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The carcinogenicity of selenium is indeed highly controversial. While we do not wish to engage in discussing this controversy, we wish to comment on Frost's statement that "Se should be viewed not as a pollutant, but as a critically essential nutrient."

Although Se has been recognized as an essential element for some animals and bacteria, its functions as a micronutrient for humans are still uncertain (*1*). Many cases of acute and chronic toxic effects of Se on humans are known (*1, 2*). Some of these effects were caused by high concentrations of Se in drinking water. Selenium has been suggested as one of the dangerous chemicals reaching the aquatic environment (*3*). Its toxicity has been demonstrated in goldfish and catfish (*4*). A concentration of Se in water as low as 0.25 mg/liter can cause a significant behavior impairment in the goldfish (*5*). Physiological and morphological changes have also been observed in algae exposed to $10^{-6}M$ Se (*6*). Because of its low safety factor [defined as the ratio of the toxic rate to the normal ingestion rate (*7*)], which is 25 for Se compared to 50 to 500 for As and 500 to 2000 for Hg, and its bioaccumulation by zooplankton in Lake Michigan, Se is considered as a potential hazard to the environment (*8*).

As environmental scientists ourselves, we are more concerned with the abundance, accumulation, and impact of Se in the environment and in the food chain. Whether an element is or is not viewed as a pollutant has little to do with its nutritional values. For example, both phosphorus and nitrogen are very essential nutrients; the fact that their abundance in natural waters causes water eutrophication classifies them as typical environmental pollutants.

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Negative Energy Impact of Modern Rail Transit Systems

It has always seemed obvious that substantial energy savings could be achieved by diverting commuters from automobiles onto rail transit. In fact, the wisdom of this idea has appeared so self-evident, to so many people, that it has been little examined. In the only direct analysis of this problem (*1*), Bezdek and Hannon calculated the energy cost of various kinds of transit construction and concluded that the United States could save energy by diverting investment from highways to rail transit. This conclusion was based on a theoretical analysis of the problem, but if one analyzes actual cases, standardizing by some measure of the services produced (passenger-miles of travel) one finds a totally opposite result. In my analysis I have used data from the San Francisco Bay Area Rapid Transit (BART) system, and here I present evidence to show that BART is typical of other modern rail systems.

Both rail transit and highways require a substantial investment of energy in their construction, and both are intended to produce passenger-miles of travel as the payoff to this investment. Hence the criterion of passenger-miles per British thermal unit (PM/Btu) seems a reasonable way to evaluate their relative efficiencies.

The BART system carries 130,000 passengers per commuting day, with an average trip length of 13.0 miles (*2*) and hence its output is 4.39×10^8 PM per year. It cost $2.28 billion (in 1974 dollars) to build (*2*, p. 163) and, by using an energy conversion ratio of 7.76×10^4 Btu per dollar (*3*), the total energy invested in BART can be calculated as 17.7×10^{13} Btu.

An urban freeway carries 18,000 daily cars per lane-mile, with an average of 1.4 passengers per car (*4*), if it is located in a travel corridor with enough traffic to justify rail transit. Thus it would take 67.1 lane-miles of freeway to carry BART's passengers. With a construction cost of $932,000 per lane-mile, and an energy conversion ratio of 11.2×10^4 Btu per dollar for highway construction (*5*), this works out to a total energy investment of 0.701×10^{13} Btu.

If one compares the construction energy invested in BART to the energy required to construct an urban freeway with the same capacity, it is evident that BART used 25.2 times as much energy. Alternatively stated, freeway construction produces 25.2 times more PM/Btu than rail transit construction.

I chose BART because it is the only operational, complete, new-generation rail system, and hence has measured data rather than engineering projections. This is important: BART cost twice as much, carries only half as many passengers, and uses double the propulsion energy as was forecast (*2*).

The result calculated above is primarily sensitive to two parameters, the high construction cost of rail systems, and their relatively low degree of use. If one takes these two parameters in turn: BART cost $32.1 million per system mile; the projected cost for three other rail systems now under construction is $34.4 million per system mile (*2*, p. 163). Hence, if BART is at all atypical on this criterion, it is atypically efficient. Total patronage is harder to compare since none of the other new systems has yet been proved. There is, however, good reason to believe that the others will do no better than BART: the average proportion of work trips, via bus and rail transit, across Boston, Chicago, Cleveland, Philadelphia, and Washington is 18.8 percent; in San Francisco this proportion is 25.1 percent (*6*). The unusually high proportion of work trips made via transit systems and the relatively high-volume traffic corridors caused by the geographic constraints of the Bay Area combine to make BART's patronage higher than might be experienced in other cities. Hence, again, if BART is atypical, it is atypical in a way favorable to BART's efficiency.

