# Near-Zero Emission Solutions: Natural Gas

# Driving to Net Zero

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# Background

The Driving to Net Zero (DNZ) initiative focuses on accelerating the deployment of electric vehicles (EVs) and the supporting charging infrastructure to decarbonize transportation Santa Clara County. Furthermore, the DNZ initiative focuses on light-duty vehicles—considering both personally owned vehicles and municipal fleets. While EVs are a good solution for decarbonizing transportation in the light-duty sector, there are fewer electrification options in medium- and heavy-duty vehicle categories. There is significant change occurring in these markets, and electrification will certainly be attractive in the near-term future for many vocations, including transit buses, delivery vans, and other return-to-base type operations that have shorter round trip distances. With that in mind, this brief report summarizes the decarbonization opportunity presented by renewable natural gas (RNG) used in natural gas vehicles (NGVs).

Fossil natural gas as a transportation fuel offers a modest greenhouse gas (GHG) benefit compared to diesel fuel—about 15-20% GHG emission reduction. However, RNG can reduce GHG emissions by as much as 65% when it is source from landfills, and by more than 100% when sourced from animal manure.[1]

# Current Market Conditions

## Natural Gas Consumption

About 175 million gasoline gallon equivalents (GGE) of natural gas are consumed in California annually, and about 65% of that is RNG. Most of the gas is consumed as compressed natural gas (CNG; 85%) and the balance is consumed as liquefied natural gas (LNG). For the purposes of the DNZ Project, we focus exclusively on CNG, because LNG is not dispensed in Santa Clara County.[2] ICF estimates that there are about 4-5 million GGE of natural gas consumed in Santa Clara County annually. The majority of this is consumed by government fleet vehicles, commercial fleet vehicles, refuse haulers, and shuttle buses (e.g., servicing San Jose airport). There are very few personally owned light-duty natural gas vehicles in operation; Honda was the last automobile manufacturer to make a CNG vehicle for the light-duty market, and they ended production in 2015.

Transit buses are typically one of the most significant market segments for natural gas buses, as seen in Southern California (e.g., Los Angeles Metro operates the nation's largest NGV fleet, with more than 2,200 natural gas buses). However, Santa Clara Valley Transportation Authority has focused on hybrid diesel-electric buses, and more recently has committed to deploying five electric buses in May 2018, with plans to add five more electric buses to the fleet in 2019.

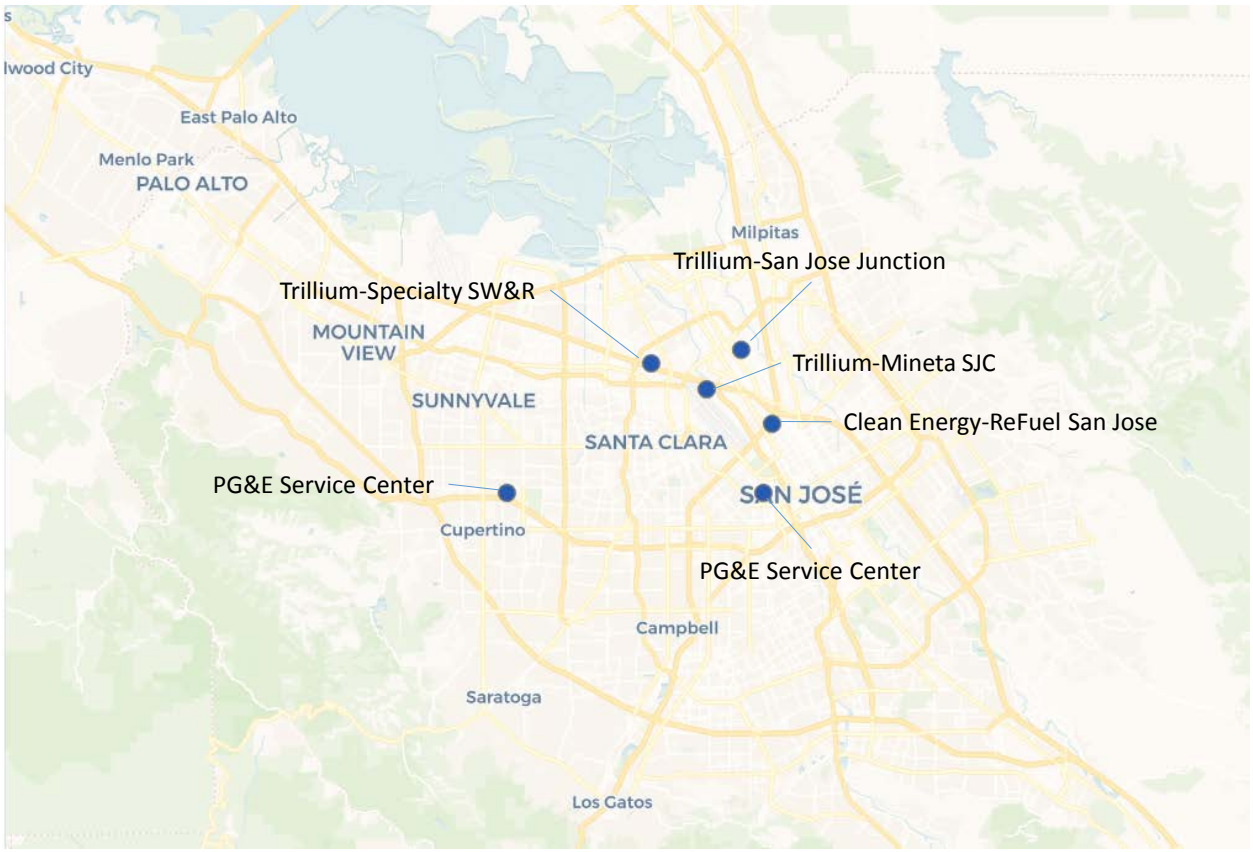
[1] Using the lifecycle carbon intensity emission factors from the Low Carbon Fuel Standard (LCFS) Program.

