Letters

Greenhouse Gas Tax

The Briefing "Greenhouse gas tax" (News & Comment, 10 Jan., p. 154) contains the remark that "[the gas tax] would end up soaking consumers of about $95 billion a year." This is so misleading that it is untrue. The estimate of $95 billion is in line with other estimates I have seen of the same possibility. But that would not be the end of it—$95 billion is big money. It is more money than the corporate income tax raises and amounts to more than 40% of the fiscal 1990 deficit. That kind of money, once collected, doesn't just go away. Something has to be done with it and, in fact, it has to come back to the consumers who were "soaked" in one form or another. I suspect it would come back partly in the form of reduced personal income taxes, partly as increased government services (which we need), and partly as a reduction in the overhanging national debt. Such a collection is what we economists call a "transfer payment," which must benefit the recipient to the same extent that it hurts the payer. In short, a greenhouse gas tax would not "end up soaking consumers."

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Radon Risk in the Home

We disagree with Philip H. Abelson's portrayal (Editorial, 8 Nov., p. 777) of both the current scientific understanding of radon-induced lung cancer risk and the basis for the Environmental Protection Agency's (EPA's) radon policy. The radon policy of EPA is not based on data from one cohort study of uranium miners (the Colorado Plateau cohort) exposed to "huge amounts" of radon. Rather, it reflects scientific consensus developed through review of the extensive epidemiologic data on thousands of underground miners exposed to a broad range of radon concentrations. Studies of miners have been conducted in the United States, Canada, Australia, China, and Europe in metal, fluorspar, shale, and uranium mines. The National Academy of Sciences, the International Commission on Radiological Protection, the National Council on Radiation Protection and Measurements, and other national and international organizations have reviewed the data and have concluded that there is strong evidence that radon causes lung cancer in humans.

Abelson questions the assumptions used by EPA for extrapolating from "high doses of radon in mines to low doses in homes." He suggests that a threshold for cancer induction exists because humans have remediation mechanisms for α particle damage. However, research has established that even low doses of α radiation produce genetic damage that cannot always be repaired. Damage from α particles is added to a background of genetic damage from multiple sources. The net effect of this accumulated damage is an increased risk of cancer. Linear models are widely held to be adequate for extrapolating from high to low doses of high linear energy transfer radiation, including that from α particle doses from radon daughters (*1*). However, large extrapolations to the residential environment are not needed for radon risk assessment. Significant increases in lung cancer mortality have been observed in miners at a wide range of cumulative radon exposures, including low levels comparable to a lifetime residential exposure at 4 pCi/liter (*2*).

Abelson also suggests that silica dust may have been an important factor in the increased lung cancer mortality observed in the miners. The potential confounding of the radon–lung cancer relationship by the presence of silica dust in mines has been investigated by epidemiologists since the 1930s. Studies have shown that lung cancer rates correlate with cumulative radon exposure regardless of silica dust levels (*3*). The International Agency for Research on Cancer (IARC) has concluded (*4*) that, for crystalline silica and amorphous silica, respectively, the evidence of carcinogenicity in humans is limited and inadequate. On the other hand, the IARC has concluded that there is *sufficient* evidence that "radon and its decay products are carcinogenic to humans (Group 1)" (*5*).

Finally, Abelson questions the public health threat posed by residential exposure to radon on the basis of ecologic studies, stating that in some states with high radon levels, "inhabitants have less lung cancer than those in states with low levels." The limitations of ecologic studies for testing etiologic hypotheses have been well established. The average radon level for a state does not necessarily reflect the levels to which the individuals dying of lung cancer were exposed. Additionally, other important factors, such as individual smoking habits and mobility, cannot be assessed in this type of study. Because of these limitations, the Study Design Group of the International Workshop on Residential Radon Epidemiology has recommended against the further use of ecologic studies for the study of residential radon risk (*6*).

The EPA recognizes the uncertainties associated with the estimation of radon risks, as well as the uncertainties of risk assessment in general, and has supported studies to reduce uncertainty (*7*). However, given the extensive epidemiologic evidence that radon causes cancer in humans, the magnitude of the estimated risk, and the potential for elevated radon levels in homes, EPA's recommendation that American homes should be tested for radon and that elevated levels should be reduced represents prudent and responsible public health policy.

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5. *Ibid.*, vol. 43, *Man-made Mineral Fibers and Radon* (International Agency for Research on Cancer, Lyon, France, 1988).
6. U.S. Department of Energy and Commission of European Communities, *International Workshop on Residential Radon Epidemiology—Workshop Proceedings, July 1989* (CONF-8907178, National Technical Information Service, Springfield, VA, 1989), pp. 7–12.
7. National Academy of Sciences, *Comparative Dosimetry of Radon in Mines and Homes* (National Academy Press, Washington, DC, 1991).

Response: Studies bearing on the carcinogenicity of radon and its products have been affected by confounders. The data have been collected on miners, many of whom have been exposed to mineral dusts, and most of whom were smokers. Some were exposed to polycyclic hydrocarbons in diesel fumes. The combination of breathing some mineral dusts and smoking is known to be synergistic in causing lung cancer in the absence of radon. This is true of quartz (SiO_2) (*1*), amphiboles (asbestiform minerals), and a zeolite. On the Colorado Plateau, heavy exposures to mineral dusts were the rule during the 1950s. Deaths from silicosis and other nonmalignant pathology characteristic of exposure to silica have repeatedly been noted in Plateau miners (*2*).

Oge and Farland state that significant numbers of lung cancers have occurred in miners exposed to levels of radon comparable to a lifetime residential exposure at 4