"CEER-X-132 TRANSPORTATION ENERGY CONSERVATION IN PUERTO RICO: POTENTIAL, APPROACH METHODOLOGY, AND PROSPECT TO 1985 BY JARO MAYDA OCTOBER 1981

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Barrels per day might [1.6 km] kilometers per gallon, miles per hour, per capita income, private vehicle transportation system, total direct transportation energy, transportation energy conservation, transportation system management, vehicle miles travelled per year. Occasionally used abbreviations are explained in the text.

NARRATIVE SUMMARY

The potential for energy savings in transportation in Puerto Rico, already shown in a previous study (Energy conservation in transportation in Puerto Rico: A policy study, CEER X-32, 1978) has further increased. The transportation share in the total energy budget grew from less than 20% in 1979 to 32.5% in 1981. While the total energy consumption was dropping by some 10%, transportation energy was decreasing by less than 4%. Official figures tended to distort the real average consumption per vehicle: the total number of active vehicles was overstated by perhaps as much as 15%, the fuel consumption was understated by more than 7% because the statistics showed only gasoline consumption, not also diesel fuel used in transportation (pages 4-7, 61-64).

Together with secondary energy expenditures incident to transportation (such as losses in refining and distribution, construction and maintenance of roads, public services, and rehabilitation of accident damages to persons and property), the transportation sector used in the fiscal year 1981 over 27 million barrels of fuel, more than 52% of all the energy used in Puerto Rico. 90% of the directly used fuel was burned by passenger vehicles, 89% of them private, 66% in urban traffic. Driving other than to job, school, or essential shopping represented about 40% of all trips, that is almost one-half of all private auto travel.

Consumption of energy in transportation in Puerto Rico was on several accounts relatively much higher than in the United States as a whole (pages 13-23). Wide margins for fuel economies exist in such areas as the maintenance of vehicles and roads; more controlled use of power equipment (such as air cooling).

Traffic engineering and enforcement; driving style and behavioral driver demand (vehicle occupancy, length and consolidation of trips, reduction of nonessential driving) and, of course, improved public transportation. Several recent estimates have confirmed a tentative figure proposed in the 1978 study: that up to 50% of fuel could be saved in Puerto Rico without substantially affecting private mobility. In 1981, this would have reduced the cost of the imported petroleum by some $290 million. This amount represents almost 40% of the cost of crude which PREPA uses to generate all the electricity for Puerto Rico in a year, if the daily bill is $2 million (pages 12, 21-25).

On average, a public policy of systematic transportation energy conservation (TEC) could be implemented on the basis of alternative scenarios, that is various combinations and sequences of measures calculated to achieve predetermined targets (percentages of past consumption or quantities of petroleum) in specific future years. This study provides an inventory of possible measures, scenario structures and levels, and a shorthand code for easier handling of the many variables. It also identifies the more than a dozen government agencies that would have to coordinate their efforts in implementing the chosen scenario. Their activities would be guided by agency task sheets, that is subscenarios arranged in the perspective of organizational implementation rather than the total TEC targets (pages 26-35).

To illustrate the methodology, data are analyzed and arranged in a model scenario for one major category of TEC measures - fuel conservation through speed control. The analysis shows the inseparable relations between speed (too fast, too slow, erratic), energy consumption, accident rates and driving while intoxicated. Other major categories are transportation system management (which includes construction/maintenance, traffic engineering and control, collective transportation), TEC related to vehicle equipment and maintenance, and

Corrected Text:

Cost-conditioned driver demand and behavior. The essential information and methodology is ready for concrete, detailed elaboration whenever there is public interest and will (pages 38-43). At present, the decisional and implementation environment is unfavorable and worsening. The rapid transit option, alive until 1980, has been lost for at least a decade. Vested interests are strong. Private vehicle transportation is heavily publicly subsidized because of low highway user costs. The average motorist is, in fact, losing substantially more than he gains, because of poor road maintenance, inadequate traffic engineering, and token enforcement: but he does not know it. Improvements cost money. An adjustment of the gasoline tax to compensate for inflation since 1974 would raise it by 10¢ a gallon, generating an income of > $65 million (based on 1961 gasoline consumption). Systematic driver information and prudent behavior would permit an average fuel economy of 20 MPG per vehicle. The tax could thus be raised by an additional 29¢ a gallon (which is 20% of the present pump price) without increasing the total yearly gasoline bill of careful, law-abiding drivers. Even with the decreasing consumption, the government would collect on the order of $250 million a year. This would go a long way also toward improvements in public transportation and the beginning of a mass rail transit for the 1990s. The easing fuel cost situation, which should facilitate some such course of action spread over a couple of years, paradoxically further reduces any meaningful systematic measures (pages 50-56). The pressure to take the expectation to 1985, the time span of this study, is for the “worst case” scenario. Some gradual decrease of fuel consumption will come only through automatic factors and technical fixes, such as the continuing switch to new, more efficient cars, mileage-increasing gasoline and motor oil additives, the spreading information about individual MPG opportunities and, perhaps substantially, the

Decrease of federal transfer payments channeled into private transportation expenses. Alternate fuels may make a fractional difference; but a more extensive use of some of them, for example liquid petroleum gases (propane, etc.), would substantially increase traffic risks unless all truckers could be trained and made to avoid abrasive driving. Among the more affirmative actions that would greatly increase TEC are: return to traffic enforcement levels which prevailed still some 40 years ago; a revised, energy-conscious traffic code; flow-improving engineering, as well as several other simple administrative measures. The initial payoff of practically any set of such affirmative actions is obviously very extensive. The passive crisis scenario will not cause the system to collapse, but will induce ad hoc, spontaneous and disorderly adjustments at great human, social and economic cost (pages 56-60).

1. INTRODUCTION

1.1 Objective

In a policy study of energy conservation in transportation in Puerto Rico, which the Center for Energy and Environment Research conducted in 1977-1978, it was concluded that the main transportation energy indicators and accounts in Puerto Rico were significantly higher in comparison with the United States as a whole; that they provided substantial margins for energy conservation; and that particularly the data concerning the private vehicle transportation sector should be further developed to provide a base for projections, goals and policies directed at transportation energy conservation (24,33; see also Table 2.)

The present study is a first effort in this direction. On the basis of consumption data and trends, and the analysis of various combinations of possible approaches, techniques and preconditions for success, the study seeks (i) to identify and define the apparent potential for transportation energy conservation (TEC), in terms of both specific fuel-economy targets and systems; (ii) to estimate the real prospect for public and private decisions.

Favoring TEC in the immediate future, a consolidated list of recommendations is presented. Elements of and direction for a more detailed follow-up are listed and outlined.

1.2. Scope and focus

There are several reasons for a cautious, limited approach at this time, such as:

+ The seemingly unlimited faith of energy and transportation planning in unquantified simulation, which dominated in the 1970s, has given way to a more balanced quantitative-qualitative policy analysis.

+ It has been recognized that "much of the predictive power of any methodology is provided by the credibility of the...assumptions underlying it" (Bib xiii); and that "a large margin of absolute error is always to be expected...the calculation [is satisfactory if] it will highlight if one option is approximately 2X or 3X as expensive over twenty years as another option"(11, 8).

The most specific caveat is provided by an attempt at energy scenarios for Puerto Rico, including transportation energy (121). The committee of the National Academy of Sciences which authored this report could not foresee the 1980-81 changes in such basic parameters as fuel supply, cost, and federal regulatory policies--and much less the effects of Reaganomics or mass transit planning in Puerto Rico. These changes substantially affected the premises of the present study and forced major mid-course adjustments.

However, the NAS report, at least in the parts dealing with transportation, raises the question of “credibility of... assumption" and ends up with an apparently “large margin of error” indeed. For example, gasoline consumption in the base year (1977) is understated by 15.7% (almost 13Mb instead of the correct figure of 15.3Mb). The low figure serves as a base for projections to 1985, as well as to the year 2000.

As for 1985, the expectation that gasoline consumption would by then drop back to 1977 levels, might possibly materialize already in 1982-83, although the rate of decrease of consumption has hovered around 2.5% per year, rather than the predicted rate.

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The text is predicted by the NAS report on the basis of smaller increases in gasoline pump prices. Other concrete references to the report's data, assumptions, and proposals are made below as warranted. The performance and priorities of the government of Puerto Rico in the field of transportation in general, and of energy conservation in particular, are perceived here. These factors favor an open policy approach rather than more or less rigid scenarios based on too many uncertain variables and speculative assumptions. The situation would, of course, change as soon as the decision-makers showed interest in the development and evaluation of concrete policy options and alternative scenarios to implement them.

1.3, Policy methodology

No matter what the particular thrust or scope may be, an exercise in the evaluation of prospects and in scenario construction is always a particular form of policy research and development. Environmental impact assessment offers an example. Its policy nature is no more in question (25:26), yet it is nothing else but an evaluation of the impact scenario (or alternative scenarios) constructed from information about the planned action. A few brief comments on the methodology, as related to the present study, may prevent some misunderstandings, both by officials and by other readers. As has been pointed out elsewhere (25,29-30), decision-makers tend to mistrust or ignore policy analysis. They seem to feel that it restricts their decisional freedom. This is no doubt true when independent policy R&D results in recommendations contrary to a politically preferred course of action which the analysis revealed as based on faulty or incomplete data, or on an inadequate (if any) examination of possible alternatives. However, upon more detached reflection, it is difficult not to recognize that the policy method provides a base for improved decision-making, even under the normal--rather than exceptional--conditions of great uncertainty. The reason is inherent in the first.

Characteristics of genuine policy development ensure all the available relevant information is collected and analyzed together. This improves the problem definition; missing data are often spotted (thus, also gauging the degree of reliability); and a broader base for comprehensive evaluation of possible solutions and constraints is created. Even at its minimum level of effectiveness, policy analysis at least raises red flags where otherwise decisions would be made on often fragmentary and overly optimistic technoeconomic considerations, without any suspicion about the excessive external (social and environmental) costs. At its best, the policy method functions as applied social system analysis (25.2). It is likely to identify approaches to problems which are effective or otherwise attractive to decision-makers because of beneficial secondary effects.

One example of such a system approach is the analysis later in this study (sections 4.2ff) of an apparently narrow and straightforward relation between fuel economy and speed, set in the broader context of causes and effects. These include drunken driving, high-risk driver groups and vehicles, accident cost and prevention, traffic engineering, management and enforcement, revised licensing and renewal requirements, adequate insurance and, of course, also the problem of too slow speed as the cause of unnecessary fuel consumption (including by other drivers) and increased accidents. The simple relation between speed and energy conservation begins to look quite formidable in this set of secondary data. They, in turn, represent an empirical base for the reconsideration of major sections of the Traffic Code and of enforcement capabilities and practices.

On a more mundane level of the millions of individual decisions, whose full total is the waste or conservation of fuel, policy analysts do not aim at telling anybody, for instance, how much leisure driving they can or cannot do. The objective and task are rather analytical: to collect and interpret data which may influence these decisions.

Indicate:

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4. (4) The cost of private vehicle transportation is highly subsidized and therefore not real.
(1) When the market mechanism and/or the government catches up with this situation, the scope of individual choice may likely be sensibly affected.
(111) What kinds of choices and trade-offs, depending on individual values and intelligence, may still afford some measure of personal freedom in moving around.
(iv) How the transportation system and needs might be restructured in an anticipatory way to make any future adjustments to critical changes in the present situation less harsh and costly. This is all an analytical exercise. It becomes prescriptive - forcing you and me to act or not to act in a certain way - only when the policy analysis and recommendations become an authoritative decision. Its implementation is then no more a policy or a scenario; it becomes an obligatory set of law rules, procedures, administrative measures, prices and tax rates, incentives and disincentives, designed to balance transportation fuel supply and demand within the framework of needs and capacity.

