Electric Cars and Lead

Lester B. Lave et al. (Policy Forum, 19 May, p. 993) recently assessed the overall rate at which lead waste is generated in the production and use of electric vehicles (EVs). Their analysis assumes that all lead wastes can be aggregated. They compare this rate of waste generation to the rate of lead waste generated by the use of leaded gasoline. This is a highly simplified analysis. A more complete analysis is complicated by many factors, such as the following.

- The rates of lead emissions to the atmosphere in secondary lead smelting, as calculated by Lave et al. using standard Environmental Protection Agency (EPA) emission factors, are overstated. Although the EPA emission factors indicate that on the order of 1% of the lead processed in secondary smelters escapes to the atmosphere, for two smelters in Los Angeles (1), these emission rates are high by a factor of approximately 1000.

- An analysis more favorable to EVs might focus only on air emissions from smelters. While it is tempting to assume that the lead leaving a secondary smelter as a solid (for example, battery casings) poses little risk if managed properly, the work of Behmanesh et al. (2) suggests that the situation is far more complex. They found that 80% of all lead sent to hazardous waste incinerators in the United States comes from battery casings from two secondary smelters. Some of this lead will undoubtedly leave the incinerators as air emissions.

- Even the fate of lead emitted from vehicles running on leaded gas is complex. Friedlander and his coworkers (3) found that approximately 25% of the lead in leaded gas remains in the vehicle. Most of the rest is emitted as aerosol, and the exposure pattern for these emissions will be strongly influenced by the particle size distribution.

Comparing EV lead wastes to lead emitted by cars running leaded gas introduces many uncertainties. Lave et al.'s analysis approaches a worst-case scenario for EVs. Undoubtedly, best-case scenarios will be put forward that ignore the complex pathways and fates of lead wastes. Until a more complete assessment of this problem is put forward, it is premature to either brush aside the issue of lead wastes from EVs or to forecast the death of the EV by lead poisoning.

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Getting the lead out

General Motors’ electric car, the Impact (below). An unusual number of letters were received about the 19 May Policy Forum “Environmental implications of electric cars.” Most criticized the thesis of Lave et al. that “these vehicles do not deliver the promised environmental benefits” and would create more lead pollution than would comparable cars burning leaded gasoline. “Amazing,” “absurd,” and “the analysis does not appropriately support its conclusions” were some of the comments.

Lave et al. incorrectly conclude that EVs are impractical and that their planned development may actually result in increased environmental pollution. These amazing conclusions result from errors of fact and incorrect assumptions regarding current and future EVs. Important factual errors include unreasonably high weight and low driving range for current lead-acid battery-powered EVs and incorrect estimates of toxic emissions produced by battery manufacturing.

More important, the authors incorrectly assume that future EVs will be powered by lead-acid batteries. Even if true, this would result by the year 2000 in only a 2% increase in the number of lead-acid batteries currently in use. However, this
nation for a total energy cycle analysis of
electric and conventional vehicles that is
part of a larger study being conducted by
several national laboratories for the U.S.
Department of Energy. Our findings lead to
corclusions that are substantially different
from those reported by Lave et al.
As a result of their assumptions, Lave et al.
overestimate the air emissions by a factor
of from 5 to 50, and the low energy density
they use for their "available" case implies a
quantity of lead use that is unreasonably
high. In fact, lead production for batteries
may actually result in an order of magnitude
less emissions than the combustion of leaded
gasoline. In any case, these emissions would
cause far less human exposure, as they would
be remote and away from the urban areas
where EVs would be used.
Lave et al. also express the opinion that
solid waste from lead mining, smelting, and
recycling will find its way into the water
supply of major cities and expose large pop-
ulations to lead. While there are poorer data
for solid wastes than for air emissions of lead,
solid lead wastes from mining are essentially
the same material as that initially present;
the solid wastes from smelting, which are
recycled, are primarily oxides and sulfates,
which are more inert than the lead itself.
In examining the tradeoffs (including
health and safety) among technologies, it is
important to work from the best available
data before eliminating any options. While
it is important to take human health con-
cerns seriously, better information is needed
before sensational claims of damage to hu-
man health are made.

