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Advanced Low-NOx Compressed Natural Gas Engines in Medium- and Heavy-Duty Vehicles Are Poised to Deliver Air Quality Benefits and Advance California's Climate Goals

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Recent commercialization of advanced low-nitrogen oxides (NOx) Compressed Natural Gas (CNG) engines for medium- (MDV) and heavy-duty (HDV) vehicles has garnered significant interest due to the potential air quality benefits. Further, utilizing renewable natural gas (RNG) in advanced CNG engines from sources such as biomass and/or biogas can achieve reductions in greenhouse gas (GHG) relative to using petroleum fuels and fossil CNG. However, the regional air quality and GHG reduction benefits of large‐scale deployment of advanced CNG trucks are currently unclear. Further, more information is required regarding RNG production potential from California in-state biofuel resources, including potential supply volumes and production pathways that provide maximum GHG reductions.

The UC Irvine Advanced Power and Energy Program assessed the air quality and GHG implications of transitioning to advanced CNG engines in MDVs and HDVs in California by developing and comparing different future adoption scenarios. The research team also leveraged prior research of biogas and biomass resources in California to consider different options for producing RNG in-state. Key findings from this research are highlighted in the following section.

Key Research Findings

The deployment of advanced CNG MDVs and HDVs can produce air quality benefits in regions of California suffering from poor air quality. Reductions in maximum 8-hour average ground-level ozone from deploying advanced CNG MDVs and HDVs could exceed -1.25 to -3.77 parts per billion (ppb) in the Southern California Air Basin, Central Valley, San Francisco Bay Area, and the Sacramento area. Advanced CNG MDVs and HDVs can also achieve regional reductions in ground-level particulate matter (PM) 2.5, including in the Central Valley and Southern California Air Basin. Reductions in PM 2.5 during the winter are particularly notable with some areas experiencing reductions in 24-hour average PM 2.5 of -1.50 to -3.41 micrograms per cubic meter of air (ug/m3). Predicted reductions for PM 2.5 in the summer in the Southern California Air Basin is -0.51 to -0.60 ug/m3.

Advanced CNG MDVs and HDVs reduce GHG emissions but the level of reduction depends on the fuel. If fossil natural gas is used as fuel, then advanced CNG HDVs and MDVs may moderately reduce GHG emissions. This finding holds true particularly if the baseline fleet is composed of less efficient diesel and gasoline technologies. For a more realistic assumption of a cleaner mix of technologies and fuels, the reduction is less (approximately 6 to 9 percent) if only fossil natural gas meets CNG demand in advanced HDVs and MDVs. Using RNG from in-state biofuel resources has the potential to reduce GHG emissions on the order of 9 to 34 percent depending on the assumed resource mix within the baseline fleet.

Initial fuel demand from advanced CNG MDVs and HDVs can likely be met by in-state biogas resources; however, large-scale deployment of these vehicles will require

advanced "biomass to RNG" production pathways. For moderate penetrations of advanced CNG MDVs and HDVs expected in baseline deployment scenarios, it is possible to meet RNG demand with in-state biogas resources if prioritized for MDV and HDV use. For scenarios assuming significant expansion in advanced CNG MDV and HDV deployment, some portion of CNG fuel demand (approximately 5 to 35%) must be met with fossil CNG unless new production pathways for RNG are advanced utilizing solid biomass.

More Information

This policy brief is drawn from the research report "Evaluation of the Air Quality and Greenhouse Gas Benefits of an Advanced Low□NOx Compressed Natural Gas (CNG) Engine in Medium and Heavy□Duty Vehicles in California" prepared by Michael MacKinnon, Brendan Shaffer, Alejandra Cervantes, and Scott Samuelsen with the UC Irvine Advanced Power and Energy Program at the University of California, Irvine. The report is available at: www.ucits.org/research-project/2017-35.

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