

JAPAN: NOT AN ENERGY EFFICIENCY MODEL

Milton Searl and Chauncey Starr

The United States used 313 million BTU per person in 1988; Japan used 130 million. In 1988 the US used 17 430 BTU per dollar of gross domestic product (in 1985 dollars); Japan used 10 655. Such statistics are cited by the press as evidence that the US can do much more to increase energy conservation and efficiency. It seems that all the US has to do is adopt more efficient technology (which presumably the Japanese are using), turn down the thermostat, turn off a few more lights and so on. The answer is not that simple. Faith in such measures will lead us to neglect the actions necessary to balance our societal objectives with resource efficiency, increase our energy supply and implement environmental measures.

The basic questions are: How does Japan achieve its low energy use per capita and per dollar of GDP? Can we do it too? If not, what must we do to increase our energy efficiency?

Energy use by sector

Energy use can be divided among five sectors: energy conversion, transportation, industrial, residential and other uses (including agriculture and commerce).

The energy conversion sector, which is often overlooked in analyzing energy consumption, involves the conversion of primary, or raw, energy into secondary forms, such as gasoline, heating oil and electricity, and the distribution of these secondary forms to consumers. It is the largest user of energy in the United States and the second largest in Japan. Because this sector is not an end-user of energy, the proper measure of its efficiency is the percentage of primary energy that is lost in conversion, transportation and distribution.

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In 1988 the US lost only 28.5% of its input energy in this sector, whereas Japan lost 30.0%. The greater efficiency of the US is somewhat surprising because the secondary energy (electricity, natural gas and petroleum products) is distributed over a much larger geographic area than in Japan.

The transportation sector is the second largest consumer of energy in the US and third in Japan. In 1988 the US used 3.62 times as much energy per capita in transportation as Japan did. Why? A major reason appears to be the difference in population density. Japan has 865 people per square mile; the US has about 65. This represents a ratio of about 13.31 to 1. To a rough first approximation (the square root of 13.31) this means people in the US are 3.65 times as far apart as those in Japan. Given the same efficiency, then, the US should use 3.65 times as much energy per capita in transportation as Japan.

A much more detailed analysis could change this coincidence of agreement slightly either way, but it is unlikely that it would show US transportation to be less efficient than Japan's. This conclusion is based on the fact that 36% of Japan's population is in its three largest cities, compared with 13% in the US. In 1988 the Japanese paid 3.62 times as much for gasoline for transportation as Americans paid. According to economic theory, economic efficiency would dictate that US consumers use far more energy per capita in transportation. For the US, there is significant inverse variation of demand with price and significant direct variation with income. These economic factors seem enough in themselves to explain the per capita differences in consumption. Interestingly, the fact that in 1988 the US used 3.62 times as much transportation energy while Japan paid 3.62 times as much for its transportation

energy means the average amount spent on transportation per capita would be roughly the same in the two countries.

The industrial sector is the largest user of energy in Japan and the third largest in the US. In 1988 US industry used 1.62 times as much energy per capita as Japanese industry did. Part of this disparity is no doubt due to differences in the composition of industrial output, but very little can be attributed to differences in the per capita GNP produced by industry. In 1985 (the most recent data we have available) US industrial output per capita was 1.07 times that of Japan, which is not nearly enough to account for the difference in energy use.

The principal reason for the difference appears to be industrial energy prices. In 1988 Japanese industries paid 1.41 times as much as their US counterparts for light fuel oil, 3.17 times as much for electricity, 4.19 times as much for natural gas and 1.71 times as much for steam coal. A rough price-weighted average indicates that Japanese industrial energy prices were about twice US prices. Higher energy prices tend to drive capital investment toward energy-saving systems. This occurred in the US following the oil price shocks of the 1970s but did not go as far as in Japan because the US had lower long-run energy prices. This tendency to balance economic efficiency with energy efficiency is illustrated in Japan by higher energy prices in the industrial sector and lower per capita (or per dollar of GDP) energy consumption. The proportion of total industrial cost spent on energy may be roughly equal in the two economies.

It is probable that some of the industrial technologies used in Japan are more energy efficient and more economic than those used in the US. (The converse is probably true in other areas, such as agriculture.)

One could, for example, compare the efficiencies of specific pieces of equipment used for specific purposes under similar operating conditions. However, when we compare national (or sectoral) efficiencies, we are not addressing specific pieces of equipment but rather the average of all equipment in use, the manner of its use and so on. Perhaps relevant is the fact that in US industry the fraction of energy per capita that is electricity is two-thirds that of Japanese industry. This suggests that US industry is not as fully electrified as Japanese industry.

In the residential sector—fourth in both nations—the US used 3.64 times as much energy per capita in 1988 as Japan did. The dominant reason for the difference appears to be floor space: US residences had almost exactly four times as much square footage as Japanese residences existing around 1980. Consequently, the US used only 91% as much energy per square foot. Furthermore, the Japanese paid 2.76 times as much for residential electricity and 4.64 times as much for natural gas. Undoubtedly, other factors such as different heating and cooling standards and climate also play a role, but by reasonable standards, the US seems to do as well as—if not better than—Japan in residential energy use.

Other uses, which account for about 13% of energy in both countries, include agriculture, commerce, miscellaneous energy and non-energy (for example, petroleum products used in fertilizers) uses. In this sector, the US uses about 2.5 times as much energy per capita as Japan. Although we have not attempted to analyze energy use in this sector, we believe the same factors that explained differences in the other sectors would also account for the difference here.

While comparisons of Japanese and American per capita and per dollar of GDP energy use do not appear to us to be meaningful, changes in these measures may have some validity, as they may point to trends in conservation and efficiency. On this score, the US does well compared to Japan. On a per capita basis, the US used 5.5% less energy in 1988 than in 1973, while Japan used 16.7% more. On a per dollar of GDP basis, the US used 25.8% less in 1988 than in 1973 and Japan used 30.0% less.

Conclusions

In response to our three initial questions, therefore, we have concluded that the US is more efficient in energy

conversion and that Japan's lower per capita energy use in other sectors is primarily due to geography, less floor space per person and energy prices. We can't change geography; we can reduce our floor space only slowly and to do so may not even be socially desirable; and if we raise our energy prices, it may adversely effect economic growth.

It is impossible by technical means to bring the US to Japan's per capita energy consumption, at any cost. For example, if we were to heat and cool the same floor space to the same degree as in 1988, but with the Japanese per capita consumption, the efficiency of our heating and cooling equipment would have to increase 3.64 times. This is technically impossible, no matter how much money we spend on R&D, new equipment or insulation. This is of course not to deny that some improvement is possible.

At the beginning it was implied that aggregate comparisons of per capita energy use between the US and Japan can be misleading. Furthermore, the rhetorical use of such statements—Japan uses 130 million BTU per capita while the US uses 313 million—fallaciously implies that the US is irresponsible in its energy use. Reliance on such data can lead to the setting of technical and economic objectives that the technical community knows are impractical but that the public and politicians believe possible. This in turn can result in the misallocation of resources, misdirection of R&D, discouragement of the development of needed energy supply, and the setting of environmental goals that are unobtainable except at the expense of large reductions in economic activity.

We believe that the US should strive for conservation and increasing efficiency of energy use—as should Japan and other nations—but that this will have to come, as it has in the past, by energy-conserving designs in new buildings, increases in equipment efficiency through continued research and development, and growth in the conservation ethic. We should not pretend that other nations have more efficient energy-using systems that we can somehow adopt, nor should we feel guilty about our supposed inefficiency.

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