

LETTERS

Energy Issues for Vehicles: R&D, Carbon Sequestration, Fuel Conversion

The article “Meeting Energy Challenges: Technology and Policy,” by Ernest Moniz and Melanie Kenderdine (PHYSICS TODAY, April 2002, page 40), correctly points out the problem of doing business as usual while waiting for fuel-cell vehicle technology to have an impact.

As described in Joan Ogden’s “Hydrogen: The Fuel of the Future?” in the same issue (page 69), the centerpiece of the present US Department of Energy plan to improve vehicle technology apparently involves a fuel-cell-powered vehicle, the “Freedom Car.” That vehicle, which would use stored hydrogen as fuel, could ultimately reduce petroleum consumption, greenhouse gas generation, and air pollution. However, a practical, economical hydrogen source that does not generate carbon dioxide will be required to obtain those benefits. The development of such a hydrogen source is a major challenge, as are the needs for practical hydrogen distribution and storage and for fuel-cell technology. It is uncertain just when such a hydrogen-powered vehicle could have a significant effect on the total fuel consumption of the US vehicle fleet; at best, that time is several decades away.

Another R&D path is likely to provide significant benefits far sooner: improving mainstream propulsion system technologies. That option would involve not only the diesel and hybrid vehicle technologies emphasized by the Partnership for a New Generation of Vehicles and previously supported by DOE, but also much more aggressive government support for the development of high-efficiency gasoline engines. Gasoline engines currently dominate the US light-duty vehicle fleet, and

their improvement should be a matter of urgency. Substantial fuel-consumption improvements, whose fuel cost savings could largely and relatively quickly offset the increase in cost, would facilitate widespread implementation, leading to significant impacts on national petroleum consumption, greenhouse-gas emissions, and reduced air pollution.

A number of new gasoline engine systems could provide significant increases in efficiency at relatively modest cost. Some of these systems may also reduce the already low emissions from gasoline-engine vehicles. Opportunities include direct fuel injection and other lean burn concepts such as hydrogen-enhanced combustion and boost, variable valve control, and variable compression ratio. Moreover, new diesel engine systems, such as boosted advanced diesels with effective exhaust trap and catalyst systems, could significantly reduce the emissions that have inhibited use of more efficient light-duty diesel vehicles. In addition, homogeneous charge compression ignition, a new low-emission, high-efficiency engine combustion concept, has potential in both diesel and gasoline engines.

However, DOE’s R&D funding of these promising technologies is insufficient relative to longer-term options such as fuel cells and advanced batteries. Moreover, DOE’s funding for internal combustion engines primarily supports diesel-related research, and little funding is focused on gasoline engine opportunities. Although industry does invest in developing new and improved engine technologies once their production viability is evident, many promising opportunities need substantial additional research to demonstrate that viability. The realization of those opportunities depends on the ideas and efforts of the research community, which, in turn, needs DOE support.

Increasing use of efficient low-emission diesel engines (some 30% more efficient than today’s gasoline engines), coupled with widespread

use of advanced gasoline engines up to 25% more efficient than today’s engines, would significantly reduce US petroleum consumption. Our government’s investment in R&D on these mainstream engine technology improvements is insufficient. We are especially neglecting high-efficiency gasoline engines. Because petroleum provides both gasoline and diesel fuel in comparable quantities, we need better gasoline engines, too. Both an increase and different allocation of DOE’s resources seem in order.

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MONIZ REPLIES: I concur with Daniel Cohn and John Heywood; their comments prompt us to elaborate.

For a publicly funded R&D program to be effective, its components must address a variety of time scales and levels of risk. In addition, its strategic goals must represent the public good in areas that are perceived as having little commercial value. In the case of motor vehicle R&D, strategic goals include reduction of both atmospheric emissions and oil dependence.

The current administration’s sharp focus on the long-term, high-risk approach of hydrogen fuel-cell vehicles appears contrary to a balanced portfolio approach that generally yields the greatest long-term impact. Just such a “picking winners” R&D approach failed two decades ago with synthetic fuels.

The intermediate-term programs—the Partnership for a New Generation of Vehicles (PNGV) and the synergistic Clean Fuels Initiative—targeted a decadal time scale and met criteria appropriate to that time frame. Those programs envisioned use of a good deal of existing infrastructure for vehicle manufacturing, refining, and distribution; they shared costs with industrial consortia; and they met specific

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