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Summary of Testimony by Alice M. Rivlin; June 24, 1981

During the next 15 years, existing technologies, coupled with market shifts to smaller cars, promise to be the likeliest source of fuel-efficiency improvements. CBO estimates that increased use of current technologies,--particularly weight reduction (including front-wheel drive, downsizing, and material substitution) and turbocharged diesel engines--could raise the average new fleet fuel economy from about 31 miles per gallon in 1985 to an estimated 40 miles per gallon in 1995. Moreover, as gasoline prices continue to rise, sales of small cars will increase relative to sales of large cars. Such market shifts promise to add about 2 miles per gallon to the average fuel economy of new cars by 1995. Thus, new cars in 1995 could achieve an average mileage rating of around 42 miles per gallon. This estimate is conservative, however, since it excludes any new technologies that might be developed during the next 15 years.

The additional purchase and maintenance costs of a car achieving 42 miles per gallon is estimated at approximately $625. This additional cost appears small relative to the associated fuel savings. At 42 miles per gallon, a car consumes about 1,056 gallons less fuel over its lifetime than it would at 31 miles per gallon. Assuming fuel prices climb to about $2.00 a gallon, the fuel savings would be worth $1,095 when discounted over the life of a vehicle. Thus, consumers would experience net savings of about $550 over the life of the car.

These technological improvements appear less cost-effective, however, when added to a 40-miles-per-gallon vehicle than when applied to a 27.5-miles-per-gallon vehicle. In particular, the costs of the diesel engine, PROCO engine, and turbocharger appear to exceed their fuel savings at the 40 miles-per-gallon level. Nevertheless, such technologies would be more cost-effective if gasoline prices or individual-vehicle-use rates are higher than assumed here or if manufacturing costs for these technologies decline as production efficiencies are realized.

Improved automotive fuel economy will yield significant reductions in oil consumption. Improvements in fuel economy since 1974 reduced U.S. oil consumption in 1980 by more than 700,000 barrels a day. Further improvements would continue to reduce oil consumption. Once the entire on-road. fleet achieved 40 miles per gallon, some 1.1 million barrels of oil per day would be saved relative to a fleet that averaged 27.5 miles per gallon--a 20 to 25 percent reduction in the nation's petroleum consumption by autos.

These improvements in fuel economy require substantial capital investment. Business-as-usual capital investment by the industry is estimated at about $7 billion a year. Improving the average fuel economy to 40 miles per gallon by 1995 would raise this to about $8 billion *a* year between 1985 and 1995. Accelerating this program to achieve 40 miles per gallon by 1990 would increase this much more, to around $12.5 billion a year from 1985 to 1990. Capital investment levels of $8 to $12.5 billion annually would continue to strain the industry's financial capacity. Failure to improve fuel economy, however, could mean continued erosion of sales of domestic manufacturers.

Mr. Chairman, I am happy to appear before this Subcommittee to discuss the outlook for the fuel economy of cars produced after 1985. As this Subcommittee begins its examination of the technical issues surrounding automotive fuel economy, I would like to discuss four related questions:

- o What level of average fuel economy is technologically feasible for new cars between 1985 and 1995?
- o Would improved fuel economy after 1985 result in savings to the consumers, bearing in mind the additional costs of producing vehicles that are more fuel-efficient?
- o How significant a contribution might improved automotive fuel economy make to the nation's efforts to conserve petroleum?
- o What would be the capital costs necessary to produce more fuel-efficient automobiles?

Technological Feasibility

Over the next 10 to 15 years, significant improvements in automotive fuel efficiency are likely. Only a few years ago, the prospect of attaining the mandated average standard of 27.5 miles per gallon by 1985 appeared remote. Technological progress, together with increasing fuel prices and consumer acceptance of smaller cars, now makes it virtually certain that the U.S. auto industry will exceed this standard, perhaps achieving an average fuel economy of 31 miles per gallon for new cars by 1985.

After 1985, further improvements in automotive fuel efficiency could come from three sources:

- o Automotive manufacturers may make more extensive use of fuel-efficiency technologies that are either already in production or planned for production;
- o Totally new fuel-saving technologies and production processes may be developed; and
- o Consumers may continue to shift to smaller, more fuel-efficient cars.

During the next 15 years, existing technologies, coupled with market shifts to smaller cars, promise to be the likeliest source of fuel-efficiency improvements, although technological innovations, such as electrically powered vehicles, could also profoundly affect fuel efficiency. Widespread application of such innovative technologies could radically improve the future fuel efficiency of U.S.-produced cars, although the impacts of such technologies are difficult to forecast. In my testimony, I will focus on the potential fuel-economy improvements that existing technologies and further market shifts could yield.