Because BART attracts passengers from buses and cars, there will be fewer vehicles on the highway, and hence less need to build highways. I have calculated this reduced highway need as 4.45 lane-miles (7), and crediting this saving to BART, the freeway-to-rail efficiency ratio changes from 25.2 to 25.1.

Construction-energy is not the entire story, however. One must also consider operating-energy. The operating-energies of BART, buses, and cars are 4740, 2900, and 8310 Btu/PM, respectively, including both propulsion energy and a pro rata share of the energy involved in constructing the vehicle (7). Thus, everytime BART attracts someone away from a car it saves energy but, unfortunately, all rail transit systems steal most of their passengers from the existing bus systems, and this wastes energy. BART has the best auto-diversion (46.5 percent, under very generous assumptions) of any rail system, but even so its net operating-energy saving is only 680 Btu/PM. This operating-energy saving is so small, relative to BART's construction-energy, that it will take 535 years even to repay the energy invested in building the system, much less save any energy. Furthermore, this result is so compelling that even in a transit Nirvana—with double the existing patronage, 75 percent of the passengers coming from cars, and a 50 percent load factor—it would still take 168 years to repay its construction energy.

Rail transit is an energy waster. If we want to improve the efficiency of our transportation systems, we should emphasize the development of more efficient automobiles, because that is where almost all of the existing transportation energy is now being used, and the development of bus-oriented transit systems, because of their energy efficiency.

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It is encouraging to see greater analytical attention being paid to energy flows in the economic system. But the difficulty of analysis and scarcity of good data are not excuses for unwarranted conclusions. Controversial ideas must meet the highest possible standards.

First, Lave asserts that "freeway construction produces 25.2 times more passenger-miles per British thermal unit than rail transit construction." Besides an inappropriate thesis, the statement does not follow from his data. The data refer to California freeways and to BART, a single California electric rail transit system. California is an extremely car-oriented state, and the only realistic way to build successful mass transit systems there would be to occlude car lanes with mass transit lanes. Then we would approach the saturation point in the remaining car lanes and in the mass transit lanes. There is little doubt that, at the saturation flow, mass transit can handle more passenger-miles per hour than automobiles. Our studies show much less capital use per passenger-mile in mass transit systems than in cars. This result alone would indicate that the seat miles per hour (a potential capacity measure) would be greater in mass transit systems than in automobiles. Also, the reaction times for starting and stopping, which control minimum vehicle spacing, apply to vehicles and not passengers. The greater number of vehicles in the auto system means that the minimum total head space of the system at capacity would be greater for cars than for mass transit vehicles. Thus the maximum potential passenger-miles per hour could be achievable with mass transit systems, not highway systems. We pointed out (*1*) that (i) highway construction was 62 percent more energy-intensive than rail mass transit construction, per dollar invested (rail construction also required more jobs per dollar); and (ii) that construction costs (excluding land) were slightly greater for a 12-foot-wide highway lane-mile than for a single rail track-mile. Thus, when potential passenger capacity and average U.S. construction techniques are considered, I am forced to conclude the opposite of Lave; that is, more potential passenger-miles per British thermal unit can be delivered by rail systems than by auto systems. But potential right-of-way capacity is not an appropriate basis for comparison. Governmental investment ought to foster the lowest total cost system of those which deliver the same service. The total cost might be based on dollars, energy, or jobs produced, both directly and indirectly, and would include the construction of right-of-way, the construction of vehicles, and the operation and maintenance of the entire system.

Table 2 in (*2*) showed the costs, per passenger-mile, of various forms of transportation. On an energy basis, electric trains are relatively the most wasteful form because of their poor load factor. But diesel-electric intercity rail transit and diesel bus transit are less energy-intensive than both electric rail and cars. And electric rail transit is less energy-intensive than urban cars, at comparable load factors. Therefore, I again conclude the opposite of Lave—rail transit is not an energy waster. And even if we were not sure of this point, energy policy should direct government transportation investment away from highways and toward rail transit. Existing highways will more than handle the bus traffic.

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Ectoparasitic Mites on Rodents: Application of the Island Biogeography Theory?

In their analysis of a summary (*1*) of ectoparasitic mite species records for North American cricetid rodents, Dritschilo *et al.* (*2*) state that the number of mite species on a host is positively correlated with host geographic range, and they interpret their "species area curve" in light of applications (*3*) of the theory of island biogeography (*4*). Dritschilo *et al.* (*2*) did not properly account for the positive correlation between host geographic range and the intensity with which the host has been studied. Reanalysis of their data shows that their data base is inadequate to demonstrate such a relationship.