2. Adequacy of the data base. Policy analysis for decision making aims not at mathematical precision, but at highly aggregated data or, where necessary, at approximations without serious distortion. Technical data, no matter how hard and apparently complete, do not make decisions, nor should they, at least not in social problem solving (25,21-23). But the policy method is very sensitive to what may be called the coefficient of confidence. Aggregation, generalization, interpolation and estimate are all legitimate ways of generating policy data for decision making. But, obviously, the quality of the end product depends here, as anywhere, on the quality of the raw material: the reasonable completeness, consistency and reliability of the primary data base. The

uncertainty and incompleteness of baseline and current data in transportation and transportation-related energy consumption is notable.

(23). It was commented upon in specific relation to Puerto Rico in the 1978 study (24,18). The problem continues. As the following seven examples show, the statistics also tend to be biased in the direction of understating the real dimensions of transportation energy consumption in Puerto Rico, with the inevitable effect on priorities and decisions.

5. Number of active vehicles: official statistics appear to have consistently overstated since 1979 the total of active vehicles. In FY'80, when the official number was 1.254 million, the active fleet was closer to 979,000, a difference of approximately 15.5%. A vehicle is not dropped from the active roster if its license is not renewed by the end of the given fiscal year. The owner may be absent and will renew the license when he returns. Or the vehicle may be temporarily deactivated and will be re-licensed when back in service. Only when a license is not renewed for two consecutive years is the vehicle taken off the active list. For this reason, the number of active vehicles in a given year must be estimated.

The accuracy of this estimate depends on the use of a realistic so-called scrappage rate, that is the approximate percentage of vehicles that have been wrecked, abandoned, dismantled or otherwise permanently deactivated during the preceding year. The official figure seems to be the result of arbitrary estimates of the scrappage rate, after the often used rate in the United States, was abandoned several years ago. And yet, it seems relatively easy to estimate fairly accurately the current scrappage rate on basis of the verified and averaged numbers for the preceding two or three years. As the estimate for any given year is verified against the actual number of not re-licensed vehicles, the new number is factored into the "trend" rate for the purpose of the next estimate.

The founded trend rate established for Puerto Rico by this system is 7.5%. This is the base for the estimate of 970,000 active vehicles in FY 1980.

Graphic illustration of the vagaries of the present system, a proposed equation for calculating the scrappage rate, and an updated note are in the Appendix.

Total direct transportation energy (TDTE). Direct transportation energy is the fuel used by the vehicle engine and equipment, such as power steering, air conditioning, and freight lifting. Two major fuels are consumed in land transportation: gasoline and distillate fuel oil (diesel), only the gasoline account is separate. It is this total that is officially considered to be the amount of energy consumed by motor vehicles.

Diesel oil consumption (1.75M in 1979) is statistically included in "Total fuel consumption," not disaggregated by sectors such as transportation, industry, agriculture, etc. (5§, Table IT). It is impossible to state with any degree of precision just how much diesel is used in transportation and should be routinely added to the amount of gasoline to obtain the TDTE account.

A substantial number of heavy trucks and tractor-trailers, some 6% of all vehicles in Puerto Rico, use diesel fuel. In the 1978 study, the transportation of freight was a hypothetical fuel consumption factor of 2.5, the factor for the passenger fleet being 1.0. This took into account elements such as visibly inadequate engine maintenance of many trucks, overloading, and the state of roads other than toll roads, then only partly open (24,32). The NAS study arrives at a figure of 11% for freight (121, Table 23; 60, Fig. 3), without an indication of sources or method. Neither of the two calculations provides a viable base for the estimate of diesel consumption in transportation.

Several new calculations were therefore performed using the following data and factors:

+ The proportion of heavy trucks in the total motor vehicles in Puerto Rico is 32% of that of the fifty U.S. states (7% against 18%)
+ Diesel represents 20% of the total U.S. truck consumption (19, 1-12), which amounts to 12.2% of total U.S. transportation energy (Id. Fig.

1.2, 1.3) The average ratio of industrial to transportation use of diesel in the U.S., from 1977 to 1979, was 112.2 (83,11, Table 27).

1.75Mb of diesel were consumed in Puerto Rico in 1979. This was part of the present calculations and extrapolations.

The figures include diesel used by railroads and waterway in agriculture in the U.S., or in the Puerto Rico data.

Despite the growing number, there is still a very small number of people in Puerto Rico using air conditioning systems that use propane.

The various calculations of the share of diesel in the total transportation energy in Puerto Rico ranged from 4.7% to 7.0%. The rounded average of 6% is considered to be a reasonable conservative projection.

This figure represented in the last several years an average of about 2% of all energy used in Puerto Rico. It must be added to the gasoline figures to obtain the real share of direct transportation energy in the total energy budget in Puerto Rico. (See Figure 2 on page 15).

The following factors were considered insignificant for the purpose of freight fuel: and of freight vehicles.

1.43 Indirect (secondary) transportation energy. Transportation also consumes a substantial amount of energy incidentally, indirectly. This so-called secondary energy was already analyzed in the previous study (24,40, Fig. 3) in the following categories:

* Gasoline Production, Distribution, Evaporation

* Vehicles: Transport, Sale, Maintenance, Tires, Parking and Garage, Administration of the transportation system.

* Infrastructure: Construction, Maintenance.

* Accidents: Emergency treatment and hospitalization, Repair of damage to vehicles and property (public, private).

A coefficient of .66 (meaning that if direct energy is 1.0, the total transportation energy is estimated to be 1.66) was used. This coefficient was derived from United States data (29:23). A 10% margin of uncertainty was assumed. Since the direct transportation energy in 1977 was 90% of the total energy consumed in

In Puerto Rico, the total transportation-related energy was estimated to be 1.66 J%x, equivalent to 5K. Even with a 10% margin of error factored in, the total amounted to at least 48%. This indicated that transportation in Puerto Rico used directly and indirectly about as much energy as all the other sectors combined (after their transportation-related energy use, primarily electricity, had been deducted). Subsequent U.S. estimates have been generally in the same range (85, 1-9), especially if the substantial accident account was added--emergency wards and rehabilitation therapies being amongst the most energy-intensive operations in contemporary hospitals.

The TECNET (Transportation Energy Conservation Network) study, prepared for the U.S. Department of Energy, is supportive even without any correction. It concluded that in the base year 1971, "the amount of fuel consumed indirectly by transportation [was] 47% as large as the energy consumed directly by vehicles. Over time, the significance of the indirect component increases" (33,41). An average increase of one percentage point a year would have brought the coefficient of indirect energy to .57 in 1981, for a total transportation energy of 1.57. This happens to be the figure arrived at quite independently (and using a different methodology) in a study of energy consumption and efficiency of 53 sectors of the Puerto Rican economy (58).

Coefficient 1.57 means that 57% must be added to the total direct transportation energy in order to estimate the total (direct and secondary) energy used in relation to transportation. This total ranged between 47.1% and 50.2% in Puerto Rico in the last three years, very close to the tentative gross estimate made in 1978. It appears safe to use in the future a coefficient of 1.6 (TDTE being 1.0) to estimate the total transportation energy in Puerto Rico in a given period. It is true that the indirect energy account includes many industry, construction, and service activities which are presumably targets for improved energy efficiency.

Efficiency in their respective sectors is crucial. However, direct candidates only cite two examples, and several others are necessary for effective energy conservation in transportation.

(4) Poor road surfaces and tire-burning acceleration contribute to a substantial increase in tire wear. The production of an average tire requires seven gallons of crude oil.

(11) Service stations account for an estimated 36.5% of the five percent loss of hydrocarbons due to evaporation. A good seal at the interface of the pump nozzle and the vehicle's filler neck can save 90% of this loss (LLL). This amounts to saving more than 1.5% of all the gasoline pumped in Puerto Rico in FY 1981, which is over 10 million gallons.

Indirect energy related to topics such as "Construction" and "Accidents" must also be considered in any long-term scenario. The former is important because the energy cost of new infrastructure construction should be weighed against the benefits of non-construction transportation system improvements. The latter is relevant due to Puerto Rico's relatively high accident rate, which is 1.7 times higher than in the United States as a whole.

Other missing data is also important. It is widely recognized that the key to transportation energy conservation lies with the owner-driver of private automobiles. Fuel consumption depends on demand and driving style.

There is sufficient data on demand, including the number and purpose of trips, their length, and vehicle occupancy rate. However, there is a lack of transportation-related data on driving style and factors that influence it, such as intelligence, training, education (discipline, courtesy, civic responsibility), mental competence, and psychological states. Data on age and sex are largely available only in the context of accidents and drunk driving statistics.

The traffic behavior pattern of the general public appears to be quite different from other geographic areas with comparable traffic structure and density. One indicator is the relatively high accident rate, as well as the number of vehicles showing signs of damage.

Involved in minor PDO (property-damage-only) accidents, these incidents are not reflected in the statistics. However, it's difficult to accurately determine the size of the group whose driving style characterizes the vehicular traffic as a whole. It could well be a minority. Here, it's important to note that many drivers in Puerto Rico, whether knowingly violating the law or simply unaware, exhibit a driving behavior that's grossly wasteful of energy.

For practical purposes, this study primarily approaches driver behavior in relation to: (i) substantially improved enforcement of existing laws, (ii) adjustments to the price of private driving to reflect the real user cost, (iii) the possibility of relating law enforcement and cost to improved conservation knowledge and behavior. This includes not rushing from one stoplight to another, or only using air conditioning when necessary, etc. This focus is determined by the perception of current and foreseeable government interests and capabilities.

This doesn't imply that nothing more could or should be done. For example, the vehicular traffic laws and driver licensing procedures are currently exclusively focused on the "rules of the road" and, less effectively, on traffic safety. The law would greatly benefit from becoming more energy-conscious.

High traffic-risk groups, such as males under the age of 25 (and to a lesser but still significant degree, under 35 years), are now identified based on accident rates and insurance claims. However, the more fundamental collective characteristic of these groups is excessive energy use due to speeding and aggressive highway behavior, regardless of whether they have accidents or not.

In the context of adequate data under discussion here, any more drastic measures directed at private drivers would probably require existing statistics to be more specifically related to driver behavior. Moreover, new data - especially quantifications of particular behaviors - would likely need to be collected.

Types of traffic behavior based on reliable samples should be developed for the purpose of legislative and enforcement justification against genuine or spurious challenges.

Conclusions:

A conscious and systematic effort to correct the pervasive weakness in transportation and energy-related statistics in Puerto Rico is called for. It may require a central validation process. Such a process may not only improve the quality of the statistical series, but also be more cost-efficient, as it would eliminate much effort which appears to be duplicated.

Such discrepancies as exist in the estimates of the active vehicle fleet (plus 15% or more) and of the energy it consumes (minus 6% or more) should be corrected without delay. Overestimating the number of vehicles has been, indeed, the practice of highway-promoting agencies. The figures of the Federal Highway Administration were found to be 12-17% too high. The improvement in statistics which happened when the Energy Information Administration was formed within the U.S. Department of Energy in 1977, showed that gasoline consumption, as calculated previously on basis of aggregated industry figures, overstated the national vehicle/gallons average by more than 100 gallons/vehicle in 1975.

An error like that is very relevant to Puerto Rico. Compared with the originally reported U.S. figure of 616 gallons, Puerto Rico's per vehicle consumption of 775 was well below the national average. However, in comparison with the corrected figure of 712 gallons, Puerto Rico was 8.8% above this average—an indicator which might have given pause to decision makers.

The preceding evaluation of the existing database in no way implies that there is not enough information available for the purpose of forward-looking transportation-energy planning and cost/benefit analysis. Even extensive changes in government policies for the coming years can be made with the help of existing data, methods of policy analysis, and so on.