Since the Energy Policy and Conservation Act of 1975, a variety of fuel-saving technologies have been incorporated into new cars. Others are planned for production in the next few years. Even so, most of these improvements will generally apply to only a portion of all cars manufactured in 1985. Significant further gains in fuel economy are possible after 1985 by incorporating these same technological improvements in a greater proportion of new cars.

In a report published last December, CBO reviewed a number of studies that estimate the additional costs and fuel-economy improvements associated with technologies now in production or planned for production soon. This review found that increased use of these technologies could raise the average new fleet fuel economy from approximately 27.5 to 31 miles per gallon in 1985 to an estimated 35 to 40 miles per gallon by 1995.

The technologies that would likely yield the greatest improvements in fuel economy in the late 1980s are reductions in vehicle weight and diesel engines with turbochargers (see the Appendix Table). Vehicle weight reductions account for about 2.0 miles per gallon of the projected fuel-economy gains. Weight reduction can be achieved in various ways, including reducing vehicle dimensions (called "downsizing"), substituting lighter-weight materials for heavy ones (for example, aluminum and plastics for steel), and reconfiguring to front-wheel drive, which allows the car to be smaller and lighter while retaining interior space. Turbocharged diesel engines account for about 1.7 miles per gallon of the projected fuel economy gains. Turbocharging improves engine operation by boosting power. The turbocharger operates most effectively under unthrottled conditions, such as on diesel engines. The diesel engine itself also improves fuel economy because of higher compression ratios. Under our projection, turbocharged diesels could be mounted on 30 percent of all new cars by 1995. This projection assumes the relatively strict (1.0 gram per mile) standard for emissions of oxides of nitrogen. Future relaxation of emissions standards could result in even greater use of the diesel engine and additional fuel-economy savings. Alternatively, stricter standards could adversely affect the fuel-economy potential of diesel engines. The remainder of the estimated fuel-economy benefits would derive from improvements in engine design, transmission design, electronic controls, aerodymanics, engine lubricants, accessory efficiency, and tire and brake design.

In coming years, as gasoline prices continue to rise, sales of small cars will probably increase relative to sales of intermediate and large cars. Such market shifts promise to add about 2 miles per gallon to the average fuel economy of new cars in 1995, on top of the 35 to 40 miles per gallon that appears technologically feasible. Thus, new cars in 1995 could achieve an average performance of around 37 to 42 miles per gallon. This represents the low end of what is technologically feasible, however, since it excludes any new technologies that might be developed during the next 15 years.

Effects on Consumers

The additional lifetime cost (including initial purchase price and vehicle maintenance costs) of a car achieving 37 to 42 miles per gallon has been estimated at approximately $600 to $650 per car--about 10 percent of the cost of a new car. 1/ This additional cost appears small compared with the implied fuel savings. For example, a car rated at 27.5 miles per gallon would consume 4,545 gallons of gasoline througout its life, assuming an average vehicle life of 100,000 miles. On the same basis, a car rated at 37 to 42 miles per gallon would consume about 2,976 to 3,378 gallons--a lifetime savings of 1,167 to 1,569 gallons. The value of these savings in 1995 is obviously uncertain. Nevertheless, assuming that fuel prices climb to $2.00 a gallon, the fuel savings would be worth $1,045 to $1,174 when discounted over the life of the vehicle. This means that consumers would experience a savings of about $445 to $524 over the life of the car.

The savings to consumers of improved fuel economy will depend on future fuel prices, vehicle use rates, and the relationship between the mileage rating and on-road performance. Even so, it is clear that consumers would experience some net savings from these fuel-saving technologies

1/ All dollar figures herein are expressed in constant 1980 dollars.

under most forseeable circumstances. For example, even taking the lowest estimated fuel-economy improvement and the highest estimated cost from the studies reviewed, the sum of the discounted fuel savings still outweighs the additional cost of the new cars, assuming that fuel costs $2.00 a gallon. Alternatively, assuming the costs and fuel efficiencies that we project, the value of the fuel savings will exceed the associated increment in vehicle cost as long as gasoline prices are above $1.28 a gallon. Likewise, even if the vehicle is driven only 75,000 miles over a 10-year period, the improved fuel economy would still result in net savings to the consumer of approximately $66 to $206, assuming that fuel costs $2.00 a gallon. In short, it appears that the fuel savings justify the added costs of technological improvements over a broad range of assumptions about fuel prices, vehicle life, and the like.

