more about PEVs on the following websites:

- Alternative Fuel Data Center – www.afdc.energy.gov
- Plug-in Electric Vehicle Collaborative – www.pevcollaborative.org
- Plug-in America – www.pluginamerica.org
- Plug-in Cars – www.pluginincars.com
- Go Electric Drive – www.goelectricdrive.org



Are Electric Vehicles Right for your Fleet?

You may not be sure an electric vehicle is the right decision for you. The following tools and resources are available to help guide you through the decision-making process.

Case Studies

Sacramento County Electric Refuse Trucks Demonstration:

Sacramento County will be a test market for all-battery electric heavy-duty refuse trucks provided by TransPower, which had been awarded nearly \$9 million by the CEC for electric truck and tractor demonstrations. Read more here:

<http://www.saccounty.net/news/latest-news/Pages/SacCounty-Chosen-to-Receive-Electric-Refuse-Trucks.aspx>.

Gilroy School District ZEV Bus: The City of Gilroy created a first-of-its-kind ZEV bus fleet. Watch the video here:

<http://www.afdc.energy.gov/case/2023>.

Sonoma County: This PowerPoint presentation provides an overview of how Sonoma County successfully installed PEV charging for its fleet.

http://www.acgov.org/sustain/documents/EV_Case_Study_Sonoma.pdf



SDG&E Workplace Charging: The Plug-in Electric Vehicle Collaborative has developed a case study about the charging stations at San Diego Gas & Electric. The workplace is host to over 100 PEV charging stations and serves not just employees, but an electric fleet of more than 25 PEVs. Read more:

<http://www.pevcollaborative.org/sites/all/themes/pev/files/docs/case-studies/SDGE.pdf>.

Several fleets in the San Diego region also use electric vehicles:



UC San Diego

Electric Vehicles: Cost Comparison

You've decided to consider adopting PEVs into your fleet. These tools are intended to help you better understand the financial benefits of adopting PEVs and the costs associated with their procurement.

Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool

The AFLEET tool is developed by the Department of Energy's Clean Cities Program. It estimates the environmental and economic costs of adopting alternative fuel vehicles into your fleet. It takes into consideration fuel costs, fuel types, and vehicle purchase price. Before getting started with this tool, having the following data available will strengthen the estimates returned:

- Vehicle class your fleet would likely adopt
- Annual vehicle miles of a single vehicle
- Vehicle purchase price
- Useful life of fleet vehicle(s).
- Financing terms in a loan is needed.

Take advantage of this tool here: <https://greet.es.anl.gov/afleet>.

Workplace Charging Calculator

The Workplace Charging Calculator was developed by CALSTART. It estimates the initial cost of installing charging infrastructure, operating costs, and how to recover them. This takes into consideration employee driving patterns, level of chargers to be installed, and energy costs. Use the tool here: <http://www.calstart.org/projects/Workplace-Charging.aspx>.

Savings in Fuel Costs

The [Alternative Fuel Data Center's Vehicle Cost Calculator](#) shows the total cost of ownership and emissions for a large variety of makes and models of most vehicles, including alternative fuel vehicles. You can also create your own custom vehicle if you cannot find the model you want. The tool is available here: <http://www.afdc.energy.gov/calc/>.

The Bren School of Environmental Science and Management at the University of California, Santa Barbara developed a high-efficiency vehicle comparison tool. Based on certain details, this tool will help inform the user which vehicle can save them the most money. The tool is available here: <http://iee.ucsb.edu/CleanCarCalculator>.

Incentives

Incentive Name	Incentive Website
Clean Vehicle Rebate Project	http://cleanvehiclerebate.org
Public Fleet Pilot Project	https://cleanvehiclerebate.org/eng/pfp
Alternative & Renewable Fuel and Vehicle Technology Program	http://www.energy.ca.gov/altfuels/
Low Emissions School Bus Grants	http://www.arb.ca.gov/msprog/schoolbus/schoolbus.htm
EVCS Loan and Rebate Program	http://www.treasurer.ca.gov/cpcf/calcap/evcs/index.asp
HOV Lane Access	http://www.arb.ca.gov/msprog/carpool/carpool.htm
California Hybrid and Zero-Emission Truck and Bus Voucher	https://www.californiahvip.org/

Incentive Project

Fleets can always visit the San Diego County Air Pollution Control District (SDAPCD) website for updated incentive information for the San Diego region. Their website is found at: <http://www.sdapcd.org/>.



Charging Stations

Steps to Installing PEV Charging Stations

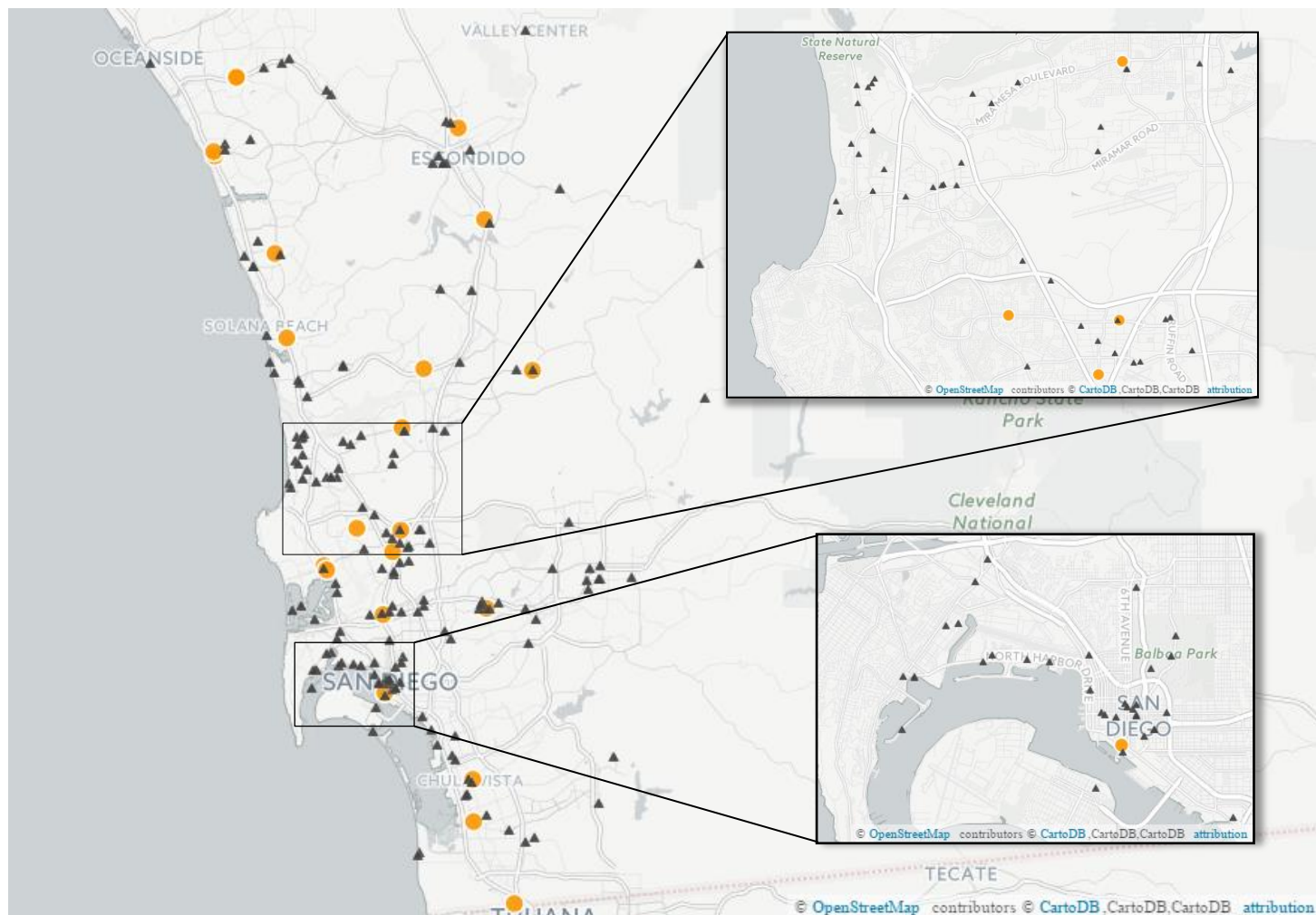
- Consider your fleet's needs over the next several years – due to the cost of charging station installations, include the fleet's projected PEV acquisitions when determining how many charging stations to install. If you anticipate an increase in PEVs, consider adding extra circuits and conduit to future charging station locations.
- Evaluate on-road mileage and charging times of PEVs – this will help inform the type of EVCS to install. If your fleet consists of PEVs that do not travel great distances during the day, 120v outlets (i.e., Level 1) may be sufficient.
- Locate EVCS and parking close to electric service – this may lower the overall installation cost.
- Consider designating PEV-only parking spaces, or fleet-only parking/charging spaces.
- Evaluate and address accessibility

The Clean Cities guide *Plug-In Electric Vehicle Handbook for Fleet Managers* includes more detailed information about the steps above and other relevant materials.¹



¹ http://www.afdc.energy.gov/pdfs/pev_handbook.pdf

Map of Public PEV Charging Stations in San Diego Region



*Triangles indicate Level 2 site; circles indicate DCFC site (Updated as of August 2015)

http://www.afdc.energy.gov/fuels/electricity_locations.html

What are the costs of installing a charging station?