"Sketch planning" (e.g., 112,1-3,4), which does not ensure costly data generation and processing, is well developed for the present needs.

This has been the case for at least a decade. The system focus in this study is consequently limited to the possibilities of energy conservation within the existing transportation system and its improvements.

2.2 Energy imports and uses are also a significant factor. The measurement in millions per year (Me/yr) equals Mo/yr x 42. For example, an energy import rate of 15.9 Mb/PY'81, translates into an average daily consumption of 1.83 Mg. As of 1981, the total energy consumed was worth about $1.8 billion, with a total cost of $3.3 billion.

Figure 1. Energy Imports and Uses in Puerto Rico (millions of barrels per calendar year). The total energy imported and consumed annually from 1974 to 1979 ranges between 70 and 85 million barrels.

2. The Potential for Transportation Energy Conservation in Puerto Rico.

2.1 Policy Baseline: The 1978 study concluded that wide margins for transportation energy conservation (TEC) existed in Puerto Rico. It proposed the following four policy baselines for the purpose of planning and implementation:

1. Transportation in Puerto Rico consumes directly and indirectly about as much energy as all the other sectors combined. The share of transportation energy in the total energy budget is roughly 38% higher than in the United States as a whole. Population-based calculations from 1979 data indicate that this relative share is approximately three times as high as initially estimated in 1977. (See Table 1, item 4.)

2. The basic mobility needs of individuals could be met with as little as 50% of the current direct transportation energy in Puerto Rico. This could be achieved with adequate maintenance of engines, vehicles, and roads, reduced use and acquisition of convenience equipment for automobiles, and reduction of driver demand (high-speed, low occupancy, nonessential driving), among other strategies.

"Upgrade and align overall driver behavior to the standards of the traffic code and common set rules. The private vehicle transportation sector is highly publicly subsidized. This means that the users of automobiles do not pay the full economic cost of gasoline, highway use, parking, and they are also subsidized on a number of other accounts. Transportation energy conservation cannot be effectively implemented outside an adequate transportation system management (TSM) in broad-sense transportation planning and resource system. This will reduce the social and environmental cost (that is adverse impacts on public and environmental health, land use and environmental aesthetics) which must be assumed to be equal in magnitude to the energy and economic costs of automobile-based transportation. The quantitative dimensions of Baselines I and II, relevant to TSM, are illustrated by various figures and tables in the following sections. Baselines III and IV are discussed in chapters 4 and 5. The formation of Baseline IV, cited above from the 1978 study, was influenced by the then still active planning of a transit system for San Juan, organized around a major rail component (see also 23, advocating light rail against a partially subterranean heavy-rail system) and the explicit possibilities of major improvements in the quality of the urban environment. This opportunity has been allowed to become a victim of changes in federal urban mass transit policies and is, in all likelihood, dead for now.

Figure 2 shows the disposition of the energy imported in FY 1982, with emphasis on the transportation sector. The heavy line connects the magnitudes which should control transportation energy conservation policies and actions. About two-thirds of total transportation energy spent in urban driving represents about 11.5Mb, that is some 22% of the total energy consumption in Puerto Rico in 1980-81. At least 70% of this fuel consumption must be assigned to metropolitan areas."

San Juan represents more than 15% of the total energy consumption on the island, despite the fact that according to a 1977 survey by the Department of Transportation and Public Works, based on a reliable sample of 1600 respondents, almost 30% of families in metropolitan San Juan were still carless. The 1980 census data are not available at this time. The proportion of carless families in comparable metropolitan areas in the continental United States is 17.58%. The overall national percentage is 15.3% (9501).

2.3 Past and present consumption trends:

Figure 2 on page 17 compares the cost of imported crude, the pump prices of gasoline, and the average daily gasoline consumption, in millions of gallons (Mg) in Puerto Rico and in millions of barrels (Mb) for the rest of the United States. (Puerto Rico figures in U.S. statistics only as an importer--that is, re-exporter--of energy in the form of refined petroleum products.) The figure contains all the essential information. It needs only a few interpretative comments:

The 1976 rise is attributable to the growth of the number of vehicles, from 82,000 new registrations in FY 1976 to 110,000 in FY 1977. The continuing rapid increase in consumption from 1977 through mid-1979 was, however, out of proportion to the increase in vehicle population. It can be explained only by more driving--vehicle-miles per car (VMT). This was the case also in the United States as a whole in 1977-78. The conclusion that the added portion of VMT in the United States was in the category of discretionary (nonessential) driving seems to be supported by the sharp drop in this category, some 13% in FY 1980, largely in response to the price increase of gasoline and a temporary scarcity in 1979. The great increase in gasoline consumption in the U.S. (1974-78) and in Puerto Rico (1975-79) corresponded to a period when the pump prices rose only at the current inflation rate. In fact, crude was in mid-1976, at its highest in gasoline consumption in Puerto Rico.

Figure 2. ENERGY DISPOSITION TREE (PYB1 in Mb)

TOTAL ENERGY IMPORTED: 97.5

Crust, One Petroleum: 3

TOTAL Plant CONSUMED: 52.6

Industry sectors:

- Extraction Brief sector
- Office Clerk
- Photovoltaic
- Government
- Conservation Services
- Residential

[Disaggregated values not available]

TRANSPORTATION

Total Energy Returned:

PASSENGER: 109
Countrywide TRANSPORT: 7%

Energy Sector: 668
178 (more x .6) > 32.1. (52.58)
4 10.3 (19.68)
35.5 (67.58)

Notes:

* See calculation in section 8. The total is assumed to be unchanged since 1979.
* The proportionate growth from 1. = to 2.38 of total energy consumed reflects the known but unquantified shift from gasoline to diesel.
* See section 2.43. This total includes indirect transportation energy. See note * on page 16.

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$14/barrel, cheaper than in 1976 at $13.60/barrel.

Gasoline consumption peaked in Puerto Rico some 6-8 months later than in the United States. A partial explanation may be found in the fact that there was no gasoline shortage in Puerto Rico (although it was predicted for mid-1979), whereas parts of the United States suffered shortages due to distribution problems and refinery policies aimed at the availability of sufficient stocks of heating oil for the 1979-80 winter.

The absence of this problem may exert a subtle but real influence on conservation policies and awareness in Puerto Rico. Both in the upward and downward portions of the graph, gasoline consumption in Puerto Rico exceeded that in the United States relatively. Thus, the 1975 to 1979 increase in Puerto Rico was almost 22%; in the United States (1974-78) it was 15.5%.

The consumption drop from 1979-1981 has been in the United States over 1.0 Mbd, or 13.6%; in Puerto Rico, it has been only 15 Med, or 7.6%. This amounts to only 56% of the decrease rate in the United States. As the monthly consumption figures show, there was no sharp drop in diesel consumption in Puerto Rico.

The two high months, which correspond to the summer and winter holiday/vacation months, have.

The text has seen some significant changes. Here's a corrected version:

Continuing relatively unchanged, the result of these trends is the growing proportion of transportation energy in the total energy budget in Puerto Rico. As Figure 2 shows, gasoline consumption in 1981 represented over 30% of total energy, up from under 28% in 1979. With the addition of diesel consumption, the total transportation energy in Puerto Rico has grown to 32.5% of the whole yearly energy consumption.

On the contrary, in the United States, the latest figures (87,22) showed that energy consumption in transportation was dropping compared to the total national energy consumption.

2.4 Comparative interpretation

The relative dimensions of energy consumption in transportation in Puerto Rico, and the implicit potential for conservation, can be further illustrated by the comparisons presented in Table 1 on page 18. According to the final official figures for CY 1980 (50,18), the gasoline consumption accounted for over half, 52.9%, of the total, with almost one-third of all energy directly committed to transportation.

2.38 Table 1 Comparative dimensions of transportation energy consumption

U.S. (except where specified otherwise)

- Petroleum share in total energy: 47.5%
- Highway-mode transportation:
- Petroleum share in TDIE: 53%
- Transportation share of total energy: 25% (direct), 28% (indirect)

Puerto Rico (1978-80)

- Petroleum share in total energy: 98.85%
- Almost 100%
- 32.5% (direct), 91.5% (indirect)

Ratios

- Direct: 1.28
- Total: 50

Passenger to freight vehicles

- Per capita gasoline: 0.62
- Per capita gasoline consumption (as compared to Western Europe: 0.3)

Petroleum Consumption

- 49.6 gallons (as a percentage of U.S.: 22%, Western Europe: 53%, Japan: 225 gallons)

Interpretation

- $0.9
- $368

(As of 27.09) The average price of gas is currently $4.35, the lowest in the U.S. Fuel consumption averages at 7.5 gallons per vehicle. For the U.S., the energy consumption by ferries, domestic air travel, and pipelines is quantitatively insignificant. See Figure 2 for more details.

Passenger vehicles include public sedans and vans, and almost 100,000 LPTs (light trucks used for private transportation). This data was reported by the New York Times on 16th September

1979, Section 3.

These figures suggest that if consumption in Puerto Rico was proportionate to PCI, it would be 17.48% and 3.2% less respectively, or 2.7 times smaller.

Tables 7 and 10 acquire additional dimension when combined with other data. The relatively small per capita gasoline consumption in Puerto Rico aligns with the population/energy ratio of 9-31 in Puerto Rico, compared to 1.2 in the U.S. This parity is confirmed by figures on per-vehicle fuel consumption.

While Puerto Rico's consumption is close to the U.S. average, the area of Puerto Rico, about 100 times 35 miles, does not align with the national average, but ranks 46th in size among the 51 state units. This is another indicator of the high transportation energy consumption in Puerto Rico.

The distance around the island is about 300 miles. The average of 32 trips around Puerto Rico for each of the 935,000 vehicles active in 1978, highlights the extent to which private vehicle transportation has been allowed, if not also actively encouraged, to become a real or felt necessity, almost irrespective of economic level.

Some additional comments may be helpful about the comparison in Table 9 - that gasoline consumption in Puerto Rico in 1979 exceeded that of Mississippi by 3.2%, when compared in terms of PCI. This coincides interestingly with another figure arrived at by a completely different methodology. In the voluntary state gasoline conservation targets set by the federal Department of Energy, Puerto Rico...

In 1980, there was a request to conserve 13.7% of gasoline, making it the second highest target in the U.S., with Alaska having the highest target at 16K. The initial target for Wiestesini'a Forest was -208. When added to the previously calculated 3.28, it would set Puerto Rico's target at -13.2%, which is almost identical to the Department of Energy's request of 13.9%.

There is a crucial need to understand the necessity for high private vehicle mileage. This is primarily due to a significant amount of commuting for work which affects certain aspects of economic development planning. A 1974 study (HL,6A1-4) discovered that in 58 out of 78 municipalities, more than 50% of labor centers were non-residential, while the rest of the labor force resided there. In 13 municipalities, more than 50K residents commuted out for work, and more than half of the labor force commuted in.

In two instances, Cataño and Carolina (both on the outskirts of Metropolitan San Juan), the rate of out-commuters was as high as 63.8% and 65.6% respectively, with in-commuters accounting for 50-58% and 68.7% of the total local labor force. The fuel cost of this exceptionally high mobility was roughly estimated to be 20% of the total fuel consumption.

The study suggested that the Intercity collective taxi system ("pablico") be expanded and that its service level and public image be improved. However, the primary reason for commuting in low-occupancy private vehicles was then, and still is, the convenience at a relatively low cost, both in terms of fuel and highway user costs.

For instance, the toll collection on expressways is too low to cover even the annual payments of principal and interest on the borrowed funds. This economic situation encourages unnecessary driving in all categories. The habit of making 140-mile round trips (at speeds exceeding the posted limit, thereby further increasing fuel consumption) to see a movie in San Juan a few weeks earlier than in the local theater was already documented in a 1978 study.

