“Life Cycle Assessment of Natural Gas Utilization in Light-duty Passenger Vehicles”

Qiang Dai

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The increasing penetration of natural gas into the U.S. energy system, including the transportation sector, has evoked questions about the sustainability of its uses. In this study, the environmental impacts of delivering driven vehicle miles are evaluated using life cycle assessment (LCA) for three passenger fleets: battery electric vehicles (BEVs) using electricity generated from natural gas combined cycle (NGCC) power plants; compressed natural gas vehicles (CNGVs), which are internal combustion engine vehicles (ICEVs) modified to burn compressed natural gas; and fuel cell vehicles (FCVs) powered by hydrogen produced from steam methane reforming (SMR) of natural gas. The results suggest that natural gas-powered vehicles, especially BEVs and FCVs, have the potential to considerably reduce the overall environmental impact associated with driven miles in comparison to conventional petroleum-powered ICEVs. For all of the three fleets, usephase dominates their life cycle environmental impacts. Therefore, improving energy conversion efficiency, both at the well-to-fuel conversion facilities and at the powertrain of the vehicles, is the key to reduce the environmental footprints of natural gas-powered mobility. The manufacture of power sources for BEVs and FCVs also significantly contributes to their respective environmental burdens. BEVs can be made to be a more environment-benign mobility option by enhancing the electrochemical properties of the lithium ion battery, while the biggest opportunity for FCV improvement rests with reduction in platinum loading in the fuel cell stack. The findings of this study also indicate that adopting carbon capture and sequestration technologies at the NGCC plant and the SMR plant can further reduce the life cycle GHG emissions of BEVs and FCVs, at the cost of marginal increase in energy consumption. By examining the effect of technological progression and temporal variations pertaining to the three vehicles, it’s furthermore determined that while technological advancement, together with more stringent CAFE and emission standards will invariably lead to future reduction in environmental impacts of personal mobility options, BEVs and FCVs are very likely to benefit from it to a greater extent, as a result of the tremendous efforts presently being exerted for their greener manufacture and more efficient powertrain design.