The cost to install a charging station varies on the type of charging station and the location in which it will be installed. Though the cost of basic charging equipment is relatively low, costs get higher with additional electrical panel upgrades, wiring, and trenching.

While it may seem necessary to install Level 2 equipment for your fleet, it may make more sense to accommodate your fleet with Level 1 (i.e., a 120-volt plug with sufficient electrical capacity) options. This is especially true for fleet vehicles that tend to be dormant and in a central location overnight.

Estimated Cost of Installing EV Charging Station ²		
	Level 2	DC Fast Charging
Hardware	\$450-\$3,000	\$12,000-\$35,000
Electrician Labor	\$100-\$1,500	\$1,600-\$3,000
Electrician Materials	\$50-\$300	\$300-\$600
Other materials	\$50-\$150	\$100-\$400

Specific Cost Considerations ³	
Conduit	\$1.50-\$2.50/ft
Trenching	\$25-\$100/ft
Concrete Patch	\$14-\$15/sq. ft
Asphalt Patch	\$10-\$11/sq. ft

Codes and Standards

When installing a fueling station, it is important to adhere to the necessary codes and standards. This guidance document provides a thorough list of codes and standards for electric vehicles and infrastructure:

<http://www.afdc.energy.gov/pdfs/48605.pdf>.

Electric vehicle charging stations are governed by codes similar to those for other electrical devices, notably, the National Electrical Code (NEC) 625.⁴

Fueling Station Aspect	Pertinent Codes and Standards
Vehicle and Charger Interface	Society of Automotive Engineers (SAE) J-1772, J-2841, J-2293, J-2847, J-2836
Vehicle Charging Stations	NFPA 70 NEC article 625
Charging Station Components	UL FFTG, UL FFWA

² Information gathered from CALSTART "Best Practices for Workplace Charging" (2012:

http://www.calstart.org/Libraries/Publications/Best_Practices_for_Workplace_Charging.sflb.ashx) and Rocky Mountain Institutes "Pulling Back the Veil on EV Charging" (2014: http://blog.rmi.org/blog_2014_04_29_pulling_back_the_veil_on_ev_charging_station_costs)

³ Ibid.

⁴ http://www.psrc.org/assets/3729/A_NEC_625_2008.pdf?processed=true



E85/ Flex-Fuel

FACTS ABOUT ETHANOL

What is E85?

Ethanol is a renewable fuel made from various plant materials ("biomass") including corn, sugar cane, barley, and wheat.

There are several blends of ethanol: E10 (10% ethanol, 90% gasoline), which is universal in California gasoline, E15 (15% ethanol), and E85 (85% ethanol). E85 can be used in flex-fuel vehicles.

How many public stations are in the San Diego region?

As of July 2015, there are seven public E85 stations in the San Diego region. By 2016, three additional stations are expected to be open to the public.

How much does it cost to fuel my vehicle?

The chart below shows the average prices of gasoline and E85 over the past 24 months.

24-month average*	
Gasoline	\$3.35
E85	\$3.09
Savings	\$0.26

*June 2013-June 2015

- The use of 13.3 billion gallons of ethanol in 2012 reduced greenhouse gas (GHG) emissions from vehicles by 33.4 million metric tons – that's like removing 5.2 million vehicles from the road
- One bushel of corn equals approximately 2.8 gallons of ethanol
- Flex-fuel vehicles can use any blend between 0-85%
- Flex-fuel vehicles account for one out of three vehicles in the entire federal fleet
- Advanced cellulosic ethanol could reduce life cycle GHG emissions by up to 86%

What types of vehicles can use E85?

- Passenger vehicles
- Pick-up trucks
- Police vehicles
- Vans
- Medium-Duty trucks

Flex fuel vehicles can use regular gasoline and E85 interchangeably.



Did you know...

There are over 80 model year 2015 flex-fuel vehicles available in the U.S. You may already have flex-fuel capable vehicles in your fleet.

Where can I learn more?

- Alternative Fuel Data Center - www.afdc.energy.gov/fuels/ethanol.html
- Choose Ethanol - www.chooseethanol.com/
- American Coalition for Ethanol – www.ethanol.org
- Ethanol Across America – www.ethanolacrossamerica.net



Are Ethanol (E85) Vehicles Right for your Fleet?

You may not be sure if a flex-fuel vehicle is right for your fleet. The following tools and resources are available to help guide you through the decision-making process.

Case Studies

Idaho County Employs FFVs and Idle Reduction: This video shows how a county in Idaho has committed to using ethanol in its fleet. Due to ethanol use and new idle reduction policies, the county saved over \$105,000 in fuel in one year. Watch the video here: <http://www.afdc.energy.gov/case/663>

City of Hoover Fleet Boasts 200-Plus Flex-Fuel Vehicles (FFV): The City of Hoover's FFV fleet has traveled over 20 million miles between 2004 and 2013, using over 1.5 million gallons of E85. Read more at: <http://www.afdc.energy.gov/case/1423>

Mammoth Cave National Park Uses E85: In 1999, the National Park committed to using E85 in its FFVs and installed their own refueling station. Watch the video here: <http://www.afdc.energy.gov/case/83>

Caltrans: Beginning in 2006, the California Department of Transportation (Caltrans) was encouraged to use more alternative fuels in their fleet, citing that of the thousands of bi- and flex-fuel vehicles actively used, they were being filled with conventional gasoline, not ethanol. In 2013, it was reported that Caltrans used over 150,000 gallons of E85 per year for their fleet of over 2,500 light-duty bi- or flex-fuel vehicles. Read more about Caltrans's alternative fuel use here:

http://www.dot.ca.gov/hq/tpp/offices/orip/climate_change/documents/Caltrans_ClimateChangeRprt-Final_April_2013.pdf. Caltrans released report from an E85 monitoring project in which the vehicle activity from four Caltrans Districts was tracked to determine how much E85 was used. The report is available here: http://www.dot.ca.gov/research/researchreports/reports/2015/final_report_task_1919.pdf



E85/Flex-Fuel: Comparing Costs

Flex-fuel vehicles do not cost more than pure gasoline vehicles. Not only are they cost-competitive, but you are able to use gasoline in a flex-fuel vehicle, making the risk of adopting an alternative fuel very low.

Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool

The AFLEET tool is developed by the Department of Energy's Clean Cities Program (Clean Cities). It estimates the environmental and economic costs of adopting alternative fuel vehicles into your fleet. It takes into consideration fuel costs, fuel types, and vehicle purchase price. Before getting started with this tool, having the following data available will strengthen the estimates returned:

- Vehicle class your fleet would likely adopt
- Annual vehicle miles of a single vehicle
- Vehicle purchase price
- Useful life of fleet vehicle(s)
- Financing terms if a loan is needed

Take advantage of this tool here: <https://greet.es.anl.gov/afleet>.

The [Alternative Fuel Data Center's Vehicle Cost Calculator](#) shows the estimated total cost of ownership and emissions for a large variety of makes and models of most vehicles, including alternative fuel vehicles. You can also create your own custom vehicle if you cannot find the model you want. The tool is available at: <http://www.afdc.energy.gov/calculator/>.