A more recent example is the revelation in legislative hearings that unlicensed street food vendors commute to San Juan over the same or comparable round-trip distances.

(10th Dec. 1981). There still remains the question of economies. Considering the low level of "Labor participation" (the official percentage is in the low 40s, some 45-50% below the U.S. national level) and the large numbers of welfare participants, where does the money for all this driving come from? Two major sources suggest themselves, in addition to a sufficient taxable income: (1) the extensive underground economy, estimated to be in the $3 billion-a-year range (Sept. 1901); (2) an about equal yearly amount of federal programs and transfer payments. Of this money, particularly the food coupons (approximately one-third of the total, or $1 billion) have become to an important extent a second currency which found its way also into the transportation sector. This aspect of transportation economics in Puerto Rico not only increases energy consumption because of the number of vehicles; it also causes fuel penalties on account of the relative age and minimum maintenance of the economically marginal portion of the fleet.

2.5 Major TRC categories and targets.

Table 2 lists the major categories of fuel penalties (that is, consumption that can be eliminated or reduced) and the corresponding transportation energy conservation potential for Puerto Rico. The contemporary data and estimates differ very little from the 1973-78 information (alts 43-54), extracted and reconciled from some twenty sources. Additionally, a more recent reference 1 (18: 42s 591 Zs 78; 861 92s 921 981 LO}: 1021 S61 62).

Table 2. Size of the categories and estimated potential for transportation energy conservation in Puerto Rico.

CAUSES OF POTENTIAL
Pury ranavetes | mec In ¢ | COENTS MAINTENANCE Vonictes
‘Tuneup 10-35) Bag. a new set of spark plugs,
3. Rev tear 25° |) The cumulative estimates distance from
Adjust idling} “2 1g borage lubricants 2.55} 2.55 |
Radial ply tires, as compared with bias ply tires, the rolling resistance of bias belted. Somewhere in the middle, 15-6 | the upper value corresponds to times the

"Fated to maximum recommended P51 (29-20 in 3580), the cumulative maximum value corresponding to optimum tire quality, maintenance, and alignment averages around 25. This is probably too conservative an increase from the 1978 estimate of 25.5%, due to the massive deterioration of roads in Puerto Rico. Drivers use up to 56% more fuel when driving on substandard roads due to loss of traction and uneven power flow through the drivetrain because of vibration (66).

Power equipment: Automatic as per EPA 1981 tests range from 7 to 19K. Exurban transmission driving averages a 1-5% loss. Weight added is 0. This is the fuel penalty in urban hot-weather operation. Added weight represents 28%. A cut-off device during acceleration can reduce fuel consumption by as much as 45% (1.69). Other power controls convenience equipment operation. Vehicles get 10 MPG more. A V-8 engine uses 18.5% more fuel than a V-6.

Traffic elements: An increase in fuel economy can be seen at 25MPH vs. normal stop-go traffic (or congested, slower traffic at 10MPH). Right-turn-on-red also increases fuel economy.

22 (Table 2 cont'd)

Traffic Flow (continued):

- Two slowdowns from 40MPH over one mile and re-acceleration (due to unsynchronized traffic lights) results in a 16% decrease in fuel economy.

- Two stops and restarts under the same conditions result in a 32% decrease.

Enforcement:

- Driving at 50MPH in a 35-40MPH zone increases fuel economy by 7%.

- Driving at 60MPH in a 50MPH zone increases fuel economy by 25%.

- Accelerating to "beat" a traffic light or to pass another vehicle at a speed above the urban 35-40MPH limit results in a 20% decrease each time. If the violator has to stop at the next traffic light, the fuel lost in stopping and consumed in re-acceleration is another 25%, for a total decrease of 45%.

- Entering an intersection on "yellow" and blocking the "green" cross-traffic equals a 20% decrease in fuel economy.

Style/behavior:

- Following a minimum of 25, according to actually carried out pilot simple rides programs."

The revised text:

This figure applies to any driver instructed in proper acceleration, smooth driving maneuvers, and anticipation of stops and slowdowns. The economy of fleet drivers can be improved up to 20%. Urban braking is estimated to use up energy. The power is higher in the case of erratic/aggressive drivers. Each "rabbit" start uses 19% fuel, as compared with normal driving. See the enforcement parameters above. Page - estimates -78 for some of urban, very "158 for high intensity view" (passengers and freight). 708 drivers violate speed limits in the US. The hard-core (multiple speeding arrests) is estimated at 3.5% or 1.5 million. Truck fuel penalty is calculated at -2.2% for each mph over 55 mph. Excess weight reference is to unnecessary objects permanently carried in the vehicle (e.g., 50 kg). These advantages were executed with the help of equipment, with rights, installed in any car; a "cruise control" (governor).

23 (Table 2 cont.) Causes of Potential fuel Penetration:

DRIVER Style/behavior: Unnecessary Idling, Demand Vehicle occupancy (all trips), Short trips, Trip purpose Essentials: Stop at school 40, Shop (Consolidated), Medical-dental.

Non-essential/"Business - social", Recreational 20 10 25.

Defined as letting the engine run for more than 30 secs. when stopped for purposes other than traffic light. Estimated consumption is 60% of typical urban driving: 0.25 to 0.4 mile for each minute of idling, depending on vehicle type and tuning. An average occupancy for work trips is 1.94. That means, for each 10, reducing from 6 to 1, and triple occupant vehicles from 2 to 1, we have a total of 19 persons in 10 vehicles. If a vehicle needs to be used at all, the consolidation of nine 1-mile trips into one 9-mile trip increases fuel economy between 2 and 2.5 times, depending on the number.

The number and length of steps. A one-mile trip is only .5 miles there and back; it may be shorter on foot, depending on the pedestrian and vehicle traffic. The for-pleasure category totals only 50% of private auto travel (home-based, meaning starting at home and returning directly, and non-home-based). These represent 40% of all such trips, the rest being made by some other mode (bus, bike, or just plain walking). The fuel economy potential coincides with the categories "vehicle occupancy" and "short trips" above, in addition to a shift to public transportation, as much as available. U.S. estimates are from 35% upward. The total for home and non-home-based trips is probably closer to 40% on the basis of the following data and empirical observations:

- Regular gasoline consumption increases by as much as 158% during two yearly holiday periods (summer, Christmas).
- City and intercity traffic density exceeds the daily peaks for essential travel and discretionary traffic on weekends. This discretionary driving represents about 50% of all private auto travel.

2.6 A summary evaluation

The importance of the estimates of TEC potential in the preceding table does not primarily lie in their numerical values. Some of these values are difficult to express with sufficient confidence, given the current state of data and art. Other potentials are knowingly understated in the table. An example is the 10% assigned to "Essential trips" because of the lack of public transportation and the apparent unpreparedness of employers, public and private, to organize vanpooling on a scale that would make a difference. Still, other potential economies, though real and substantial, are not inherent in transportation as such, but in the priorities and attitudes of the police. U.S. data support the empirical hunch that the hard core of willful, systematic traffic violators in Puerto Rico is relatively small. The great majority of other lawless drivers follow the example of those who are "getting away with it".

"It." Thus, a return to "normal" enforcement would probably have a quick multiplier effect. However, the decisions necessary to mobilize this TEC potential make it proportionately more difficult. Only strong and determined governments dare to tackle the effects of the social Greshan Law. For these and other related reasons, the principal value of the estimated fuel conservation potentials is not in any exact number. It is found in two other aspects of the table:

(1) It suggests the comparative order of magnitude and the relative payoffs of various energy conservation actions.

(2) It disaggregates as well as confirms the global conclusions expressed in policy baselines I and II, cited at the beginning of this chapter (see. 2.2).

The 1978 estimate of a conservation potential of 50% of “current direct transportation energy”, while providing "all the essential capacity" in Puerto Rico, was admittedly heuristic, that is, designed to stimulate more intensive analysis and precise enumeration by technical specialists (2b, 53,65-66). Even without this follow-up, it must be assumed that the very tentative original estimate is now confirmed and supported by the inventory in Table 2 (which is simply an updated synopsis of the original data). For instance, the following fuel economies add up to 50%:

25% from careful vehicle maintenance and driving
Decreased occupancy (work trips)
Selective air conditioning
Reduction of discretionary driving
Other (traffic management & enforcement)

These are very conservative estimates. The 15% estimate on account of discretionary driving and failure to form carpools, was made by the former Director of the Office of Energy in July 1979. Several inconsequent counts during the morning rush hour (07:30-08:30) showed that almost one-half of the passenger vehicles had their air conditioning on. The list above does not include such substantial fuel-saving measures as better road maintenance; other items from Table 2 could be added or substituted. The 50%

The following estimate has been subsequently supported by:

(1) A number of general and specific studies of energy futures, all of them emphasizing conservation as a source of energy, and identifying transportation as the principal conservation target, specifically with reference to Puerto Rico (21) (14).

(2) Concrete, quantified demonstrations of the extensive fuel economies that can be achieved by relatively simple improvements in maintenance, driving style, and awareness (C2).

(3) The increasing recognition that, besides massive technical fixes such as CAFE - the Corporate Average Fuel Economy standards mandated by the Energy Conservation Policy Act of 1975 [27.5 mpg for 1985 models] - substantial fuel savings can result from the sum total of separately insignificant conservation practices. For example, one million minutes of unnecessary idling (equivalent to one minute idling by every vehicle in Puerto Rico), due to poor timing of traffic signals and driver carelessness, represents about 17,500 gallons of gasoline or the yearly mileage of 35 cars (335,000 miles), worth $26,000 (at $1.50/gal). This amount of fuel is lost by idling several times over every day in San Juan.

(4) Recent global estimates of possible fuel economies, published in informational material by the U.S. and P.R. governments (78,53), range from 30% to 50%, depending on the age and efficiency of the vehicle and on the engagement of the driver. The individual concern and attention are becoming more critical as the federal technical fixes (e.g., CAFE) may be postponed or made less effective.

(5) Still another similar estimate (40-60% saving) comes from an urban planner (J.B.Gibson, Designing the new city (1977), quoted in The Futurist, Sept 1979, page 61).

6. SCENARIO ANALYSIS AND CONSTRUCTION: AVAILABLE CONCEPTS AND TECHNIQUES

6.1 Synopsis

The preceding Table 2 represents an inventory of the various causes of fuel penalties and the corresponding estimates of potential for transportation energy conservation. Although it

The text was shown to be sufficient for the purpose of a rudimentary but significant global estimate. However, this is only the first stage of scenario making. The actual implementation of planned fuel conservation requires more than a classified diagnosis of what causes fuel waste. Drivers must be made to act so as to conserve. No other mechanism comes even close to the effectiveness of the cost of driving that hurts. In that sense, TEC is the function of various incentives and disincentives. Some of them are outside the control of the government, such as the cost of crude, refining and distribution of motor fuels. Others can be controlled by the government: gasoline tax, excise tax and/or license fees directed against fuel wasting vehicles or accessory equipment; parking fees and tolls on low-occupancy vehicles entering congested areas. Another group of TEC-promoting measures and actions falls under the headings traffic system management and enforcement. The various cost-oriented and management/enforcement measures also need to be inventoried and evaluated for the purpose of TCE scenarios. Finally, it is necessary to put together and analyze various possible combinations of measures, the identification and quantification of specific conservation targets, the possible priorities, sequences, levels of intensity, and time horizons and limits. The concepts and methods related to the second and third-stage scenario inventories are explained and illustrated in the following sections.

3.2 Inventory of TBO-promoting measures. One of the better examples of such an inventory appears in a 1979 study by the Congressional Office of Technology Assessment (78,116-117). Entitled the "Petroleum conservation case," it lists the following measures and policy options:

1. Highway construction: decline by YOR by the year 2000.
2. Mass transit: potentially increased, primarily route (capital investment, operations).
7. Mandatory fuel economy: 33mpg by 1990, 40mpg by 2000.
8. Speeds: Rigid enforcement of basic safety.