[2] LNG is more common for long-haul applications because of its higher energy density, and with more fuel on board the vehicle, travel distances can be longer. For instance, most of the LNG stations in California service the goods movement industry in and around the Ports of Los Angeles and Long Beach.

## Natural Gas Refueling Infrastructure

There are six publicly accessible CNG stations in Santa Clara County, as shown in the figure below.[3] Two of the stations are owned by PG&E, three are owned by Trillium, and the last is owned by Clean Energy. The PG&E stations are publicly accessible and service their own fleet vehicles—PG&E reported in 2016 that they have about 300 CNG vehicles.[4] The Trillium station at the airport supports shuttle buses, taxis, and other vehicles servicing the airport. As part of its Alternative Fuels Program, the airport installed the CNG station in 2002—and as recently as 2010, it serviced two dozen shuttles and more than 100 taxis, dispensing 600,000 GGE annually.[5]

There are also two privately owned stations that are not publicly accessible—the GreenTeam station in San Jose and a Recology-owned station in Gilroy, CA.




The Trillium-owned station at San Jose Junction was opened in 2015 and is a private-public partnership between the County and Trillium. The station cost about $1.5 million to build, with costs partially offset by $300,000 in grant funding from the California Energy Commission (CEC). The County has roughly 2,500 vehicles, and anticipates converting up to 25% of its

[3] Station information retrieved from the Alternative Fueling Station Locator, a part of the Alternative Fuels Data Center, which is maintained by the US Department of Energy.

[4] PG&E, Greening Our Fleet, www.pgecorp.com/corp_responsibility/reports/2017/en05_fleet.html

[5] SJC Airport, Air Quality, https://www.flysanjose.com/taxonomy/term/361. ICF notes that the data on SJC's webpage appears to be from 2010.

vehicles to CNG before 2023. The County started fueling shuttle buses owned by the Sheriff's department, and has since added other CNG vehicles to its fleet.

The privately owned stations, and the Trillium Specialty Solid Waste & Recycling (SW&R) station highlight one of the optimal use cases for CNG: refuse haulers. CNG is typically cheaper than diesel fuel; however, the fuel savings need to offset the higher upfront costs of the vehicle—much like EVs in the light-duty sector. Refuse haulers are an ideal application for CNG because they are high mileage/high fuel use and return to the same centralized location at the end of each day, thereby making it easy to install fueling infrastructure that will be used.

## Incentives for Natural Gas

### Natural Gas Vehicles

In 2015, the CEC started funding vehicle incentives for the purchase of NGVs through the Natural Gas Vehicle Incentive Project (NGVIP), which is administered by the University of California, Irvine. The NGVIP provides funding on a first-come, first-served basis at varying levels of incentives depending on the gross vehicle weight (GVW). As of April 2018, the CEC reports that about $7.7 million are reserved in unpaid vehicle incentives, and a waitlist for an additional $3.9 million in incentives.

