NREL
NATIONAL RENEWABLE ENERGY LABORATORY

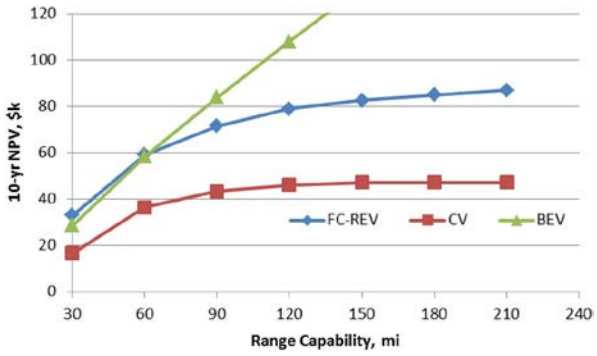
NREL Uses Fuel Cells to Increase the Range of Battery Electric Vehicles

Highlights in Research & Development

NREL analysis identifies potential cost-effective scenarios for using small fuel cell power units to increase the range of medium-duty battery electric vehicles.

Battery electric vehicles (BEVs) offer great potential for decreasing lifecycle costs in medium-duty applications, a market segment currently dominated by internal combustion technology. Characterized by frequent repetition of similar routes and daily return to a central depot, medium-duty vocations such as parcel delivery are well positioned to take advantage of the low operating costs of BEVs.

Unlike conventional vehicles, however, BEVs are constrained by long recharge times and a spotty public charging infrastructure. Consequently, the current BEV market is largely limited to vocations where planned routes don't exceed the vehicle's battery range.



Extrapolation from parcel delivery vehicle data and base-case assumptions showing the 10-year "net present value" of a fuel-cell range-extended vehicle, a conventional vehicle, and a BEV with various driving range capabilities.

With a focus on cost-effectively boosting BEV range and increasing market appeal, analysts at the National Renewable Energy Laboratory (NREL) investigated the use of small electricity-producing hydrogen fuel cell stacks to supplement the vehicle's battery pack as it nears depletion. This arrangement leverages the low cost of grid electricity for most of the miles traveled while enabling the use of hydrogen fuel for range extension when necessary.

By using hydrogen as a range-extending fuel, the BEV can retain its zero-tailpipe-emission capability as well as its potential for operating on 100% renewably generated energy. Hydrogen is a potentially emissions-free alternative fuel that can be produced from domestic resources.

NREL found that small fuel cell power units provide extended range at significantly lower capital and lifecycle costs than additional battery capacity alone. And while fuel-cell range-extended vehicles are not economically competitive with conventional vehicles given present-day economics, NREL identified potential cost-competitive scenarios that take into consideration component costs and configurations, duty cycles, and energy costs.

Performed in collaboration with industry partners and the Fuel Cell Technologies Office in the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy, NREL's analysis employed real-world vocational data and near-term economic assumptions to (1) identify optimal component configurations for minimizing lifecycle costs, (2) benchmark economic performance relative to both battery electric and conventional powertrains, and (3) understand how the optimal design and its competitiveness change with respect to duty cycle and economic climate.

Technical Contact: Eric Wood, *eric.wood@nrel.gov*

Reference: Wood, E.; Wang, L.; Gonder, J.; Ulsh, M. (2013). "Overcoming the Range Limitation of Medium-Duty Battery Electric Vehicles through the Use of Hydrogen Fuel Cells." *SAE Int.*; DOI: 10.4271/2013-01-2471.

Key Research Results

Achievement

NREL analysts investigated the use of small fuel cell systems to boost the range of battery electric vehicles.

Key Result

Small fuel cell power units provide extended range at significantly lower capital and lifecycle costs than additional battery capacity alone.

Potential Impact

While fuel-cell range-extended vehicles are not economically competitive with conventional vehicles under base-case assumptions, NREL identified potential cost-competitive scenarios that take into consideration component costs and configurations, duty cycles, and energy costs.

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

15013 Denver West Parkway
Golden, CO 80401
303-275-3000 | www.nrel.gov

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