Prevention Policy: Increase diesel cars by 25% by 1985; 60K more by 2090. Taxes: Ban or tax gas guzzlers. Implement high gasoline tax and efficiency incentive tax. Establish an annual VAT tax of 5%. National inspection and maintenance program. Improvement of traffic laws. Promote carpooling, auto use controls, and subsidized telecommunication networks to substitute for auto travel. Public education and appeals.

The list also contained the deregulation of fuel prices, which was sanctioned by legislation as of September 30, 1961, and was actually implemented early in 1901. The act also makes it possible to see how extensive (though not necessarily permanent) some of the most effective measures can be reduced or eliminated at the federal level, that is, for all practical purposes, removed from the state-level conservation repertoire.

A simpler inventory of measures was proposed in the federal Department of Energy's project of "productive conservation in urban transportation" (29, Dec. 1979). This included: enhancing group travel, setting specific fuel-economy targets (29, 20, 308), reduction of number and length of trips (promotion of homework with the help of communication technology), reducing energy intensity (change of travel mode [car to transit, increased use of bicycles]), reducing traffic congestion, and growing policy and technology elements that reinforce each other.

Elsewhere, the "techniques for reducing in-use automotive fuel consumption" were conceptualized in three categories (101,00): 1. Modification of vehicles, 2. Modification of traffic flow, 3. Modification of driver behavior.

The minimum conservation program proposed in 1979 by the Puerto Rico Office of Energy contained the following measures: Regulated parking, continuation of work in transport, reduction of engine idling (the law was repealed), traffic engineering including traffic lights activated by traffic flow, improved public transportation (buses, bicycles), and increase office, tax, and license fees to reduce the import of large and medium-sized models. The last measure was... [cut off]

3.9 Reference inventory for Puerto Rico

In comparison with these and other references, the most complete and eclectic inventory of TBO-promoting measures is the one summarized in Table 2 above, based on the 1978 policy study. The various measures can be graphically ordered as seen in Figure 8 on the opposite page.

The figure brings out, once again, the predominant role the driver plays in an effective conservation effort. Of the three categories of "modifications" cited above from the DOT study, "vehicle" corresponds to "technical innovation" (left top of the “spoke wheel"); “traffic flow” corresponds to “TSY/Road maintenance” (right top) “driver” corresponds to all the remaining categories, with "cost" being the major incentive/disincentive.

Even the initial disaggregation of the category “cost” in the demand-related column (left bottom) indicates the variety of levels and functions of cost. It also implies that not all of them are equally effective or easy to implement. Table 3 on page 30 shows a possible ranking of various measures using the criterion of difficulty.

Difficulty is the function of the degree of decisional discretion, that is, collective and individual human control over the various TEC measures. It has been most frequently assumed in transportation energy analysis that, in view of the difficulties related to individual discretion, only “automatic” technical fixes ought to be relied upon for TEC. Such an assumption extensively reduces the scope of possible action. It is not an adequate policy premise if the tasks of policy analysis for decision making include the prevention of future mobility crises.

Figure 4, Fuel and TEC. Drivers conditioned P/E HRY HN CAL VARIATION DEMAND, BEHAVIOR INCENTIVES DISINCENTIVES INFORMATION EDUCATION DEMAND RELATED

Text after corrections:

Behavior-Related Cost Energy-Sensitive Law + Fuel Operation. Enforcement of vehicle tax, perceived fuel penalty for power equipment, driving style, highway use, parking, and accident prevention. Low occupancy toll, transportation alternatives such as public and institutional vanpool, transportation system, private carpool, park and ride, inspection and maintenance, work time alternatives, staggered hours, flextime, fuel economy, and other incentives or restrictions like alternate days driving.

Table 3: Energy conservation measures ranked according to assured difficulty in enactment and implementation.

Automotive Fixes [External/Federal]
1. Cost of imported energy
2. Federal laws and regulations
3. Innovation (e.g., federally mandated fuel economy for new cars)

Discretionary Fixes [State government: subject to political decision making and related pressures]
1. Technical-management
  - Infrastructure
    - Maintenance
    - Non-construction improvement
  - Construction
  - Traffic engineering
  - Comprehensive inspection/maintenance (mechanical-emissions- fuel economy)
  - Transportation/mobility alternatives
  - Work time alternatives
  - Government vanpooling (supported by withholding of parking privileges or by high parking cost)
2. Legal-administrative
  - Traffic control + Energy-conscious traffic code
  - Enforcement and traffic
  - Parking restrictions
  - Fiscal incentives / disincentives
  - Travel restrictions (e.g. alternate days driving) other than by cost/taxes

Discretionary Behavior [Total or substantial individual control]
1. Individual energy conservation measures
  - Vehicle maintenance
  - Reduced use of energy-intensive convenience equipment
  - Reduced vehicle mileage
  - Travel during less congested periods

- Increased vehicle occupancy for work travel (carpooling)
- Reduced nonessential/pleasure travel
- Alternatives to private vehicle

2, 3, 4 Structure of Alternative Scenarios

The final phase in scenario ranking is the selection and combination, or alternative combinations, of the available elements of the scenarios.

Following Criteria, 3-41: Combining Measures and Sequences. What combinations are possible and practical? How much fuel is it likely to save? The rudimentary scenario in section 2.6 above is an example.

3-42: Quantified Fuel Target. What absolute quantity (Mg) can be achieved? Assuming that the conservation plan proposed by the PR Office of Energy for 1960 (9) attempted to comply with the then minimum federal target of 58, the scenario quoted in section 3.2 (page 27) would be an example.

3-43: Combined Approach. What combined measures and at what level of intensity would be necessary to achieve alternative numerical conservation targets in a given year (e.g., 7%, 10%, 15%) or in a sequence of years (30% in the first year, an additional 10% in the second year, an additional 5% in the third year)? What percentage of past fuel consumption should be conserved?

3.44: Alternative Levels of Intensity or Assumptions. Finally, alternative scenarios can be developed by postulating various possible/desirable levels of conservation effort and intensity, of time frames and limits, of inevitable/tolerable impact. This structure is illustrated, for example, by the alternative scenarios developed for the study of U.S. energy demand and conservation until 2010 by the Committee on Nuclear and Alternative Energy Systems of the National Academy of Sciences. The various scenarios are described in terms of the following energy conservation policies:

A - Very Aggressive: deliberately arrived at reduced demand requiring some lifestyle changes.
B - Aggressive: aimed at maximum efficiency plus minor lifestyle changes.
C - Moderate: slowly incorporates more measures to increase efficiency.
D - Same as C, but with a 3 percent average annual growth.
E - Unchanged; present policies continue.

The difference between A and E is 16 quads Btu (or 16%) in the transportation sector, 77 quads (or 13.5%) in total energy projections. The assumed cost of energy is four times higher under A than under E.

"22.3.5 Possible Scenario Structure and Levels for Puerto Rico

The following four levels of possible TEC effort and the corresponding policies, planning, and programs were tentatively defined in the early stages of this study (Fall 1979):

SCENARIO I: Unchanged Policies - This involves a minimum or passive response to price changes and mandatory expenditures in infrastructure and public transportation. It includes some information/education actions while waiting for the crisis to improve government performances. It does not involve any real changes in policy, law, regulations, management, and existing institutions. There will be some effort to respond beyond the minimum, possibly returning to enforcement levels of 3-10 years ago.

SCENARIO II: Involves changes in private transportation policies such as an increase of gasoline tax beyond the inflation factors. It actively promotes vanpools and carpools with the introduction of real transit (bus and/or rail on separate guideways). It will entail changes in law and institutions, with continuous explanation of individual conservation measures that can offset cost increases.

SCENARIO III: Activist Policies - The most rapid feasible implementation of various measures introduced in Phase 2, above.

SCENARIO IV: Codification. Agency Task Sheet 3-6 explains the purpose of codification. Detailed elaboration of alternative scenarios requires handling many variables, possible groupings, alternative quantified conservation targets (percentages, cardinal numbers), lead times, agency tasks, and rates of implementation.

On the level of magnitude represented by Puerto Rico, this can be done without electronic data processing. However, some simplified method for easy manipulation of the variables, especially the development and comparison of heuristic flow charts, is required when the time horizon is more distant than in the present study, or with regard to those scenario levels which require a sustained system approach. This is the case of SCENARIO III and SCENARIO IV as defined above (although they are obviously not realizable within the 1981-85 span).

The following simple codification follows."

The scheme was designed and pretested during this study. It is included here for the sake of completeness and as a starting point for a potential follow-up.

33 3.62 Proposed scheme. The complex variables were organized on the following levels, with letters or number codes assigned as indicated below.

Major groups:
A - Administrative implementation, regulations, institutional coordination, and changes. Enforcement.
C - Cost to driver other than P (cost of vehicle, operation, maintenance)
D - Driver demand and behavior
E - Education and information (Driver demand and behavior modification other than through A, C, P, F, and V-type measures)
F - Fiscal/cost measures and controls: Fuel-economy oriented incentives/disincentives. Fund raising for transportation-related government activities
G - Goal
L - Legislation
R - Road transportation infrastructure maintenance and improvement
T - Transportation system management

Y - Vehicle fuel economy, equipment, maintenance

Subgroups (types of measures or behavior):
Group codes with Arabic numbers attached. For example, T1, T2, T3, etc. identify various aspects of traffic system management. Further breakdown into more specific categories or measures is achieved by means of adding numbers or lowercase letters: if T3a is public transportation, then T3b is buses, T3p is "publicos" (urban feeder and intercity system can be distinguished as T3pu and T3pi), THe is transit (separate guideways for buses or rail). (groups, measures, agency responsibilities)

LP - Legislation necessary to enact a fiscal measure
FV - Excise tax favoring fuel-efficient vehicle
Lf - Legislation aimed at traffic management (energy sensitive traffic code)
Ufa - Administrative/regulatory measures to implement Lf
Uta - Change in licensing of professional drivers.

Quantified targets: Expressed by a percentage or quantity following the coded measure. E.g.

WV27. # (Speed Limit Enforcement) DE2/208 (Instruction of fleet drivers in simple rules of economic driving) Target Year, Y is the target year. The lead time in years is expressed as Y-2, etc. Thus, e.g., Y-3 = enactment of enabling legislation and regulations, Y-2 = administrative preparations, budgeting, etc., Y-1 = implementation begins; public information/education, Y = the measure is implemented and effective (Y+ - monitoring and adjustments) 9-63 Agency Task Sheets.

Under the system approach, which is implied (and further elaborated and illustrated in the next chapter), the Scenarios group the measures and actions in function of the targets or other desired results, not by implementation sectors or agencies. However, for the purpose of implementation, the existing agency structure must be utilized unless and until it can be adjusted as energy management and conservation might indicate. The scenario systems must therefore be broken down into agency-by-agency sub-scenarios, here styled Agency Task Sheets (ATS). The function and structure of the ATS is summarized here for the sake of completeness and as a possible base for follow up.

Purpose: Each ATS defines and explains the rationale, alternatives and the individual or cumulative effects of each proposed measure, technical questions of timing, sequences and interactions with other related measures, and the anticipated difficulties of political, socio-psychological and managerial nature.

Form and Language: ATSs aim at middle-level administrators and program managers, on two assumptions: (i) that it is their information and attitude that most immediately determines what in fact happens, (ii) that the addressee agencies would be, in the alphabetical order of codes: AGAA - Obligatory Liability Insurance (participation in accident prevention and driver education), REC - Public Service Commission (regulation of trucks, vehicles, taxis), BIP - Bike Control (gasoline, parking, interest charges), BIE - Public Instruction (young driver education; information).

To see the typo-proof version of your text, please refer to the following:

"It's easy to prove their school children's federal agencies (with specific sub-identifications).