Manufacturers

These are the biggest manufacturers of E85 vehicles. Look through the 2015 Clean Cities Vehicle Buyer's Guide for more details.¹ The Clean Cities Guide to Alternative Fuel and Advanced Medium- and Heavy-Duty Vehicles is another source of alternative fuel vehicles.²



GMC



CHEVROLET



DODGE



Cadillac



BUICK



TOYOTA



NISSAN

¹ http://www.afdc.energy.gov/uploads/publication/2015_vehicle_buyers_guide.pdf

² http://www.afdc.energy.gov/uploads/publication/medium_heavy_duty_guide.pdf

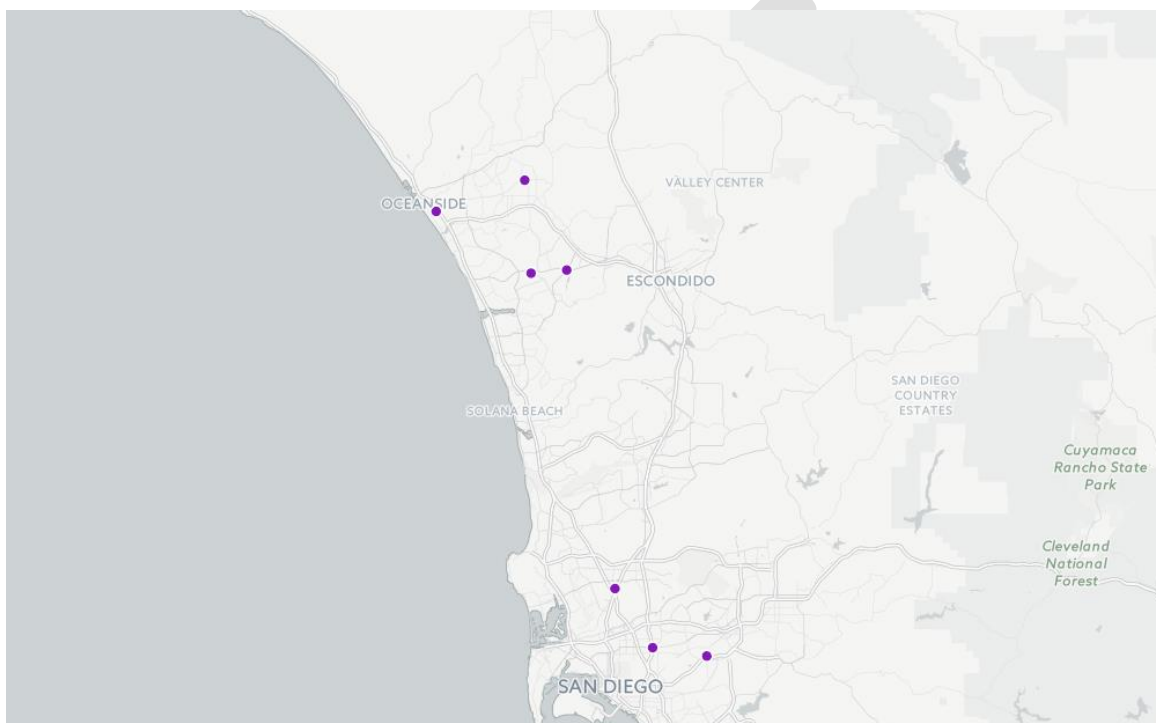
Fueling Stations

Using Fueling Stations

Fleets that want to incorporate E85 into their fleet operations can either rely on public fueling stations or install their own, private, fueling station.

When installing new petroleum fuel tanks, or upgrading old fuel tanks, it is recommended that your fleet uses or upgrades to an ethanol-compatible tank. Even if your fleet is not yet ready to have a tank dedicated exclusively to ethanol blends, this ensures cost savings in the future if your fleet ever does decide to have a private, dedicated E85 fueling station.

Map of Public E85 Fueling Stations in San Diego Region



(Map updated as of August 2015)

http://www.afdc.energy.gov/fuels/e85_locations.html

Installing E85 Equipment

Installing E85 equipment is very similar to installing conventional gasoline equipment. These are considerations when adding a private fueling station:

- **Determine fueling specifications** – How much fuel storage is needed for your fleet? Ensure to store enough fuel for your fleet. If there are other fleets nearby, it may be possible to share transport loads.
- **Is there an existing tank to be repurposed for E85?** – If so, ensure that the tank is properly cleaned out and that it is compatible with holding ethanol blends of E10 and higher.
 - **Underground tank:** It may be necessary for the existing underground storage tank's manufacturer to provide a statement of compatibility of their product with certain ethanol blends. All tank manufacturers have issued statements of compatibility with blends up to 98%. Read more in the EPA's guidance for the storage of ethanol blends in existing tanks: <http://www2.epa.gov/ust/alternative-fuels-and-underground-storage-tanks-usts>. Be sure to notify California's Underground Storage Tank Program of the intent to store ethanol-blends.

- **Above-ground tank:** Above-ground manufacturers have provided statements of compatibility with all ethanol blends including E85.
- **Dispensers:** It is preferred to install UL-certified E85 equipment, which became available in 2010. Be sure that blends of ethanol, such as E30 and E85, are sold from dedicated hoses with proper labeling.

Read more about the proper handling, storing, and dispensing of E85 here:

http://www.afdc.energy.gov/uploads/publication/ethanol_handbook.pdf.

Read more about E15 and Infrastructure here: http://www.afdc.energy.gov/uploads/publication/e15_infrastructure.pdf.

Ethanol Retailer also provides a comprehensive check-list for installing or converting your existing equipment to dispense ethanol blends: http://www.ethanolretailer.com/images/uploads/md_checklistforretailers_print.pdf.

Codes and Standards

When installing a fueling station, it is important to adhere to the necessary codes and standards. This guidance document provides a thorough list of codes and standards when developing ethanol infrastructure:

<http://www.afdc.energy.gov/pdfs/48603.pdf>.

The general standards for the dispensing and storage of ethanol fall under the National Fire Protection Association (NFPA) 30 Flammable and Combustible Liquids Code.³ It covers fire and explosion prevention, storage of liquid in containers, storage systems, and processing facilities. More specific codes and standards for other aspects of biofuel stations are found in the table below. Many of these codes and standards also apply to conventional gasoline fueling stations.

Fueling Station Aspect	Pertinent Codes and Standards
Containers	NFPA 30 American Society for Testing and Materials (ASTM) Standards for Containers American National Standards Institute (ANSI)/ Underwriters Laboratory (UL) Standards for Containers US Department of Transportation (DOT) 10CFR49
Dispensing Operations	NFPA 30 NFPA 30A NFPA 385 NFPA 10
Storage of Liquids	UL 2245, 2080, 2085 NFPA 91, 30A Steel Tank Institute (STI) Corrosion Control Standards

³ <http://www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=30>



Hydrogen Fuel Cells

FACTS ABOUT HYDROGEN

What is hydrogen?

Hydrogen is found in organic matter and in water (H₂O). The majority of hydrogen for transportation is produced by extracting it from natural gas. Hydrogen can also be extracted from water; however, this is a more energy intensive method.

Hydrogen fuel cell electric vehicle (FCEV) is a vehicle that is powered by hydrogen. Hydrogen is pumped into pressurized cylinders in the vehicle. The fuel cell converts the hydrogen into electrical energy to drive the motor.

Fuel cell vehicles are zero-emission vehicles that emit water vapor and warm air as exhaust.

How many public hydrogen stations are in the San Diego region?

The region's first public hydrogen station is scheduled to be installed by early 2016.

How much does it cost to fuel my vehicle?

According to the Department of Energy (DOE), a full tank of compressed hydrogen will cost around \$50 (and provide a range of approximately 300 miles). The DOE also estimates that the future costs will fall to \$30 to fill a tank of hydrogen.

The target price for hydrogen is \$4.00/gallon of gasoline equivalent.

Auto manufacturers such as Toyota and Hyundai provide vehicle buyers free hydrogen for three years.



- Much of the hydrogen in the US is produced in three states: California, Louisiana, and Texas (Energy Information Administration, EIA)
- Approximately 10-11 million metric tons of hydrogen are produced in the US each year; enough to power 20-30 million cars or 5-8 million homes (EIA)
- Hydrogen fuel can be made from many sources, including wind, solar, biogas, and biomass in addition to natural gas
- A fuel cell is required to last 5,000 hours or 150,000 miles before needing to be replaced

Courtesy of CA Fuel Cell Partnership

What types of vehicles use hydrogen?

Hydrogen fuel cells are a fairly new technology, but there are still plenty of vehicles that can use this type of fuel.

- Passenger vehicles
- Shuttle buses
- Transit buses
- Forklifts

A sampling of the available vehicles can be found on the California Fuel Cell Partnership (CAFCP) website: <http://www.caftp.org/carsandbuses/makesandmodels>.



Did you know...

- More than 80 hydrogen-powered buses operate globally, include 15 in California
- Fuel Cell vehicles take less than five minutes to refuel
- FCEVs are zero emission and run on compressed hydrogen fed into a fuel cell "stack" that produces electricity to power the vehicle
- Learn about the Fuel Cell Electric Bus Roadmap for California here: <http://www.caftp.org/sites/files/FCEB-RoadMap-Infographic.pdf>



Where can I learn more about hydrogen?