In evaluating the benefits of improved fuel economy, however, it is important to recognize that each additional mile-per-gallon improvement results in less fuel savings (and hence fewer benefits) than the preceding mile-per-gallon improvement. For example, improving fuel efficiency from 27.5 to 28.5 miles per gallon results in fuel savings of 128 gallons over the life of the average vehicle. By comparison, a one-mile-per-gallon improvement from 37.5 to 38.5 miles per gallon results in lifetime savings of only 69 gallons.

Because of this effect, some technological improvements appear less attractive when added onto a 40-miles-per-gallon vehicle than they do when added onto a 27.5-miles-per-gallon vehicle. In particular, the costs of the diesel engine, the stratified-charge gasoline engine (PROCO), and the turbocharger appear to exceed their benefits at the 40-miles-per-gallon level. Nevertheless, such technologies may become more cost effective if gasoline prices increase beyond the level projected here, if individual vehicle use rates are higher than assumed here, or if manufacturing costs for new technologies decline as production efficiencies are realized. In addition, both the stratified-charge gasoline engine and the turbocharger yield emission control benefits not accounted for in these calculations.

Petroleum Conservation

Improved automotive fuel economy can yield significant reductions in national petroleum consumption. The improvements in fuel economy realized since 1974 have substantially reduced U.S. oil consumption--more than 720,000 barrels a day in 1980, almost 13 percent of the automotive fuel that would have been consumed in 1980 (assuming no change in vehicle-miles travelled) had we continued producing and buying cars like those produced in the early 1970s. These savings have been stimulated by two factors: increases in world oil prices, and the standards for automotive fuel economy established under the Energy Policy and Conservation Act of 1975. Further improvements in fuel economy would continue to reduce the nation's petroleum consumption. The full benefits of achieving 40 miles per gallon would only be realized, however, after the improved vehicles were completely phased in. Once the entire fleet of automobiles on the road achieved 40 miles per gallon, some 1.1 million barrels of oil per day would be saved relative to a consumption level of about 4.4 to 5.0 million barrels a day by a fleet that averaged 27.5 miles per gallon. This represents a 20 to 25 percent reduction in the nation's consumption of petroleum products by automobiles, or savings equivalent to 5 percent of the nation's total consumption of petroleum.

Automobile Industry

The improvements in automotive fuel economy discussed here would require substantial capital investment. Several of the studies that were reviewed in our December report included estimates of capital expenditures. They indicated that the costs of the special tooling needed to produce vehicles getting 37 to 42 miles per gallon would be about $20 billion; additional investment, estimated at $25 billion, would also be required for related plant and equipment.

Post-1985 improvements in automotive fuel economy would not, however, require a total 10-year incremental increase of $45 billion over the industry's normal capital investment levels, which run around $7 billion per year. Roughly $3.5 billion per year--a total 10-year increase of $35 billion--of the capital requirements of improving fuel economy could probably be absorbed in the manufacturers' normal, business-as-usual capital replacement cycle. This would leave about $10 billion of additional capital investment, thereby raising the industry's capital investment requirements from their normal level of around $7 billion a year to around $8 billion a year between 1985 and 1995.

Market pressures, however, resulting from consumer demand and stiff competition from imports, could possibly compel the industry to accelerate production of fuel-efficient cars and to raise the average mileage of domestic new cars to around 40 miles per gallon by 1990. In this instance, the capital costs of improving fuel economy would be incurred in five instead of ten years, and some plant and equipment would be replaced before normal schedule. This means that only about $18 billion could be absorbed in the normal investment cycle, leaving a total of around $27 billion of greater-than-normal investment between 1985 and 1990. Together with the normal investment levels of around $7 billion a year, this implies that the total capital investment of the industry could average as high as $12.5 billion a year if the industry is to achieve a 40-miles-per-gallon average by 1990.

Capital investments of $8 billion to $12.5 billion annually would continue to strain the industry's financial capacity. The speed with which U.S. companies turn to producing more fuel-efficient vehicles will, however, be critical to their future sales volume and financial health. The large share of new car sales captured by foreign manufacturers during the past year or so, and the concurrent decline in domestically manufactured sales, is largely attributable to the superior fuel economy of the imports. Failure by domestic auto manufacturers to make further improvements in fuel economy after 1985 could result in a continuation of the reduced market share held by domestic manufacturers.