35 HAC - Treasury (excise taxes on gasoline, vehicles, equipment: traffic structure (various commissions: Transportation and public works)

'81 Socio-economic: Health and environmental quality: jury Education; Consumer Affairs--representing the broad support system effective TEC would require.

ELAN - Planning Board

ERE - Traffic police and support (e.g., computerized driver records)

Side 5 Office of Energy | TRE' / AG) road construction and maintenance; traffic engineering

For renewals, orders, driver licensing

FIR: Transportation planning (transit) Community Commission

Other jurisdictions, appropriately identified, will be given separate feedback functions.

The proper rebuilding effort would require three principal steps: (3) Draft model scenario; (44) Transformation into ATSs (sub-scenarios) and field testing in the agencies; (441) Fine-tuning of the scenarios with the help of feedback from real-life users.

%6 '4. THE NEED FOR SYSTEM APPROACH

Developments in transportation planning technical analysis and planning have traditionally tended towards reductionism and a sectoral perspective. Presented as a superior, problem-oriented way, this "engineering approach" (20) at best solved one problem without regard to--or even awareness of--other existing or potential problems.

Even if planning was systemic in the techno-economic (22), it concentrated on one-half of the real system, neglecting the other. If our problems, many of which can be traced back to the limited and skewed planning vision, are not worse, the reason is that the real-world systems are in fact very complex human ecosystems (21) with all the adaptability and resilience of natural ecosystems.

Much that has happened in response to new changing circumstances was due to the automatic built-in socio-economic mechanisms. We have managed not because of the oversimplified schemes of government planners and decision makers."

Despite and outside of them, we need to integrate this system dimension into our thinking and decision-making. The natural adaptation is better than no adaptation. The limitations of human-political wisdom are such that we must rely on the inherent capacity of systems to bounce back. But the new equilibria established in spite of errors and lack of foresight are never at the level or in the form which would result from willed, comprehensive policies. Just think of the difference in our transportation, energy, and environment if 20% of the $550 million, spent on highway construction from 1969 to 1972, had gone into the beginnings of an effective rail-bus transit in San Juan and on the island. The ideas (e.g., TUSCA) were there. It was the premise that transportation planning and management ought to be just a specific example of eco-management, that guided the 1977 analysis and critique of the ongoing "Metro" planning for San Juan. I emphasized the relations between transportation needs on the one hand, and energy, air quality, and urban human environment on the other. Under the mandate of the environmental impact analysis in 1980, the direction of a new planning stage was set (see Figure 5, where the group "Cost" represents the bulk of techno-economic planning; under the traditional approach, recommendations based on these parameters would connect directly with the decision on the new system, bypassing all other loops, or at best, after-the-decision, environmental impact assessment, this being short going through a formalistic analysis). Since this was the first truly systemic effort in the history of planning and decision-making in Puerto Rico--not only in the transportation field--it is particularly noteworthy.

[37] Cost and other factors were considered in the planning stage.

28 This was the first really systemic effort in the history of planning and decision-making in Puerto Rico--not only in the transportation field--and it is particularly noteworthy.

It's regrettable that it was allowed to become a victim of changes in federal policies and funding. It should be reinstated in its full intended scope as early as possible. The "cost of no-action alternative", though not quantified, is obviously very substantial. In the specific context of TEC, Baseline IV cited in sec. 2.1, corresponds to similar system considerations. Policy planning elsewhere has moved in the same direction in the last few years (2, 10, 12, 35, 40, 27, 22, et al.). At its lowest reaches, transportation system management (TSM) is essentially a set of separate programs and actions with some effort at coordination. Combining TEC with air quality is very recent (20); yet emission control tuning represents some 75% of the total fuel economy achievable through engine maintenance. Two TSM levels are obviously necessary: (i) Transportation system planning (as discussed above) and (ii) Transportation system management in the narrow, operational sense. The following set of figures and tables is an exercise in analyzing a very specific TEC management problem--the reduction of fuel consumption through speed control--in its system framework. It shows the difference between the policies, justification of the control measures, and the effectiveness of such an approach as compared with single-track approaches to TEC through traffic control and speed limit enforcement based only on traffic-code "rules of the road". Figure 6 on the opposite page features the TEC-related components of the system in question (except driving while intoxicated; see Figure 7 for this parameter). The whole system is schematized on page 40. Figure 5 uses the speed of 40mph as the average target value. The most fuel-efficient steady speed varies in fact from about 35mph to about 45mph according to the size and power of the automobile. Experimental vehicles have shown even more dramatic increase in fuel consumption than that shown in Fig. 6. Viking IV, which averaged 67.5mpg during a cross-country rally (Seilinghan WA to...

Washington DC achieved best fuel economy, 109mpg, at 35mph at 40mpg consumption increased already by 12.28%; at 70mph it was 38.8% more (Popular Science, January 1982, page 60).

Unfortunately, the following text is not clear and cannot be corrected without further context.

Continued from page 387:

Indirect energy use and non-energy investment, economic start time driving while intoxicated 4.9. Interpretation of Figures 6 and 7. The implications of U.S. national figures are even more significant for Puerto Rico, due to the substantially higher accident rates in all categories, as well as the faster growing fleet of subcompacts--especially models with the worst collision safety record.

4.21 The speed factor.

Figure 6 shows why low speed is also a proper target for TEC through traffic rules, engineering, and management. Policy analysis and decision-making concerning high speed are more complex. There is an almost linear relation between fuel diseconomy and the average rate of fatal accidents. This rate grows exponentially when low driver age, DWI and their combinations are factored in. It is paradoxical that a change in the fleet composition--the rapidly growing share of small passenger cars--desirable from the viewpoint of fuel economy, is adding a serious accident factor. In addition, the very fuel economy of small cars may be a...

Disincentive comes into play when it concerns driving at slower, fuel-saving speeds. This complex interrelationship, simply expressed in the schematic figure above, represents but one example of the insights not readily available through singular analysis. The resulting traffic management mandate reflects the several dimensions and brings them into a common focus. This requires a shift to smaller/lighter passenger vehicles. It should be fostered directly through excise tax, indirectly through gasoline tax. But this policy also increases the government's responsibility for the prevention of the more severe traffic risks. These must be controlled at their origins - excessive speed and other traffic violations that cause collisions between vehicles of increasingly disparate size and weight, particularly freight and passenger vehicles.

Additional statistical data illustrate the last point as well as other aspects of Figure 7.

Vehicle size: The most critical data are these:

- The proportion of compacts and subcompacts in the total fleet in Puerto Rico is about two-thirds--almost 50% higher than the U.S. national ratio.
- Cumulative data on 99% of all accidents (the U.S. Fatality Accident Reporting System) established already in 1975 that the fatality rate of subcompacts was 1.93 that of full-size cars.
- According to 1979 data, 58 fatalities occurred in small cars that crashed with bigger cars; in crashes between small cars and trucks, 97% of fatalities occurred in the former.
- Tractor-trailers represented only 0.9% of the fleet, but were involved in 8.9% of the fatal accidents. Their fatality rate was relatively low, even in collisions with other trucks. Of a total of fatal incidents involving trucks (U.S., 1979), less than 7 (322) were fatal.
- The fatal accident rate grows proportionately with speed beginning at about 50mph/80kph. The average U.S. ratio of fatal accidents to all accidents is 1:1470.

At speeds above 6 mph, the rate is about seven times higher, at 1:67. An analysis of 270,000 accidents in North Carolina in 1973 showed a fatality rate 15 times higher at speeds above 50 mph (accounting for 28% of all accidents), compared to accident speeds below 30 mph (45% of all accidents). Drivers below 25 years of age have a death rate 2.36 times higher than drivers 25 years old or older. Males below the age of 25 have almost twice the accident rate of females in the same age group, and also account for about twice the injuries. Drivers 35 years or younger are involved in 36% more fatal accidents than those older than 35. The age separation line of 35 years also corresponds to a sharp bend in the DUI-related curves.

Driving while intoxicated shows interesting relationships between DWI, age and accident involvement, with important implications for possible policy and law changes with regard to licensing (and suspension) of young drivers. For instance, the overall ratio of driver/vehicle involvement in fatal accidents is 1.3, meaning that about 27% of drivers in such accidents are killed. However, the ratio for drivers younger than 25 years is 2.4. This implies that young drivers are more likely to be involved in collisions, while they themselves are more likely to survive than drivers over 25. Compared with the 35-and-older group, the rate is 100% higher, or about double.

The relation to DUI is illustrated by these figures: the percentage of DUI drivers under 25 years in all accidents (figures for fatal accidents alone are not available) is 36% compared to 25% in the 25-34 years group, and an average of 10% for drivers 35 years and older. This means that 0.6 times more young drivers involved in accidents are intoxicated, compared with drivers over 35. The statistically unavailable connection to fatal accidents is implicit in the fact that DUI is responsible for more than one-half of fatal accidents overall; and that drivers in the 20-24 years group (12% of all drivers) were involved in more accidents.

Involved in 214 fatal accidents in 1979, i.e. 75% more than corresponded to their number. It has been suggested that "young drivers are possibly less able to drive adequately after drinking" (28, 42, 52, 56: 908; also reference * on page 45).

4.4 The corresponding scenario model The following set of tables shows the development of a concrete scenario based on Figures 6 and 7.

4.5 Comprehensive policy analysis integrates the controlling data and parameters in Figures 6 and 7 with other previously cited and supporting data and parameters.

4.42 It is a conceptual model which organizes the policy data for the purpose of their transformation into a scenario.

4.49 It is the possible scenario matrix, the base for detailed recommendations of measures, combinations, sequences, time frames, and cost estimates, as well as institutional responsibilities and coordination.

Policy Analysis and Objective control at the slow and fast extremes is an important source of fuel economy and, therefore, one of the principal tasks of traffic engineering and management.

Driver education and awareness supporting laws and regulatory settings, considering also the parameters. Speed limit enforcement is necessary. In addition to fuel diseconomy, fast speeds cause four-fifths of severe/fatal accidents. Young age and intoxication are the principal causes of accident-causing speeds.

In the absence of other braking factors (very high fuel costs; stringent traffic controls), the improved style of new, smaller cars could act as a disincentive to driving at more economic speeds. Small cars suffer disproportionately in collisions with bigger vehicles. Trucks have an overall record of higher-than-average negligent/reckless driving. Low speeds and excessive idling (over 60 seconds while driving) are the source of another externality: the impact of increased fuel consumption on urban air quality.

Conclusions: The primary objective of fuel economy needs to be analyzed and attacked within the whole set of factors and

Parameters: There are three major categories involved that need to be balanced:

1. Technical fixes: Improvements of the vehicle (decreased vehicle weight, better engines and transmissions, aerodynamics, tires, etc.) independent of driver behavior.
2. Economic fixes: Factors such as gas pump prices, taxes, incentives, indirectly affecting driver behavior.
3. Direct control of driver behavior.

The resulting incidental benefits are secondary to the main objective but are still important in their own right. These mainly include the reduction of human and economic costs related to severe accidents. Reinforcement of the primary objective and the secondary control measures, as well as the total resulting payoff, should foster positive decision making and implementation. Assuming all other data and factors are comparable with those in Figure 7 (based on U.S. as a whole - factors like age, proportionate growth of small car fleet, truck accident ratios; see additional references in Notes), Puerto Rico has substantially higher accident rates: fatalities per vehicle registered, fatalities per total accidents, injuries per total accidents.