- Alternative Fuel Data Center: www.afdc.energy.gov/fuels/hydrogen.html
- California Fuel Cell Partnership: www.fuelcellpartnership.org/
- DOE Fuel Cells Technology Office: energy.gov/eere/fuelcells/fuel-cell-technologies-office
- FuelCells.org: www.fuelcells.org/
- Fuel Cell & Hydrogen Energy Association: www.fchea.org/
- International Association for Hydrogen Energy: www.iahe.org
- Hydrogen Analysis Resource Center: hydrogen.pnl.gov/
- Fuel Cell Today: fuelcelltoday.com/

Are Hydrogen Vehicles for your Fleet?

You may not be sure if a FCEV is the right choice for your fleet. The following tools and resources are available to help guide you through the decision-making process. Please note that hydrogen FCEVs are in the early stages of commercial deployment, and are already showing promise in real-world applications.

Case Studies

Fuel Cell Electric Buses: Sunline Transit Agency, in partnership with the Southern California Association of Governments, will deploy hydrogen fuel cell buses that serve the Southern California region. Learn more about this fleet: <http://www.sunline.org/clean-fuels-fleet>.

Fuel Cells for Industrial Facility: This case study highlights the different applications of hydrogen fuel cells for operations at industrial facilities. Read more at: <http://www.plugpower.com/wp-content/uploads/2014/12/Whitepaper-Fuel-Cells-A-Smart-Decision.pdf>.

Alameda-Contra Costa Transit District (AC Transit) Launches Innovative Hydrogen Fueling Facility: This case study shows how successful AC Transit, and a coalition of regional transit partners in the Bay Area, has been in serving 7 million people with its hydrogen production and dispensing station to fuel its zero-emission fuel cell buses. Read more at: <http://www.actransit.org/2012/04/10/ac-transit-launches-innovative-hydrogen-fueling-facility/>.

GM Fuel Cell Vehicle travels over 100,000 Miles: General Motors has a fuel cell that has traveled over 100,000 miles in real-world driving. Learn more about Project Driveway and the success of this vehicle here: <http://media.gm.com/media/us/en/gm/news.detail.html/content/Pages/news/us/en/2013/Oct/1022-fc-equinox.html>



Hydrogen Fuel Cell Vehicle: Comparing Costs

You've decided that it makes sense to consider buying FCEVs; however, it is still unclear what the vehicle(s) and infrastructure will cost.

Currently, there are no calculators or tools to accurately assess the cost of owning or leasing a FCEV. One of the primary reasons for this is because these vehicles are new to the market. Another reason is that many calculators assess fuel cost as part of their analysis; the cost of hydrogen for retail use does not have an accurate metering system.

Despite these unknowns, there are things we do know:

- Automakers such as Toyota are covering most fueling costs for early-adopting FCEV purchasers/owners. As of September 2015, Toyota's fuel cell vehicle, the Mirai, has been set at \$57,500 and a \$499/month lease.¹
- The Hyundai Tucson Fuel Cell costs \$499/month for 36 months with \$2,999 down.²
- The Mercedes Benz B-Class F-Cell has no listed price yet, but offers an application to its pilot program.³
- As of September 2015, the Honda FCX Clarity is no longer available for lease until the release of its 2016 model.⁴

Incentives

There are various incentives available for the purchase/lease of a FCEV, and there may be special opportunities for demonstration projects as well.

Incentive Name	Incentive Website
Clean Vehicle Rebate Project	http://cleanvehiclerebate.org
Public Fleet Pilot Project	https://energycenter.org/public-fleet-project
Alternative & Renewable Fuel and Vehicle Technology Program	http://www.energy.ca.gov/altfuels/
Low Emissions School Bus Grants	http://www.arb.ca.gov/msprog/schoolbus/schoolbus.htm
HOV Lane Access	http://www.arb.ca.gov/msprog/carpool/carpool.htm

¹ http://www.greencarreports.com/news/1095511_2016-toyota-mirai-priced-at-57500-with-499-monthly-lease

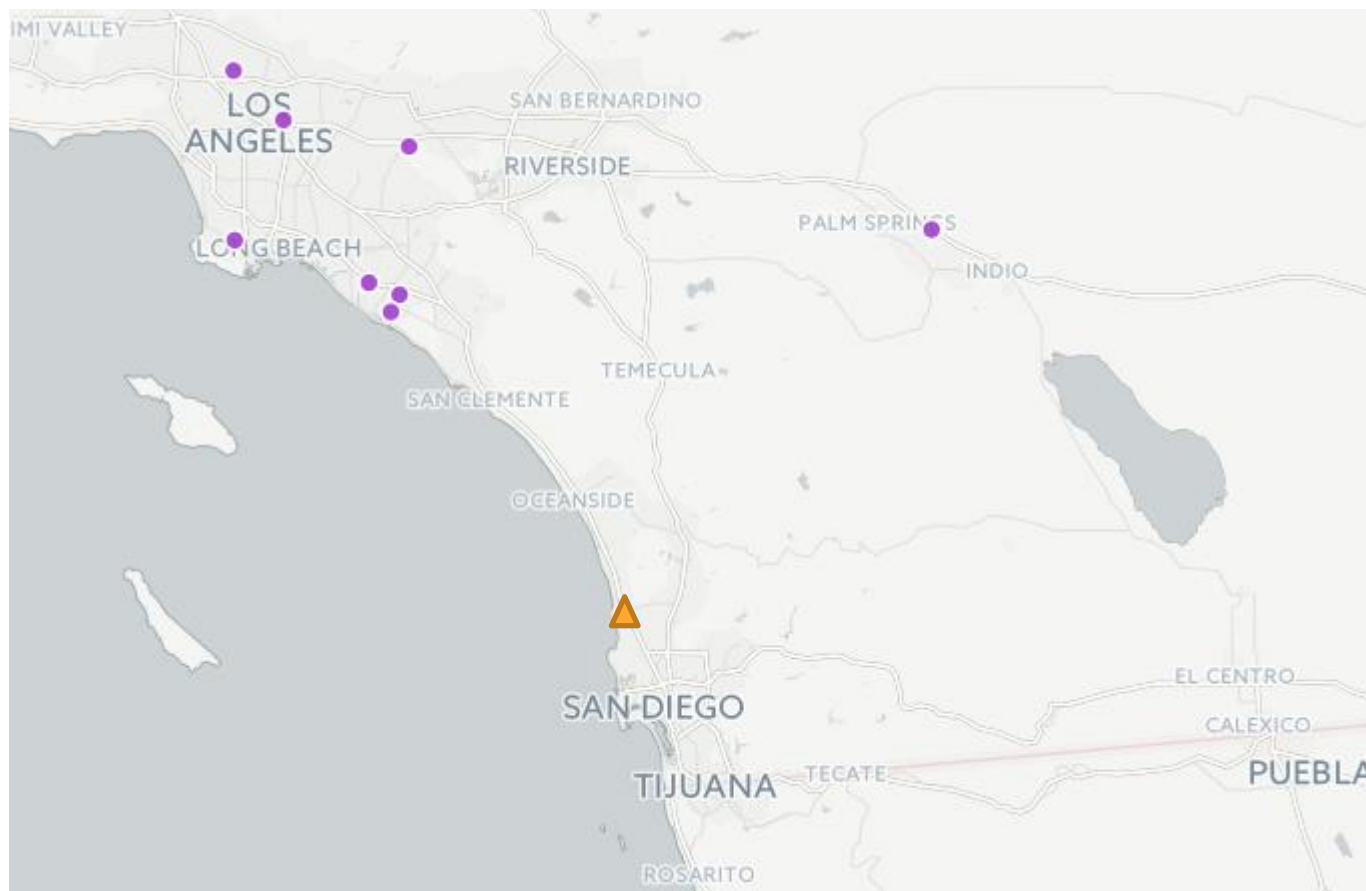
² <http://www.hyundainews.com/us/en/models/tucson-fuel-cell/2015>

³ http://www.mbusa.com/mercedes/benz/green/electric_car

⁴ <http://automobiles.honda.com/fcx-clarity/>

Fueling Stations

Map of Existing and Future Public Hydrogen Fueling Stations



*circles indicate existing fueling stations; triangles indicate planned stations
(Map updated as of August 2015)

http://www.afdc.energy.gov/fuels/hydrogen_locations.html

What are the costs of installing a hydrogen fueling station?