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We have serious reservations about the ac-
ccuracy and completeness of Lave et al.'s
study. Curiously, despite a wealth of recent
and easily accessible data on current battery
and electric vehicle performance, the study
relies on outdated technical data on batter-
ies and EVs. The study's "available technol-
ogy" battery is already obsolete, and its
"goal" technology battery is available now.
The study assumes a vehicle energy con-
sumption level three times higher than the
General Motors Impact and inappropriately
references the performance of a 15-year-old
vehicle, the ETV-1.
The study overstates the potential in-
crease in lead demand resulting from EVs.
Realistically, the zero-emissions vehicle re-
quirement in California, Massachusetts, and
New York would result in only a 1% in-
crease in lead demand in 1998, and there is
broad consensus that lead-acid batteries will
only be used to power electric cars in the
near-term.
The study also does not point out that
starter batteries for conventional gasoline-
powered vehicles are by far the primary con-
sumer of lead. Those that are serious
about minimizing the risks from lead may
find it ironic that EVs are the key to devel-
oping a nontoxic substitute for the lead-
acid battery.

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Lave et al. conclude that a 1998 model
electric car would release 60 times more
lead per kilometer than a comparable car
burning leaded gasoline. This is absurd. For
example, every motor vehicle in operation
in the United States today has at least one
lead-acid battery. Assuming a battery lead
mass of 11.8 kilograms, battery consump-
tion of two batteries per vehicle, and a
vehicle lifetime of 165,000 kilometers, the
authors' methodology would result in calcu-
lated battery lead per life-cycle kilometer
of 0.143 grams per kilometer. This, in turn,
contrast, smelter waste is often exposed to weathering.

Gellings and Peck, Gaines and Wang, and Hwang complain about our range of battery energy densities. However, the low end of our battery technology range can be purchased in auto supply stores; the upper end of the range is not yet available. Is it “unreasonable” to use the low-end battery in an EV? Perhaps. What battery energy density–vehicle range makes an EV attractive?

Hwang also asserts our vehicle energy efficiency is too low. However, the GM Impact, under ideal conditions, is not indicative of the range of 1998 vehicles (including light trucks and minivans) in actual driving conditions. We agree with Hwang that current lead-acid batteries are the major use of lead and the major contributor to lead in the environment.

Rubinstein and Austin assert our estimates are “absurd.” However, contrary to their assumption, virgin lead is not recycled before being made into batteries. Thus, instead of 10 milligrams per kilometer of lead being discharged, they should have calculated that 7.1 milligrams per kilometer is discharged for virgin lead and 4.3 milligrams per kilometer for recycled lead. As roughly two-thirds of lead is recycled, discharges are 5 milligrams per kilometer, of which 17% is emitted into air: 0.9 milligrams per kilometer. As leaded gasoline resulted in roughly 22 milligrams per kilometer of air emissions, the correct figure is 3% of air emissions. Lead in solid waste migrates slowly, contributing little to current air emissions. Contrary to their conclusion, the data are consistent with a 96% decrease in lead air emissions.

Socolow seeks a middle ground. If current lead discharges are not acceptable, setting a cap at this level is not acceptable.

Sperling and others suggest that forcing the introduction of EVs in 1998 will push the technology and quickly lead to satisfactory vehicles. Technology forcing has worked in some cases (for example, vinyl chloride monomer) and not worked well in others (for example, passive automobile seat belts). New technologies should not be embraced without systematic economic and environmental analysis; see (2, 3) for recent EV studies. The 1998 mandate means that automobile and battery manufacturers must spend hundreds of millions of dollars on current battery technology: lead-acid, nickel-cadmium, and nickel-metal-hydride. These batteries would require up to 1000 pounds of toxic metals in each EV. Herculean efforts would be required to smelt and recycle these metals without significant environmental discharges. Forcing lead-acid or other available technology (and the associated recharging infrastructure) is not attractive compared to pushing advanced technologies such as fuel cells. Research and development should focus on promising technologies that do not require the processing of large quantities of toxic materials.

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References

Corrections and Clarifications
In the Research News article “Controversy: Is KS really caused by new herpesvirus?” by Jon Cohen (30 June, p. 1847), the quote from Susan Kowl of the Memorial Sloan Kettering Cancer Center was incorrect. The quote should have read, “I think we all need to be treatment activists to move the field forward.”