National Academy of Sciences: NGVs Have Greatest Near-Term Potential to Replace Light-Duty Vehicle Petroleum Use

Overview

Light duty vehicles (LDVs), such as passenger cars, pick-up trucks, vans and SUVs, account for the single largest share of U.S. petroleum demand and account for 17 percent of total U.S. greenhouse gas (GHG) emissions. The new National Academy of Sciences (NAS) report, "Transitions to Alternative Vehicles and Fuels," evaluates technologies to address LDV oil use and GHGs over the 2030 and 2050 timeframe.[1] It is very similar to the recent Future Transportation Fuels study by the National Petroleum Council (NPC) of the Department of Energy, which also evaluated alternative fuel technologies through 2050.[2]

The NAS report has very positive findings for natural gas vehicles (NGVs, or CNGVs – compressed natural gas vehicles – in the NAS report). It finds that NGVs are a "***quick and economical way to reduce petroleum use***" (NAS, p. 8) and have the greatest potential for achieving petroleum reductions in the near term due to their favorable economics compared to other alternatives. In scenarios developed for the report, NGVs are the only alternative to meet the goal of reducing petroleum consumption by 50% by 2030, and they achieve well over 80% reductions in petroleum use by 2050 (NAS, p. 5). Like all other alternatives examined, NGVs are not sufficient on their own to achieve the goal of 80% reduction in GHGs by 2050, but there is considerable potential for NGVs to achieve this goal in combination with other technologies (such as hybridization, renewable natural gas (RNG), and hydrogen) that is not explored by the study.

In terms of both petroleum reduction and GHGs, the NAS report is very similar to the NPC report in its conclusions. The NPC found that NGVs have potential for ***"larger, faster, and earlier"*** (NPC, p. 2) impacts on petroleum use than any alternative. And, although the NAS report does not explore ways in which NGVs might play a role in ultra-low GHG emission scenarios, the NPC report does include a discussion of the potential of renewable natural gas (RNG) and synergies between CNG and hydrogen fuel technologies to achieve emission reductions far beyond those offered by pure fossil CNG. Moreover, as recognized by the NAS report, CNGVs can utilize hybrid-electric vehicle (HEV) technology - or, by extension, plug-in HEVs (PHEVs) – to further increase fuel economy and reduce GHGs compared to conventional CNG vehicles.

[1] National Academy of Sciences. "Transitions to Alternative Vehicles and Fuels." March 2013. http://www.nap.edu/catalog.php?record_id=18264

[2] National Petroleum Council. "Natural Gas Analysis." 1 Aug 2012. http://www.npc.org/FTF-report-080112/Natural_Gas_Analysis-080112.pdf

NAS's Key Findings for Natural Gas Vehicles

- In the NAS report, the "CNGV emphasis" scenario is the **only** scenario which achieves 50% reduction in petroleum use by 2030. It is also one of several technologies capable of reducing petroleum use by more than 80% by 2050. (NAS, p. 5)

- Under this scenario, CNGVs achieve a new vehicle market sales share of 25% of new vehicles by 2030 and 80% by 2050 (NAS, p. 334). This "mid-range" scenario is the committee's "best estimate of the progress of the technology if it is pursued vigorously." (NAS, p. 5)

- The report notes that CNGVs are not capable by themselves of achieving the goal of reducing GHGs by 80% by 2050 (emissions are reduced by 62% in the "CNGV emphasis" scenario), but *none* of the other technology paths, in isolation, meet this threshold. (NAS, p. 4) Unfortunately, the report does not explore the well-documented ways in which CNGVs can be combined with other technologies to achieve ultra-low GHG scenarios.

- The report recognizes that current incremental costs for CNGVs are due in part to the small-volume conversion production model, and that the potential for widespread adoption is predicated on significant cost reductions from a transition to high-volume OEM production. (NAS, p. 35)

- The report also finds that "there is enough domestic natural gas to greatly increase its use for the transportation sector without significantly affecting the traditional natural gas markets." (NAS, p. 8)

- CNGVs are also found to require the lowest per-vehicle infrastructure investment cost of any technology (that is, the cost of a refueling or recharging station spread across the number of vehicles that it can serve in a day): $810 per vehicle, compared to nearly $3,000 per vehicle for PEVs and PHEVs. (NAS, p. 45) Notably, the cost of CNG infrastructure is primarily borne by private CNG refueling companies like VNG, with no burden on the consumer; by contrast, much of the projected $3,000 per-vehicle incremental cost figure for PEVs is assumed to be home recharging equipment that the end-user may have to purchase themselves, which increases the effective cost of the vehicle for consumers.

- In regards to light-duty CNGV infrastructure development, "regional, clustered development" is regarded as "the preferred model," as with PEVs, FCEVs, and other alternative fuel vehicles (NAS, p. 64).

Potential Role of NGVs in Ultra-Low Emission Scenarios

The NAS study's scope does not consider CNGVs in combination with other technologies "for the sake of simplicity" (NAS, p. 343). However, there are well-documented ways CNGVs can help achieve an ultra-low emission, 80% GHG reduction scenario that are not considered in the NAS study, although they are discussed in the NPC report and other sources:

- **Hybridization:** The NAS Report itself acknowledges that hybrid-electric vehicle (HEV) technology can be applied to CNGVs and achieve the same benefits at the same cost as with gasoline vehicles (NAS, p. 35). Thus, under a CNGV emphasis scenario, the CNGV fleet would likely see increasing hybridization, with greater fuel economy and lower emissions.

- **Biofuels – RNG:** As detailed in the NPC report, CNGVs can operate on conventional natural gas blended with renewable natural gas (RNG) which can achieve lifecycle GHG emission reductions of over 90%.[3] Even relatively low level RNG blends can result in significant GHG reductions beyond what is provided by fossil CNG. Liquid drop-in biofuels discussed by NAS could achieve reductions of 55%, by comparison (NAS, p. 46).

- **Hydrogen:** In its recent 2017-2025 GHG regulations for LDVs, EPA concluded that NGVs "support future commercialization of hydrogen FCVs" (fuel cell vehicles) due to several areas of technological synergies between these gaseous fuels.[4] The NPC report further details synergies between NGVs and FCVs via shared advanced storage technologies as well as the ability of NGVs to fuel on lower-carbon hydrogen-CNG fuel blends.[5] For all these reasons, NGVs and FCVs should be viewed as complementary, not competitive, in long-term alternative fuel scenarios.

The potential GHG benefits from scenarios using CNGVs in combination with HEV technology, RNG fuel, and/or hydrogen is likely greater than similar scenarios using liquid fuels. For example, a scenario emphasizing HEVs running on biogas-blended CNG and FCVs would achieve even lower emissions than the liquid biofuels + EVs + FCVs scenario outlined in the NAS study. This type of gaseous fuel scenario should be explored in future studies.

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[3] National Petroleum Council. "Renewable Natural Gas for Transportation." 1 Aug 2012. http://www.npc.org/FTF_Topic_papers/22-RNG.pdf

[4] Environmental Protection Agency. "2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards." 15 Oct 2012, p. 62816. http://www.gpo.gov/fdsys/pkg/FR-2012-10-15/pdf/2012-21972.pdf

[5] National Petroleum Council. "Study Topic Papers." 1 Aug 2012. http://www.npc.org/FTF_topic_papers.html