The cost of installing a charging station varies based on the type of fueling station and location in which it will be installed. Hydrogen stations are currently cost-shared by the State of California through the Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP).⁵

A "hydrogen station" is typically added to an existing fueling station (gasoline or compressed natural gas, CNG). Hydrogen fueling equipment includes a dispenser, storage tubes and a compressor. Like CNG, hydrogen is a compressed gas that is stored above ground in cylinders. Hydrogen can be delivered to the station as a compressed gas or as a liquid, which is then warmed up to form a gas and then compressed. Hydrogen can also be made on site from natural gas or water. If the station makes hydrogen on site, the footprint can be significant to accommodate for the production equipment.

⁵ <http://www.energy.ca.gov/contracts/transportation.html>

This document from NREL provides cost estimates for a station installation: <http://www.nrel.gov/docs/fy13osti/56412.pdf>.

Codes and Standards

Codes and standards are already in place for hydrogen fueling stations. This guidance document provides a thorough list of codes and standards to adhere to when developing hydrogen infrastructure: <http://www.nrel.gov/docs/fy13osti/56223.pdf>

Codes, standards, and regulations for the generation, installation, storage, piping, use, and handling of hydrogen fall under the National Fire Prevention Association standards (NFPA2).⁶

Provisions apply to the production, storage, transfer, and use of hydrogen in all occupancies and on all premises. NFPA 2 includes fundamental requirements for hydrogen in both gaseous and liquid phases and contains additional use-specific categories, such as vehicle fueling facilities, systems for fuel cell power and generation, applications involving combustion processes and special atmospheres, and operations in the lab. More specific codes and standards for other aspects of biofuel stations are found in the following table. Many of these codes and standards also apply to conventional gasoline fueling stations.

Fueling Station Aspect	Pertinent Codes and Standards
Containers	NFPA 1, 2, 70 (NEC)
Dispensing Operations	NFPA 2 SAE J2601 Fueling Protocol ASME B31.12 Hydrogen Piping and Pipelines
Storage of Hydrogen	UL 2075 SAE J2579 Vehicle Fuel Systems

⁶ <http://www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=2>



Natural Gas

FACTS ABOUT NATURAL GAS

What is natural gas?

Natural gas used as a transportation fuel is used as compressed natural gas (CNG) or liquefied natural gas (LNG). Natural gas is a mixture of hydrocarbons, predominantly methane (CH₄).

CNG is natural gas that has been compressed and stored as a gas in high pressure tanks up to 3,600 pounds per square inch (psi). LNG is natural gas that is cooled to a temperature below -260°F.

Nearly 87% of U.S. natural gas is domestically produced and boasts 20-40% less carbon monoxide and 80% particulate matter than gasoline. According to the Natural Gas Vehicle Coalition, there are about 112,000 natural gas vehicles on U.S. roads.

How many public natural gas stations are in the San Diego region?

There are approximately ten public CNG stations in the San Diego region, with two more in development.

How much does it cost to fuel my vehicle?

CNG is generally less expensive than gasoline. Further, the price per gallon equivalent of CNG does not experience volatile fluctuations like gasoline or diesel.

24-month average*	
Gasoline	\$3.35
CNG	\$2.13
Savings	\$1.22

*June 2013-June 2015

- On a well-to-wheels basis, natural gas vehicles (NGVs) produce 22% less greenhouse gas (GHG) than comparable diesel vehicles and 29% less than gasoline vehicles
- Nearly four in five transit buses in San Diego County run on CNG
- CNG passenger vehicles are eligible for California's HOV lane access decal, which allows single-occupant vehicles to drive in the HOV lanes

What types of vehicles can use natural gas?

Several types of vehicles can use natural gas. It is a versatile fuel.

- Vans
- Pick-up trucks
- Refuse hauler
- Low-speed vehicle
- Med- and heavy-duty vehicles
- Transit Bus
- Light-duty vehicle



Types of natural gas vehicles

- **Dedicated:** These vehicles are designed to run only on natural gas.
- **Bi-fuel:** These vehicles have two separate fueling systems that enable them to run on either natural gas or gasoline.
- **Dual-fuel:** These vehicles are traditionally limited to heavy-duty applications, have fuel systems that run on natural gas, and use diesel fuel for ignition assistance.

Renewable Natural Gas (RNG), also called biomethane, or sustainable natural gas, is produced from biogas (i.e., swamp gas, landfill gas, or digester gas). When processed to a higher purity standard, RNG can be used as an alternative fuel in NGVs.



Where can I learn more about natural gas?

- Alternative Fuel Data Center Natural Gas: www.afdc.energy.gov/fuels/natural_gas.html
- AFDC Renewable Natural Gas: www.afdc.energy.gov/fuels/emerging_biogas.html
- Natural Gas Vehicles for America: www.ngvamerica.org/
- CNG Now!: www.cngnow.com/
- California Natural Gas Vehicle Coalition: www.cngvc.org/
- Department of Energy: energy.gov/natural-gas
- American Gas Association: www.aga.org

Are Natural Gas Vehicles for your Fleet?

You may not be sure if a natural gas vehicle is right for you. The following tools and resources are available to help guide you through the decision-making process.

Case Studies

Refuse Fleets Using CNG: Fleets of heavy-duty refuse trucks have seen success with switching to CNG. In this case study by the Department of Energy, three refuse fleets are highlighted: Republic Services, a national waste and recycling services company; Groot Industries, Inc., a small residential pick-up and disposal company in Illinois; and the City of Milwaukee's Department of Public Works (DPW). Read more at:

http://www.afdc.energy.gov/uploads/publication/casestudy_cng_refuse_feb2014.pdf.

Transit Buses Using CNG: Of the City of Culver City's fleet of 650 vehicles and equipment, 46 are CNG including transit buses, refuse trucks, heavy-duty public works trucks, park vehicles, and other staff vehicles. Read more at

<http://www.socalgas.com/documents/innovation/natural-gas-vehicles/NGV-CulverCity-CNG-Bus.pdf>.

Several San Diego fleets also use natural gas vehicles:



San Diego International Airport: Carbon Reductions through Renewable Natural Gas Provided by Clean Energy

Clean Energy (CE) has been providing CNG to San Diego International Airport (SD Airport) customers for about 10 years, but in October 2013, began providing renewable natural gas to two SD Airport stations. CE's brand of RNG is called "Redeem", and it is captured from different renewable sources such as landfills and wastewater treatment plants. The decomposition of organic matter produces bio-methane, an otherwise harmful gas when released into the atmosphere, which is captured and treated before being injected into the grid as pipeline-quality methane. The RNG flows to CE stations through the natural gas pipeline, and dispensed as transportation fuel to those who fuel at CE stations.

In an effort to reduce greenhouse gases (GHG), SD Airport encourages the use of alternative fuels for all transportation modes that serve them. Natural Gas vehicles (NGVs) give airport fleets the largest carbon reduction possible for vehicles such as cutaway shuttles, buses, and vans. NGVs are available in most platforms and are used by rental car shuttle, parking shuttle and vehicle for hire shuttle customers, making natural gas the most common alternative fuel used at the SD Airport.

Ultra low sulfur diesel vehicles and gasoline vehicles produce a well-to-wheel carbon intensity of 94.71 and 95.86 gCO₂/Megajoule (MJ), respectively. When the SD airport vehicles started fueling on pipeline natural gas (before introduction of Redeem), the average well-to-wheel carbon intensity was 67.70 gCO₂/MJ. These numbers are taken from the California Air Resources Board GREET standard which was most recently updated in 2010.¹

Now that CE is flowing Redeem to these stations, vehicles fueling at CE stations are contributing only 27.8 gCO₂/MJ. This puts NGVs in a similar carbon reduction category as plug-in electric vehicles (PEVs), which contribute 35 gCO₂/MJ after the PEV engine efficiency is included in the calculation.

Over the past 12 months, CE's combined SD airport fueling has reduced carbon emissions by 4,965 metric tons when compared to gasoline or diesel. This is the equivalent of taking over 1,000 cars off the road.

Customers and regional transportation authorities are encouraged to use the emissions calculator that is available on the CE website. It's relatively easy to use and gives a general snapshot of the positive environmental impact one can make by operating NGVs in place of gasoline and diesel vehicles. It's important to note that the emissions calculator provides a reduction based on an estimated average CI value, and actual reductions may vary as the overall carbon intensity of Redeem changes as new RNG sources are added to CE's supply portfolio.

The Emissions Calculator can be found here: <http://www.cleanenergyfuels.com/emissions-calculator/>.



¹ ARB GREET standard: http://www.arb.ca.gov/fuels/lcfs/121409lcfs_lutables.pdf

Natural Gas: Cost Comparison

You've decided that it makes sense to consider adopting NGVs into your fleet. However, it is still unclear what the vehicles and infrastructure will cost. These tools are intended to help you better understand the financial benefits of adopting NGVs and the costs associated with their procurement.