A composite picture of a typical fatal accident in Puerto Rico, as gathered from police records and daily press (1979-80), includes one or all of these characteristics:

- Unlicensed driver
- Age below 25
- Excessive speed
- Early morning hours
- Sunday
- No information available (probability of charges against the apparently liable driver)

According to the South Carolina Commission on Alcohol and Drug Abuse (cited by the National Safety Council, 1979), per capita alcohol consumption in Puerto Rico and the U.S. is approximately equal. This makes accidents related to alcohol a top issue for government regulation and controls. The National Transportation Policies through the year 2020 (pages 238-239) have frequent calls for raising the minimum driving age to 18 and requiring a minimum age of 21 for alcohol consumption.

(In mid-1990)

Page 46: Conceptual Model Observes: Types of Focus

Conceptual Model Causes Control, Primary Driving Measures: Exceeding fuel type violations, initiating driving speed links at non-economic traffic laws. Speeding between semaphores, frequent changing of lanes to pace, beating stop lights.

Driver Categories: General, Trade, Youth, Total.

Aggressive driving confrontation. Driving in general category includes: energy drivers, lenient education, relatively low speed training, attention standards, license renewal.

Routine speed on lane conditions, resilience, driving below prescribed speed limit (or energy space conditions). Reasonable maximum traffic speed in left-hand lane.

Secondary conditions: indirect energy, social/economic costs, basis of accidents. Growing number of accidents; only 19% of accidents or small cars are ascribed to mechanical defects.

Possible Contributory Factors: Better surface in left lane.

Page 48: Scenario Matrix Major Categories of Control Measures and Individual Measures.

Estimate Agency Responsibilities and Interactions. Systematic enforcement of present traffic law. Energy-sensitive vehicular strategy. Public information and continuing education. See the following.

Page 48: Comments

The next step would be to enumerate the various discrete measures under the major categories, code them for easier handling, and estimate their direct effect on fuel economy or their influence (indirect effect) on other conservation measures.

Comparable scenario matrices could be developed with the help of the same methodology with regard to such other technical measures as are listed or implicit in Tables 2 and 3 (pages 21-23 and 30 above). These measures tend to fall into three major categories.

The elaboration of the full alternate scenarios could thus proceed on the basis of the following four matrices: A, Fuel conservation through speed control (the policy analysis and conceptual model).

The model developed above;
3. Transportation system management (ISM in the narrow sense, see 4.2 above);
4. Fuel economy related to vehicle equipment and maintenance;
D. Cost-conditioned driver demand and behavior.

Several considerations add up to the conclusion that instead of an exercise in detailed scenario construction conducted in an implementation vacuum, it is more useful at this time to offer an illustrative open-ended list of measures from all four categories. The selection of the items for this consolidated list has been determined by the extent to which this sample could illuminate the opportunities for THC improvements between now and 1985 on the level of SCENARIO II (see 3.5).

The major consideration for this approach has been dictated at the outset of this study (see 1.2), "the performance and priorities of the government of Puerto Rico in the field of transportation in general, and of energy conservation in particular... favor an open policy approach rather than more or less rigid scenarios based on too many uncertain variables and speculative assumptions. The situation would, of course, change as soon as the decision makers showed interest in the development and evaluation of concrete policy options and alternative scenarios.

As Table 2 shows, the initial payoff of practical actions is patently very extensive. The prime purpose of the policy method as applied in this study (the introductory explanation 2.2 and 1.3) is precisely to provide a set of principles for the selection, as well as a progressively more detailed (including quantifications) analysis of the various concrete decisional options as they may become feasible.

The TEC monitoring curve over the first 18-24 months of application would show the real effectiveness of the various strategies selected and compared with the initial expectations. This would be the basis for further, progressively detailed strategies.

A subsidiary set of considerations is technical. Despite the apparent...

Continuing the faith of many practitioners in the magic of absolute numbers arranged in neat columns, there has been a growing number of disappointments. These are evident in various fields, from economics to environmental assessment to Jersey Prosecutions. Experience has often shown the uselessness of efforts to arrive at exact quantifications valid beyond the following six to twelve months. Even computers cannot simulate beyond the quality of the raw data they are fed. Many of the data for Puerto Rico are insufficient or lacking, including such first parameters as the number of active vehicles and diesel consumption in transportation in a given year. But also, the summary conclusions in section 1.45, last paragraph, advanced quantitative analysis has begun to learn from this experience. The base prediction of crude oil price for 1985 ranges from $39.70 (the contemporary average price) to $50, a margin of 35%. The estimates' underlying parameter, the predicted U.S. economic growth during the four years in question, have a range of 100%. It is difficult to see a clear line of distinction between such gross estimates and the order of magnitude numerical base of policy analysis. Except for explicit methodology, the two appear practically identical.

"Energy projections to the Year 2000. Division of Analytical Services, U.S. Department of Energy. September 1981"

5. THE Prospect

5.1 The decisional and implementation environment

The decisional and implementation environment in Puerto Rico is unfavorable to any meaningful, systematic transportation energy conservation. Anything significant that may appreciably reduce the excessive fuel wastage in the next several years will be the result of more or less automatic adjustments of the system to external crisis factors, not of any deliberate sustained government policies and actions.

5.12 The worsening situation.

The basis and frame of reference an effective TEC has, in fact, worsened even since this study was first tentatively designed in

Mid-1979. At least four major areas or factors can be pointed out:

1) The loss of the rapid transit option. The importance of rail transit lies not only in direct TEC but also in the viable alternative it provides to much commuting (jobs, school) as well as some discretionary driving. If properly designed (as was, for example, proposed in 1972: 23), it also physically controls private vehicle traffic and provides a major opportunity for the improvement of land use and the human urban environment.

2) The light-rail concept was, in fact, the main component of several leading options in the last effort to put the San Juan "Metro" on track (see sec. 4.1 and Fig. 5, pages 36-38). Even with the dubious original heavy rail design (1967, see 20) and despite the rejection of two private construction offers, San Juan was in the mid-1970s still one of the primary candidates for a federal grant. It could make a much better case than such cities as Denver, Miami or Atlanta where new federally supported systems were approved.

3) The opportunity was aborted in favor of an all-bus alternative which was then not completed in the meantime. New construction costs skyrocketed. The major consequences are not only those related to TEC, nor even the social considerations - there are still close to 30% of families in San Juan who depend entirely on public transportation. Rather, the most worrisome consequence is the drastic reduction and qualitative change of available options.

4) The "Agua y Guagua" project is admittedly not a rapid transit, but only an incremental improvement of the present system. Even that is unlikely to be in operation before the late 1980s. Any major improvement of public transportation in the metropolitan area, even without the rail component, would require separate guideways for buses on the express trunk line, plus an elaborate integrated feeder system of call buses and public access. Considering the lead time, cost, life expectancy, and already tested new technologies (like trolley buses without an overline), this is a significant challenge.

Overhead wire, by every 5-6 miles for about 90 seconds by running through a catenary segment (like that needed for light rail), the differences between what worked in 1980 are not very significant. Recharging this system, on the other hand, the cost of the no-action alternative, completely overlooked in present decision-making, is staggering. The most obvious, though not the only aspect, is the fact that the present bus/public system could simply not handle even the minimum essential transportation requirements in the case of any prolonged scarcity of gasoline. It is of little comfort to know that the same is true of several major metropolitan areas in the United States. (14) Traffic lawlessness. Compliance with traffic laws was linked to particularly in Table 2, Figure 6, and the related text. Over the last several years, enforcement has dropped down to a level on which it has virtually no meaningful relation to the need for control required by the principle of public order, not to speak of the additional energy-saving dimension. Yet, even erratic token enforcement seemed to have measurable effects. The following figures, related to speed enforcement on the two main roads (PR 52, Expresso Las Americas, and PA 22, Expresso De Diego), and on the rural collector road which also have a posted 55 mph limit, illustrate the points. The average number of speed citations on PR 52 and PR 22 in the calendar years 1980 and 1981 was 21,509 a year. An average 70,000 vehicles use the main roads, each day. Monitoring has shown that over half of them exceed 55 mph. This amounts to some 35 million vehicle trips/year during which the speed limit is exceeded. The 21,500 citations thus amount to some 0.355% of the total violations. Thus it can be said that the enforcement is merely token. Other roads (e.g., PR 30, Caguas-Humacao-Mayagüez, etc.) have a traffic density of vehicle miles traveled (VMT) against those main roads (73.58% of the combined total); but only some 30.8% of the total speed citations were issued on these roads during FY 1980.

And 1961). This represents a 50% better rate of toll roads in terms of absolute numbers of citations. The severity of violations was appreciably higher on the collector roads: 124 more drivers exceeded 55 mph, as compared with the main roads. Almost twice as many drivers exceeded 65 mph, and the top 15% of speeders traveled at an average 2.3 mph faster.

52 Speed was monitored during day hours. It does not reflect drunk driving which occurs mostly during evening and night hours. Citations are issued on a 24-hour basis. On the basis of this comparison, the rate of citations, particularly on the collector roads, may appear to be even less adequate (144).

The pool of skilled, cautious and disciplined drivers appears to have been stabilized at some absolute number many years ago, while the total driving population has grown by several hundred thousand. The practical collapse of regular traffic enforcement has not only eliminated the constraints on naturally aggressive and undisciplined, mostly young drivers, but has also produced a completely new phenomenon: the middle-class grandmother deliberately speeding through a stop light with a station wagon full of school children--future young drivers cheering her on, if not also making threatening gestures at other drivers who barely managed not to get hit.

This is not the kind of driving population naturally inclined toward a reasonably disciplined and intelligent driving style which alone could conserve as much as 20% fuel for the same total mileage driven. Only enforcement and high enough cost (that is, gasoline tax) could begin to have any effect on it. Meanwhile, if the federal food money comes in a block grant and is distributed in cash, this will mean more money also for gasoline (not only $7 in cash for a $10 food coupon) and without even a hint of illegality.

(iv) The relative decrease of motor fuel cost. The price of gasoline has been stable or even

The text has been corrected as follows:

The prices have been slightly decreasing over the course of the last 12 to 28 months. Even a stable price means a decrease in the real cost, since inflation has been running at around 10% during this period. Although this is most likely a temporary phenomenon, it sends entirely wrong signals to most drivers, at least as far as TEC is concerned. 5-12 Record of official TEC actions. Even the little that has been achieved shows how much could be done. The record with respect to the 1979 conservation program (listed on Page 27 above) is as follows: A park-and-ride pilot program ended when the federal funding ceased. At the present time, only two industrial enterprises on the island have regular vanpool services for their employees.

A "right-turn-on-red" law was passed two years before the 1979 conservation program. Although the yield is relatively modest, even this potential is not being achieved for two main reasons: (i) lack of funds for the necessary geometric changes to provide a free lane for right turns, and (ii) ignorance on the part of drivers and institutional managers. For example, simple surface markings at key exits on the Rio Piedras campus of the University could provide free turning lanes; in their absence, hundreds of cars waste fuel every day waiting behind the first car which must wait for the traffic lights. The system of targets at the Expresso fare is a major achievement due to the past difficulties with the underground software. It has had a measurable TEC impact, but much more needs to be done elsewhere. Public transportation has not noticeably improved. While there has been a major shift to small cars (which is probably the one factor which has caused whatever reduction in fuel consumption that has occurred--see Figures I and J), it was not due to the conservation program. In addition, the government has conducted clinics since the fall of 1980 as a part of a three-year program designed to help citizens reduce fuel consumption and cost by providing advice and technical support.

"Assistance on automobile maintenance and driving habits, factors to be learned in choosing a new car, and planning efficient use of the automobile to avoid unnecessary trips." Based on the number of pamphlets distributed in shopping centers, schools, municipal centers, and private enterprises (which guaranteed the attendance of at least 50 persons for one day), it was estimated that some 200,000 persons participated during the first 12 months. Additional impact through spoken word was assumed. On the level of 200,000 conscious participants, the program would have reached less than 20% of licensed drivers. Despite the comprehensive description, the initial program was limited to fuel conservation through better vehicle maintenance. Waste through indiscriminate equipment use (for example, the use of air conditioning without respect to the temperature or exceptional safety precautions or the failure to adjust air conditioning for the most economic performance when using it to reduce drag at a steady expressway speed) or through uneconomic driving style was not included in the program. It may be added in the future.