More recently, the CEC awarded two $8 million grants to San Joaquin Valley Unified Air Pollution Control District and the South Coast Air Quality Management District for truck voucher projects. Note that since the Bay Area Air Quality Management District did not apply for this, that these funds will not be available in Santa Clara County.

Low nitrogen oxide (NOx) natural gas vehicles are also eligible for incentives through the Clean Truck and Bus Voucher Project. In previous years, about $13 million in incentives for low NOx engines have been allocated, which equates to about 500 trucks.

### Natural Gas Fueling Infrastructure

As noted previously, the CEC has provided funding for NGV fueling infrastructure via the Alternative and Renewable Fuel and Vehicle Technology Program. In its most recent funding solicitation, the CEC focused on natural gas fueling infrastructure for school districts. The solicitation was under-subscribed (they distributed $1.5 million in funding out of $3.5 million available). Based on the low demand for funding, and due to the availability of funding from previous fiscal years, the CEC has not allocated any additional funding for natural gas fueling infrastructure for fiscal year 2018-2019.[6]

# A Near-Zero Solution: RNG and Low NOx Engines

## Renewable Natural Gas

RNG is produced over a series of steps–namely collection of a feedstock (such as waste or manure), delivery to a processing facility for biomass-to-gas conversion, gas conditioning,

[6] Orenberg, Jacob. 2018. 2018-2019 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program. California Energy Commission, Fuels and Transportation Division. Publication Number: CEC-600-2017-010-CMF.

compression, and injection into a common carrier pipeline. RNG can be combusted to generate on-site electricity and be used to fulfill renewable energy goals/requirements. Over the last several years, however, there has been considerable growth in the use of RNG in the transportation sector. This is linked in large part to the U.S. Environmental Protection Agency's (EPA) determination in 2013 that RNG is an eligible fuel under the federal Renewable Fuel Standard (RFS).[7] Furthermore, RNG earns credits in California's Low Carbon Fuel Standard (LCFS) Program. Feedstocks for RNG include, but are not necessarily limited to landfill gas, waste water treatment plants, municipal solid waste, animal manure, agricultural residue, and forestry or forest product residues.

The recent passage of Senate Bill 1383 (Lara, 2016) and approval of CARB's Short Lived Climate Pollutant (SLCP) Strategy,[8] which are focused on reducing the emissions of black carbon (soot) and methane, and fluorinated gases, positions California over the next 10—15 years to harness significant in-state resources to capture biogas and produce RNG for transportation fuel and pipeline injection.

The introduction of RNG into the transportation sector has the potential to allay some of the local and regional concerns linked to the GHG emissions and other potential environmental impacts from fossil natural gas use. The GHG footprint of RNG is linked to the feedstock, location of the facility relative to the end user, and the type of vehicle in which the fuel is used. RNG from landfill gas, for instance, reduces GHG emissions by about a factor of 2 to 3 when compared to conventional diesel fuel on a lifecycle basis. RNG from animal manure can reduce GHG emissions even more by capturing methane—a GHG pollutant with 25 times the global warming potential of carbon dioxide—that would have otherwise been vented into the atmosphere.

## RNG in Low NOx Natural Gas Engines

The NGV industry and the RNG industry are currently advocating around the prospects of pairing the low carbon fuel with certified engines for medium- and heavy-duty vehicles from Cummins Westport, including the ISL G 8.9 liter and the ISX 11.9 liter engine. This engine is appropriate for many applications in the goods movement sector, including short and regional haul applications, as well as in refuse hauling applications. These engines have received certification from the EPA at levels 90 percent lower than the current standard for NOx emissions of 0.20 g/bhp-hr.[9] In other words, pairing RNG with the low NOx engines has the potential to reduce criteria pollutant emission reductions, reduce GHG emissions, and decrease petroleum consumption.

Although there is limited natural gas consumption in Santa Clara County, there are still opportunities for medium- and heavy-duty fleet vehicles to use RNG as part of a broader decarbonization strategy.

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[7] In 2015 the EPA determined that RNG from landfill gas (LFG) is eligible to generate renewable identification numbers (RINS; the currency of the federal RFS program) in the category labeled as cellulosic biofuels or D3 RINs. These are the highest value RINs in the RFS market.

[8] CARB, Short-Lived Climate Pollutant Reduction Strategy, March 2017. Available online: https://www.arb.ca.gov/cc/shortlived/meetings/03142017/final_slcp_report.pdf

[9] The NOx emission standards for engines are established in units of grams of pollutant per brake horsepower hour (g/bhp-hr).