Vehicle and Infrastructure Cash-Flow Evaluation Model (VICE)



The VICE tool is developed by the Department of Energy's Clean Cities Program (Clean Cities). It estimates the environmental and economic costs of adopting NGVs into your fleet. It takes into consideration fuel costs, fuel types, and vehicle purchase price. Before getting started with this tool, having the following data available will strengthen the estimates returned:

- Are you thinking of procuring only vehicles or both vehicles and fueling infrastructure?
- Will you be investing in NGVs and fueling infrastructure at the same time?
- Is your fleet tax exempt?
- What types of vehicles are you considering to replace? (transit bus, school bus, track truck, paratransit, delivery truck, gasoline pick-up truck, or gasoline taxi)

Keep in mind the following:

- Incremental cost of vehicle
- Average vehicle miles traveled (VMT)
- Average vehicle life
- Fuel economy
- Any infrastructure tax credit or incentives available? (see Incentives section)
- The number of NGVs you want to acquire and your timeline for acquisition

The tool, an excel spreadsheet, can be found here: http://www.afdc.energy.gov/vice_model/.

Savings in Fuel Costs

There are tools available to estimate your fuel savings when switching to a NGV. The basic information to have on-hand when using these tools are:

- Average number of miles driven per year
- Average miles per gallon (MPG) of the fleet vehicle
- Number of vehicles to be switched to NGVs

The [Alternative Fuel Data Center's Vehicle Cost Calculator](http://www.afdc.energy.gov/calc/) shows the total cost of ownership and emissions for a large variety of makes and models of most vehicles, including alternative fuel vehicles. You can also create your own custom vehicle if you cannot find the model you want. The tool is available here: <http://www.afdc.energy.gov/calc/>.

[CNG Now!](http://www.cngnow.com/vehicles/calculator/pages/information.aspx) has a CNG calculator that determines your estimated fuel savings at the pump when switching from gasoline vehicles to CNG. The tool is <http://www.cngnow.com/vehicles/calculator/pages/information.aspx>.

Incentives

Incentive Name	Incentive Website
High-Occupancy Vehicle Lane Exemption	http://www.arb.ca.gov/msprog/carpool/carpool.htm
CNG Tax Exemption for Transit Use	http://www.oal.ca.gov/
Alternative and Renewable Fuel and Vehicle Technology Program	http://www.energy.ca.gov/contracts/
Alternative Fuel Tax Exemption	http://www.irs.gov/pub/irs-pdf/p510.pdf
DOE Loan Guarantee Program	http://energy.gov/lpo/loan-programs-office
Low Emissions School Bus Grants	http://www.arb.ca.gov/msprog/schoolbus/schoolbus.htm
Proposition 1B Goods Movement Emissions Reduction Program	http://www.sdapcd.org/homepage/grants/grants.html
Carl Moyer Memorial Air Quality Standards Attainment Grant Program	http://www.sdapcd.org/homepage/grants/grants.html

Fleets can always visit the San Diego County Air Pollution Control District (SDAPCD) website for updated incentive information for the San Diego region. Their website is found at: <http://www.sdapcd.org/>.



Fueling Stations

Using Fueling Stations

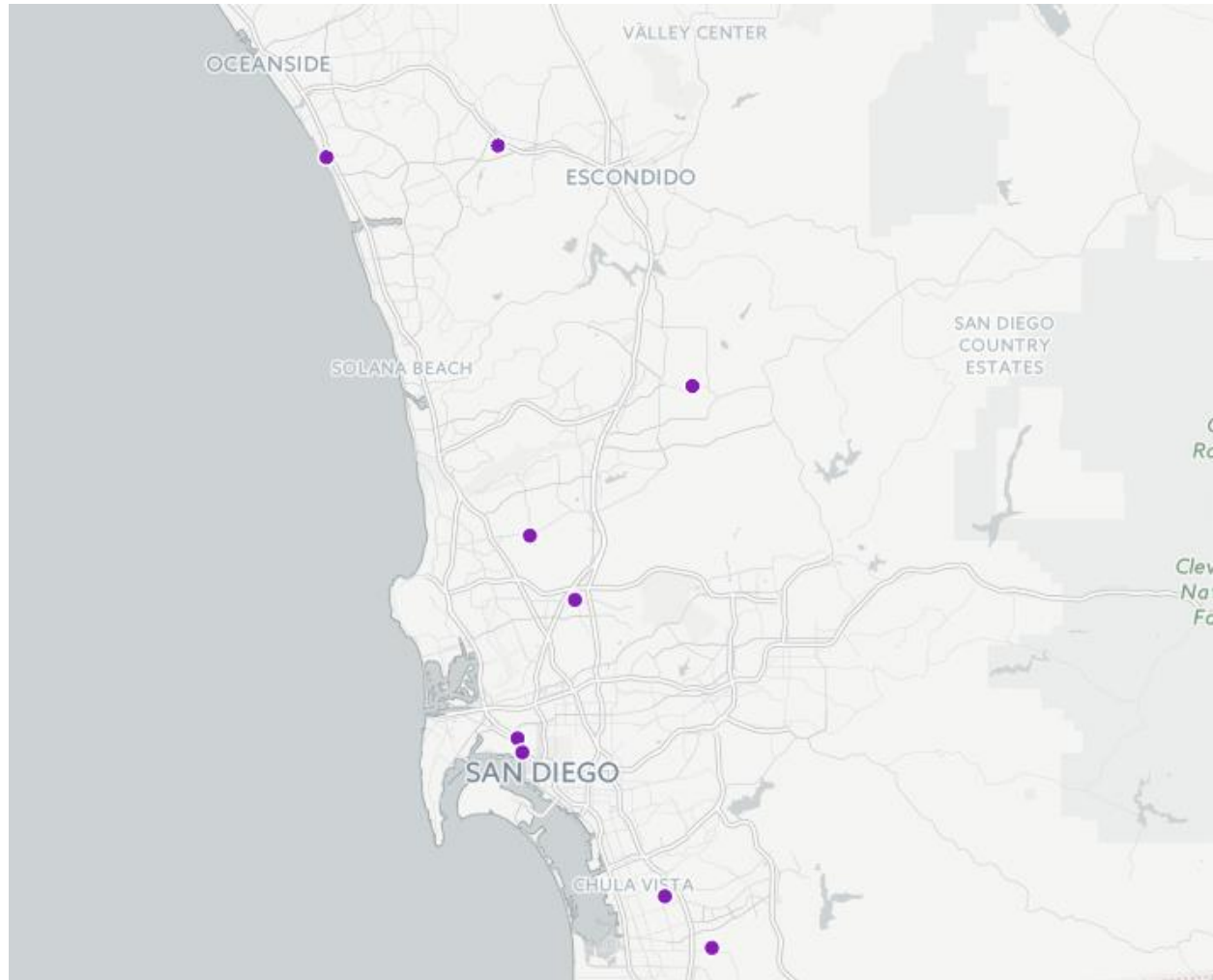
The following options are available:²

- **On-site private fueling:** The fleet/end-user has a fueling station constructed on the fleet's operating site, and the fuel is available only to that fleet. This typically requires a long-term fueling agreement with the natural gas provider/installer.
- **Off-site private fueling:** Fueling station is located away from the fleet/end-user's operating site. The fleet/end-user is given exclusive access to these stations with some sort of code/card system. These stations are owned by a third party.
- **On-site fueling for fleets with public access:** The fleet/end-user has a fueling station constructed on the fleet's operating site, and the fuel is available to not only the fleet, but to the public as well.
- **Off-site public fueling:** A third party builds a CNG fueling station in an area that is convenient for a variety of fleets and private consumers to access. It is open to anyone who needs to fill a vehicle with natural gas. This is a popular option among fleets because it is a convenient and familiar fueling experience without the fuel commitment needed with on-site private fueling option.



² Minton, Rob. "Fueling Your Natural Gas Vehicle". Green Fleet Magazine. November 2014.

Map of Public CNG Fueling Stations in San Diego Region



(Map updated as of August 2015)

http://www.afdc.energy.gov/fuels/natural_gas_locations.html

What are the costs of installing a fueling station?

The VICE model (above section) covers fueling station costs and considerations. To read more about the costs involved in installing a fueling station, the Department of Energy has a comprehensive guide, *Costs Associated with Compressed Natural Gas Vehicle Fueling Infrastructure*³, which detail cost ranges for infrastructure, cost considerations (such as permitting), with recommendations from the natural gas industry.