Conclusion

Increased use of fuel-saving technologies that are currently in production, or that are slated for production within the next five years, could increase the average fuel economy of new autos to about 35 to 40 miles per gallon. Additional fuel economy increases of about 2 miles per gallon are also likely to occur as buyers shift toward smaller, more fuel-efficient autos in response to continued increases in gasoline prices. This means that, even without innovations that may yield further improvements in fuel economy, an average fuel economy of about 37 to 42 miles per gallon appears technologically feasible for new cars in 1995. Indeed, market pressures could force domestic automotive manufacturers to produce such cars by 1990. Furthermore, given that some further innovations are likely during the next decade, an average fuel economy of somewhat above 40 miles per gallon is probably within reach by 1995. Such fuel-economy improvements would significantly reduce petroleum consumption relative to current trends and would be cost effective to consumers--that is, the additional cost to consumers for more fuel-efficient automobiles would be more than offset by savings in gasoline expenses.

The capital investment required to produce such vehicles is estimated at $8 to $12.5 billion annually after 1985 depending upon the speed with which these improvements are achieved. Although the U.S. automotive manufacturers spent about $10 billion on capital investment in 1979 and $13 billion in 1980, their ability to sustain such high levels of expenditure is uncertain. A continued high rate of capital investment would place significant financial pressure on the industry. Failure to improve fuel economy, however, could mean continued erosion of domestic automobile sales through competition from imports.

APPENDIX TABLE A. CBO ESTIMATES OF FUTURE FUEL ECONOMY IMPROVEMENTS AND COSTS OF TWELVE EXISTING TECHNOLOGIES

Technology	Percent Market Penetration			Percent Improvement in Fuel Economy		Consumer Cost Increases (1980 dollars)				
						In Initial Vehicle Cost		In Maintenance Costs a/		
	1985	1995	Increase from 1985 to 1995	Per Vehicle b/	Average Vehicle	Per Unit b/	Average Vehicle	Per Unit	Average Vehicle	Total for Average Vehicle Lifetime
Weight Reduction										
Material substitution	50	100	50	4	2.0	131	66	0	0	66
Front-wheel drive	80	100	20	12	2.4	166	33	0	0	33
Downsizing	60	60	20	10	2.0	146	29	0	0	29
Four-Speed Automatic Transmission	27	54	27	6	1.6	198	53	36	10	63
Electronic Controls c/	5	25	20	15	3.0	179	36	0	0	36
Diesel Engine	7	30	23	15	3.5	679	156	0	0	156
Stratified Charge Engine	0	12	12	15	1.8	679	81	0	0	81
Turbocharger	7	30	23	10	2.3	332	76	112 d/	26 d/	102 d/
Lubricants	20	70	50	3	1.5	1 to 15	1 to 8	9 to 103	5 to 52	6 to 60
Aerodynamics	60	100	40	5	2.0	17	7	0	0	7
Accessories	50	100	50	2	1.0	16	8	0	0	8
Rolling Resistance	50	100	50	2	1.0	26	13	0	0	13
Total					26.9 e/		559 to 566		41 to 88	600 to 654

SOURCE: Congressional Budget Office, Fuel Economy Standards for New Passenger Cars After 1985, December 1980.

a/ Maintenance costs are pro-rated on a per-mile basis (unless otherwise noted) and discounted at a 10 percent annual rate.

b/ Estimates for mutually exclusive technologies are not additive. For example, estimates for the diesel and the stratified-charge engines are not additive since these technologies cannot both be applied to the same vehicle. On the other hand, the benefits and costs of a major reconfiguration program could be determined by adding the estimated fuel-economy and cost increases for several programs, including material substitution, front-wheel drive, and aerodynamics. Based on the estimated costs and benefits summarized above, a major reconfiguration program would result in a fuel-economy gain of approximately 21 percent at an incremental vehicle cost of $314. This is reasonably consistent with GM's X-car experience, the Chevrolet Citation having a fuel economy of 18 percent and cost increment of $282 over the Chevrolet Nova, which it replaced. (Energy and Environmental Analysis, Inc., Technological/Cost Relations to Update DOE/Faucett Model; Draft Final Report, October 1979, pp. 2-75 and 2-76).

c/ Only includes variable valve selector for the post-1985 period.

d/ Maintenance costs of the turbocharger are incurred in year six of the vehicle's life.

e/ Percentages are compounded (multiplied) to total 26.9 percent.