The following table lists general costs associated with various sized fueling stations.

³ http://www.afdc.energy.gov/uploads/publication/cng_infrastructure_costs.pdf

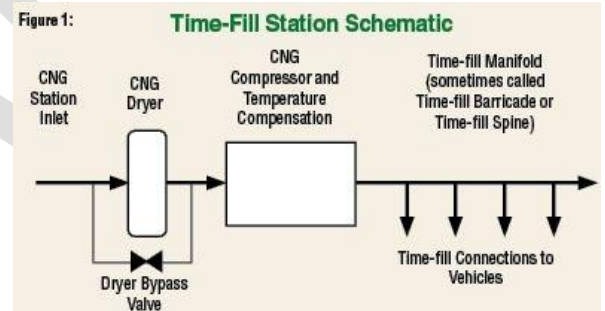
Estimated CNG Station Cost⁴

Station Size	Cost Range
Individual Time-Fill (5-10 gge/day)	\$5,500-\$10,000
Starter Station (20-40 gge/day)	\$35,000-\$75,000
Small Station (100-200 gge/day)	\$250,000-\$600,000
Medium Station (500-800 gge/day)	\$550,000-\$900,000
Large Station (1,500-2,000 gge/day)	\$1.2-\$1.8 million

Designing a CNG Fueling Station⁵

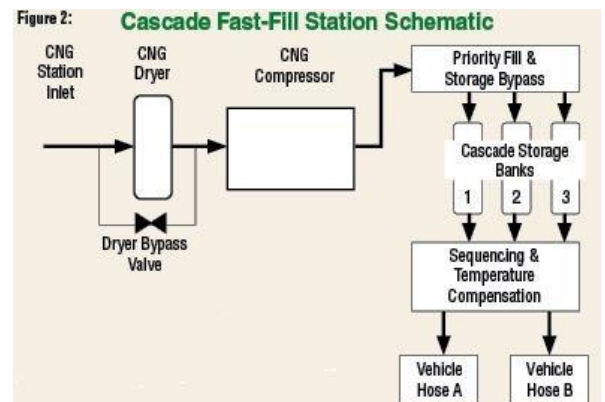
Time-Fill Station

A time-fill station receives fuel from a local utility line at low pressure and then an on-site compressor converts the gas to a high pressure. However, the compressed fuel is not stored. Vehicles fill up directly from the compressor. Usually there is a tank with compressed fuel too, but that is meant to keep the compressor from turning on and off throughout the day. These stations are suitable for vehicles with large tanks that refuel at a central location every night.



Fast-Fill Station

A fast-fill station receives fuel from a local utility line at low pressure and then an on-site compressor converts the gas to a high pressure like a time-fill station. The difference is that after being compressed, the fuel is stored so that it is available for a quick fill-up. These stations are most suitable for retail situations in which many light-duty vehicles may arrive throughout the day and need to fill up quickly.



Detailed explanations of designing a fueling station, along with information about sizing and fueling station components can be found in this article: <http://www.government-fleet.com/article/story/2014/06/designing-a-cng-fueling-station.aspx>.

⁴ Summarized from AFDC's *Costs Associated with Compressed Natural Gas Vehicle Fueling Infrastructure*. Sept 2014. http://www.afdc.energy.gov/uploads/publication/cng_infrastructure_costs.pdf.

⁵ Images from government-fleet.com.

Codes and Standards

When installing a fueling station, it is important to adhere to the necessary codes and standards. This guidance document provides a thorough list of codes and standards when developing natural gas infrastructure:

<http://www.afdc.energy.gov/pdfs/48611.pdf>.

The general standards for natural gas fall under National Fire Protection Association (NFPA) 52 Gaseous Fuel Systems Code.⁶ This code addresses the design, installation, compression, storage, and dispensing system of CNG and LNG. It seeks to mitigate the risk of fire and explosion hazards. More specific codes and standards are in the table below.

Dispensing and Storage	Pertinent Codes and Standards
Dispensing Component Standards	NFPA 52 Canadian Standards Association (CSA) NGV 2, 1, 3.1, 4
Dispensing Operations	NFPA 52
Dispensing Vehicle Interface	Society of Automotive Engineers (SAE) J1616 RP, J2406 RP
Storage Containers	NFPA 52



⁶ <http://www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=52>



Propane Autogas

FACTS ABOUT PROPANE AUTOGAS

What is propane autogas?

Propane autogas is also known as liquefied petroleum gas (LPG).

While gaining popularity as an alternative fuel in the United States, propane is the third most common transportation fuel in the world.

Nearly all U.S. propane is produced domestically and over half of it is a byproduct from natural gas purification.

Propane is a clean burning fossil fuel with lower greenhouse gas emissions than gasoline.

How many public propane stations are in the San Diego region?

There are 15 public propane stations in the San Diego region as of July 2015.

How much does it cost to fuel my vehicle?

Generally, propane autogas is less expensive than gasoline.

24-month average*	
Gasoline	\$3.35
LPG	\$2.86
Savings	\$0.49

*June 2013-June 2015

- There are over 80,000 bus, taxi, and delivery services nationwide that use propane autogas in their fleets
- Propane autogas is the third most common transportation fuel in the world
- Propane accounts for 2% of the nation's energy use
- There are more propane autogas fueling stations available in the U.S. than any other alternative fuel station (aside from electric charging stations) as of July 2015

What kind of vehicles use propane?

- Forklifts
- Low-Speed Vehicles
- Buses
- School Buses
- Lawn equipment
- Trucks
- Shuttles
- Delivery services



Where can I learn more?

- Alternative Fuel Data Center: www.afdc.energy.gov/fuels/propane.html
- National Propane Association: www.npga.org
- Propane Education and Research Council: www.propanecouncil.org
- Autogas USA: www.autogasusa.org
- Propane: www.propane.com



Are Propane Vehicles for your Fleet?

You may not be sure if a propane vehicle is the right choice for your fleet. The following tools and resources are available to help guide you through the decision-making process.

Case Studies

Propane School Bus Fleets: School bus fleets using propane autogas have saved school districts nearly 50% on a cost per mile basis for fuel and maintenance. This Alternative Fuel Data Center (AFDC) case study highlights four school bus fleets in Texas and one in Virginia. Read more at: <http://www.afdc.energy.gov/uploads/publication/case-study-propane-school-bus-fleets.pdf>.

Propane is a Reliable Fleet Fuel: This AFDC case study notes how successful propane autogas has been as a fleet fuel. This discusses how several fleets across the country have found success with propane. Read more at <http://www.afdc.energy.gov/case/2043>.

DHL Delivers on Green: This Green Fleet Magazine article highlights DHL's propane autogas fleet. Read more here: <http://www.greenfleetmagazine.com/channel/propane/article/story/2012/10/dhl-delivers-on-green-grn.aspx>.

Several fleets in the San Diego region use propane autogas:



Chula Vista Elementary School District

The Chula Vista Elementary School District has 10 propane autogas buses out of its fleet of 118. These autogas buses were made possible thanks to a state funding opportunity. Each year, these propane vehicles drive an average of 15,000 miles per year.



Old Town Trolley Tours

Old Town Trolley Tours in San Diego is home to 30 propane trolleys. These trolleys give tours to approximately 500 to 1,000 San Diego visitors per day. In the year 2014, the propane trolley fleet traveled over 434,300 miles, displacing nearly 30,000 gallons of gasoline equivalent and reduced about 125 tons of GHG emissions. For more questions about the fleet and their green fleet, contact Norm Niles, Maintenance Manager at (619) 298-8687.



Propane Autogas: Cost Comparison

You're considering integrating propane autogas into your fleet. These tools are intended to help you better understand the financial benefits of adopting propane vehicles and the costs associated with their procurement and infrastructure.

Alternative Fuel Life-Cycle Environmental and Economic Transportation (AFLEET) Tool

The AFLEET tool was developed by the Department of Energy's Clean Cities Program. It estimates the environmental and economic costs of adopting alternative fuel vehicles into your fleet. It takes into consideration fuel costs, fuel types, and vehicle purchase price. Before getting started with this tool, having the following data available will strengthen the estimates returned:

- Vehicle class your fleet would likely adopt
- Annual vehicle miles of a single fleet vehicle
- Vehicle purchase price of vehicles typically purchased
- Useful life of fleet vehicle(s) – of typical fleet vehicle
- Will a loan be used to purchase vehicles? If so, what are the terms of the loan?

The AFLEET tool is here: <https://greet.es.anl.gov/afleet>.

Savings in Fuel Costs

There are tools available to estimate your fuel savings when switching to a propane vehicle. The basic information to have on-hand when using these tools are:

- Average number of miles driven per year per vehicle
- Average MPG of the fleet vehicle
- Number of vehicles to be switched to propane

The [Alternative Fuel Data Center's Vehicle Cost Calculator](http://www.afdc.energy.gov/calc/) shows the total cost of ownership and emissions for a large variety of vehicle makes and models, including alternative fuel vehicles. You can customize a vehicle if you cannot find the model you are looking for. The tool is: <http://www.afdc.energy.gov/calc/>.

The [Propane Autogas Calculator](http://www.propanecostcalculator.com/autogas/) allows users to compare propane vehicles to diesel and gasoline. This tool will determine lifetime operating costs for a propane autogas vehicle and its lifetime ownership costs. The web tool is found: <http://www.propanecostcalculator.com/autogas/>. Additionally, the Propane Education and Research Council offers phone apps to help you calculate propane cost savings: <http://www.propane.com/on-road-fleets/calculator/>.



Incentives

There are several incentives available to finance your propane vehicle or equipment. The most up-to-date list of incentives for propane equipment and vehicles can be found on the AFDC website: <http://www.afdc.energy.gov/laws>.

Incentive Name	Incentive Website
Low-and Zero-Emission Vehicle Research, Demonstration, and Deployment Funding	http://www.fta.dot.gov/documents/MAP-21_Fact_Sheet_-_Research_Development_Demonstration_and_Deployment_Projects.pdf
Low Emission School Bus Grants	http://www.arb.ca.gov/msprog/schoolbus/schoolbus.htm
Carl Moyer Memorial Air Quality Standards Attainment Grant Program	http://www.sdapcd.org/homepage/grants/grants.html
Propane Appliance, Vehicle, Forklift, and Irrigation Engines Rebate Program	http://www.westernpga.org/wperc-rebates/

Fleets can always visit the San Diego County Air Pollution Control District (SDAPCD) website for updated incentive information for the San Diego region. Their website is found at: <http://www.sdapcd.org/>.



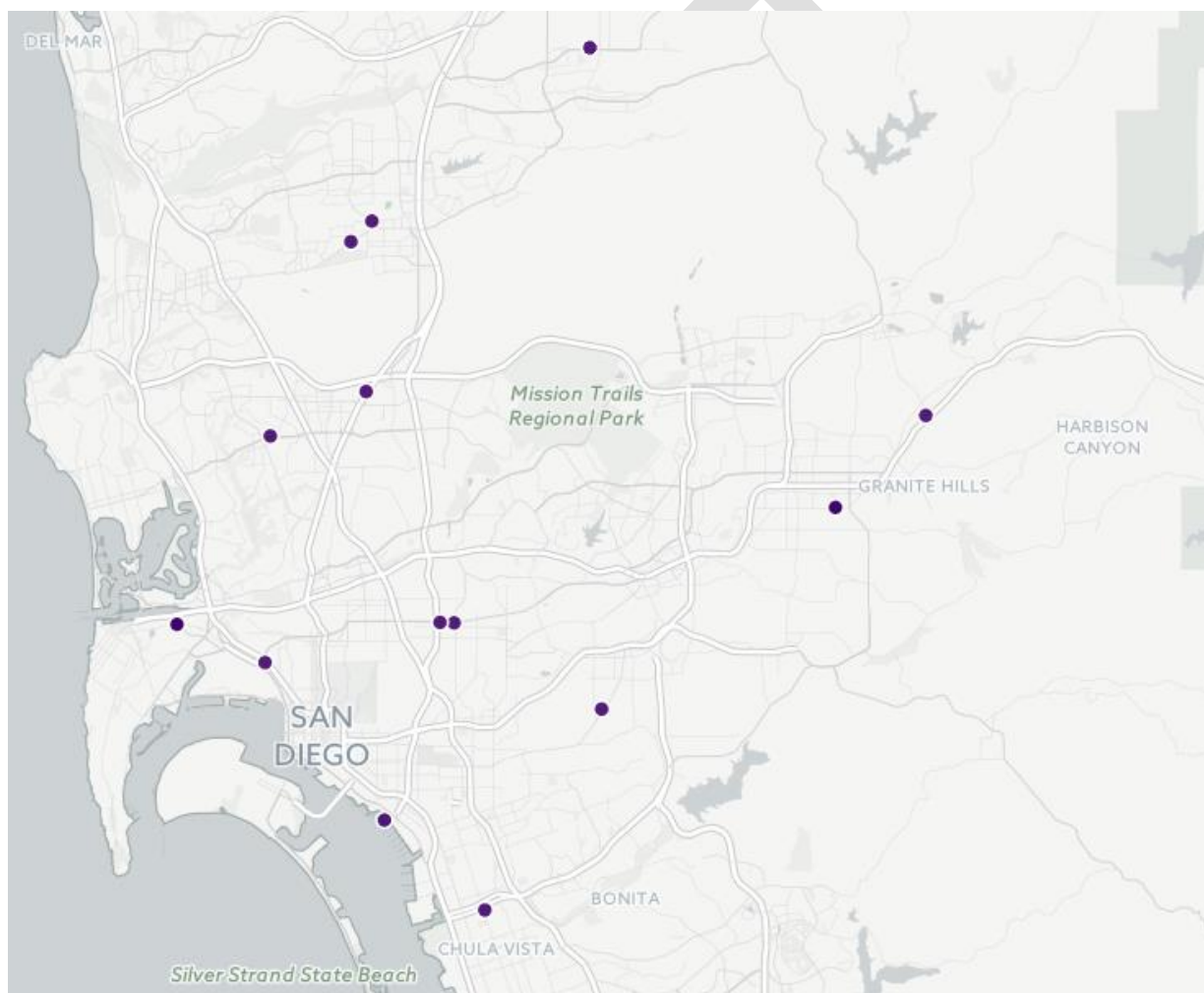
Fueling Stations

Propane fueling stations and dispensers can be placed alongside gasoline, diesel, or other alternative fuels. The infrastructure is very similar to gasoline and diesel refueling equipment.

Ownership Models (typical)

1. **Owning a larger station:** Fleets can choose to own a large propane station in order to benefit from special fuel pricing. These stations can typically accept a full truck of autogas from the supplier (about 9,000 to 12,000 gallons).
2. **Leasing equipment:** Fleets who are new to propane or who have a small fleet size may lease the tank, pump, and dispensing equipment from a fuel supplier in return for a fuel supply contract. Infrastructure to support the equipment is paid for by the lessee.

Map of Public LPG Fueling Stations in San Diego Region



(Map updated as of August 2015)

http://www.afdc.energy.gov/fuels/propane_locations.html

What are the costs of installing a fueling station?

The Department of Energy has a comprehensive guide, *Costs Associated with Propane Vehicle Fueling Infrastructure* (http://www.afdc.energy.gov/uploads/publication/propane_costs.pdf), which details the range of infrastructure costs, and other cost considerations (such as permitting), with recommendations from the propane industry.

Estimated Propane Station Cost¹

Station Size	Cost Range
Small Station 500-1,200-gal storage tank 1 single-hose dispenser	Purchase new: \$25,000-\$50,000
Medium Station 2,000-gal storage tank 2 dual-hose dispensers	Purchase new: \$50,000-\$75,000
Large Station 15,000-18,000-gal storage tank 2-4 dual-hose dispensers	Purchase new: \$150,000-\$300,000 Leasing: \$15,000-\$50,000 per year

Codes and Standards

When installing a propane autogas fueling station, it is important to adhere to the necessary codes and standards. The Alternative Fuel Data Center offers a thorough list of codes and standards for developing propane autogas infrastructure: <http://www.afdc.energy.gov/pdfs/48612.pdf>.

The NFPA 58, Liquefied Petroleum Gas Code², addresses the construction, installation, and operation of propane fueling stations and equipment. It seeks to provide safe methods for propane storage, transportation, and use in order to mitigate fires and explosions. More specific codes and standards are included in the table below.

Fueling Station Aspect	Pertinent Codes and Standards
Vehicle Fuel Dispense and Dispensing Systems	NFPA 58 Underwriters Laboratory 567
Storage Containers	NFPA 58 American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code American Petroleum Institute (API)-ASME Code for Unfired Pressure Vessels for Petroleum Liquids and Gases

¹ Summarized from AFDC's *Costs Associated with Propane Vehicle Fueling Infrastructure*. August 2014. http://www.afdc.energy.gov/uploads/publication/propane_costs.pdf.

² <http://www.nfpa.org/codes-and-standards/document-information-pages?mode=code&code=58>