5.13 Institutional and other major factors, most of them dealt with in detail in the previous studies (23 to 25), are briefly discussed here to complete the perspective and to add some fresh information.

1) Lack of an institutional focus for policy development and implementation in the field of transportation energy.

2) Major gap between available empirical and analytical knowledge and the public capabilities to receive and apply it.

3) Other political and executive priorities, partly contemporary (changes in federal grant policies), partly projected to 1964.

4) Strong vested interests. The private vehicle transportation sector (PVTS) is relatively stronger in Puerto Rico as compared with the U.S. as a whole. The 89% of transportation energy it consumes is about 30% more than the corresponding U.S. share. It has generated a powerful economic "motor-vehicle complex." Such a

The complex represented 23% of the GNP in the U.S. in 1980. No such global figure is at hand for Puerto Rico, but sectoral figures imply the size. For instance, the value of gasoline used in FY 1981 was $575 million, 60% of which was supplied by a major refinery that was failing and for which this was the only reliable source of income. The outstanding loans in the motor vehicle sector were almost $600 million, and the outstanding installment debt by buyers was approaching $500 million, according to a Puerto Rico Treasury report dated 31 March 1961. In a legislative report on lobbying prepared in 1978, auto manufacturers and distributors, auto finance companies, and gasoline station operators were listed as the three most intensive lobbying groups.

(v) Transportation welfare system. As pointed out in detail in previous studies (23, 35-38: 2b, 57-60), the Public Transportation System in Puerto Rico is highly publicly subsidized. This fact was considered important enough to be one of the four policy baselines (item ITZ, cited on page 11 above). Only the price of fuel before tax has risen to its real market level since January 1981, when the price equalization system—the averaging of the prices of domestic and imported crude petroleum—was abolished in the U.S. The result has been a massive welfare system in favor of private automobile owners. This has created unfair competition for public transportation, the cost of which also depends on raising salaries.

This sector received an unprecedented boost in the new regulations governing investment in Puerto Rico by the so-called "936" companies (subsidiaries of U.S. companies). The only exception from the principle that the investment must be in productive sectors was made in favor of financing automobile purchase loans.

In regard to highway user cost, the tolls on PR 52 and 22 would have to be raised by 60% to cover the full cost, including the debt service. (This would come to slightly over $22 for the whole length of the Las Americas expressway, based on a user-cost analysis.)

For urban expressways in the U.S., see 2k, 60, note. With this increase, the total toll income would rise to $33M a year. The direct benefits to the driver - savings on fuel, oil, tire wear, maintenance, depreciation, travel time, lesser accident rate, convenience, and comfort - were calculated several years ago at $80K a year. By now, the total must be well over $100K a year. With reference to the whole road system in Puerto Rico, the user cost was estimated to be 25% less than the average user cost in the U.S. It was then (1978), based on the total of excise taxes (vehicles, gasoline, licenses), an average of $233/vehicle/year. The amount rose to $258 in 1979, but dropped to $236 by 1981. The gasoline tax has remained at 16 cents since 1974. It represented then about 4% of the pump price of $0.50/gal. At the present average price of $1.45/gal, the tax represents only 12.5%. If it had kept pace with inflation, it would amount in 1981 to some 26 cents per gallon. At the percentage level at which it was enacted in 1974, the tax would be now about 68 cents per gallon.

This amount would still be in the lower range worldwide. Gasoline taxes range between $1.59 and $2.25/gal. in many countries in Europe as well as in the Third World. As distinguished from the toll roads, the cost-benefit ratio for the general highway user in Puerto Rico is strongly negative. The average driver spends $950/year on gasoline. The latest studies (SE; 62) show that even on "fair pavement" (as distinguished from "very good" or "good"), the average fuel consumption increases by about 35% on account of lost traction, uneven power flow through the drive train due to vibrations, and the need to periodically slow down and reaccelerate. On substandard pavement, which is now common on Puerto Rican highways, the total can increase to well over 50%. Taking the conservative lower figure of 35% fuel loss, the increased cost to the average driver in Puerto Rico is $300/year. That does not include such items as the more rapid wear of tires, damage to the drive train, shock absorbers, etc.

The text should read:

"Note. A 10¢ increase in gasoline tax (representing only adjustment for inflation) would cost the average driver $967.50 a year, but would yield $967.50 for road maintenance, traffic engineering and enforcement, and leave a substantial sum for increased rental improvement of public transportation. If the toll road users were charged the full cost, it would add another $11M to government incomes.

And it would put an end to an irrational welfare-within-welfare system. At present, the uncollected margin of the toll road debt service cost is paid from the gasoline tax; the toll road users benefit at the cost of all road users. The road maintenance cost is covered from the general funds while drivers benefit at the cost of all taxpayers. Even if all the money comes eventually largely from the same pockets, it has created distorted cost perceptions which are a great obstacle to any reform.

Finally, there are two unfavorable psychological legacies from the past. One is the exacerbated dependence on federal funding. This was already critically analyzed in the 1977 study (23, 3-9). The Agua-Guagua project is still expected to be financed by 80% federal and 20% matching state funds. The other is the continued emphasis on supply-side solutions (new energy sources), rather than on a balanced approach which includes demand controls, that is conservation. Although the old economic growth model has not been valid for quite some time, it is deeply ingrained in political thinking and in the expectations of the consumer society. It is also more attractive to do prestige studies about energy sources for the next century than to insist that drivers should not spend more than ten gallons of gasoline a week - and, in fact, make it difficult for them to do so.

5.2: Implications for realistic expectations.

5.21 The "crisis scenario" which was tentatively defined at the beginning of this study (Fall 1979; see page 32, Scenario I. above), played in part, turned out worse for the rest. The elements of the present..."

Scenario areas: Rapid rail transit for San Juan was lost. No budget-based mass transit is considered. In fact, the substantial federal subsidy (about one-third of the operational cost) for the present bus service will be withdrawn beginning with the fiscal year 1969, and will have to be absorbed by the state government which already subsidizes the bus authority by another substantial amount. No substantial expansion or improvement can be expected.

The "public" system is effective, but is completely gasoline dependent, inadequately regulated and supervised, and has been able to resist integration with the buses. Public policy has not only accepted the excessive reliance on private vehicle transportation but has provided an unprecedented incentive (see the note on page 54). The external costs of this course of action (see section CHALLENGES, 51) are practically irreversible and contrary to any conceivable long-term transportation policy, and are being ignored.

Furthermore, in relation to urban congestion, the government is unwilling to face the cost of this system in terms of infrastructure, maintenance, traffic engineering and public order, not to mention excise taxes which would certainly promote conservation and provide funds for major improvements. Saving anything - water, electricity, money, gasoline - is an integral part of the social ethic, reinforced in the case of electricity, only by adequate cost disincentives.

As far as public decision making and actions are concerned, the prospect is for the "worst case" as defined in the crisis scenario: "minimal or passive response...; waiting for the crisis to come." Any improvement of the transportation system sufficient to make it operate in a manner which would contribute will require additional funds, most likely coming from the outside.

Conservation through automatic factors and technical fixes is the public position, which means that there will be no deliberate effort to foster systematic change. It does not end here.

This means that the small, gradual reduction of fuel consumption will likely continue. The following technical fixes are expected to contribute to TEC and are not sought internally or externally: automation factors and a continued switch to small, fuel-efficient cars. Since approximately 90% of new vehicles introduced in Puerto Rico are not 1-S-, a rate of 27-2 (expected by 1985) would not considerably affect the situation there. A progressive decrease will perhaps reduce the safe levels. The closing of CORCO's refinery, announced in February 1982, shows how the island's supply is vulnerable even if the contemporary glut of fuel will not cause a shortage of imported gasoline in the foreseeable future. An increase in gasoline excise tax, considered since the beginning of 1981, was presented to the Legislature in February. However, an increase by 5¢/gal does not even adjust the existing rate (see page 35 above). An announcement of an adequate tax increase to be implemented in installments and then pegged to the gasoline price is of urgent importance (a practice adopted by several states and in force in various Caribbean countries), yet it has apparently never been considered. The current fuel pricing stability, if not a slight decrease, makes the present time particularly favorable for the much more substantial needed tax increase. As a result, the total mileage driven for pleasure driving and increasing vehicle occupancy is expected to rise substantially.

The future fuel consumption depends on several factors including significant fuel conservation efforts, secure and high-quality fuel supply, speed and engine efficiency. The improvements in overall performance and coordination of all involved agencies (see page) are necessary to get this message across. Engineering fixes such as mileage-increasing gasoline additives, motor oils, and up-shifting dashboard signals are also part of the solution.

For the most efficient acceleration, consider alternative fuels such as gasohol, ethanol, LPG (propane, etc.). These may have, at best, a very small fractional effect in the foreseeable future. In addition, LPGs are most suitable for use by commercial vehicles and fleets. It is being stressed in technical literature that the use of LPGs requires "many more precautions than in the normal use and handling of gasoline; drivers must be trained to avoid 'abrasive' driving." A great deal of training would be necessary considering the widely noticed driving style of many Puerto Rican truck drivers.

The electric-hybrid vehicle, a good candidate for the fleets of such enterprises as the telephone company, the water and electric authorities, or for use within closed compounds (low speed, short distances, frequent stops), began to be tested for use in Puerto Rico, but the project depended completely on federal funds. These were also terminated.

More advanced affirmative actions are needed. To do anything better than to repair broken roads and rely on automatic fixes for some fuel conservation would require that transportation in Puerto Rico be put on a self-sustaining basis. That means that primarily the private sector (but also trucking) would have to pay the full high-way user cost. This is not as difficult as it may look. But it would require a massive effort on the highest levels of the government to explain to private drivers (A) that they are in fact losing, by a wide margin, in the "welfare" system (see page 55); and (B) that and how they can compensate for even major tax increases by more careful and discriminate driving. It has been shown by practical testing that any average driver can save 20% fuel by following a few simple rules (which, by accident, also contribute to public safety and courtesy).

Page Break

Since 20% of the current cost of gasoline is about 29¢ per gallon, the tax could be progressively increased to 45¢ per gallon, rather than the presently proposed 21¢, without any effect on the economy.

Total yearly gasoline bill. At one $56 level, the tax would still be low in comparative terms, and it could reduce gasoline consumption, perhaps even by more than 20%. Taking the 1980 consumption of 655 gal. as a base, even the decreasing consumption could yield at 600M gal. about $270K yearly; at 550M gal, it would amount to $247K. Very sensible improvements would, in fact, cost much less because the various services suffer at the present time only of lack of qualified personnel and relatively minor material supplies. This is true in particular of two services the increased efficiency of which would make a great difference also with regard to TEC. One is the traffic police, at times with fewer than 300 patrol cars covering the whole island. Many severe fuel penalties among those listed on page 22 above are also violations of the traffic code in force. Merely returning to the mediocre enforcement levels of 5-10 years ago would represent substantial contribution to TEC. It should be determined why the system of citizen denunciations of major traffic violations not observed by the police, instituted some 12 years ago, did not function; it should be properly reformed and launched. Although it would be a great improvement if the police went by the law as it is, a revised traffic code would facilitate the job by (1) incorporating technical considerations relevant to the present conditions, (2) making the fines adequate to the enforcement needs, (3) facilitating temporary or permanent removal from the highways of chronic repeat offenders and dangerous drivers. The traffic law revision prepared in 1978-79 (and not enacted as of this time) was merely a consolidation of the existing statutes. It was inadequate in the terms outlined above; it was completely blind as far as TEC is concerned. The other service is traffic engineering. Besides the obviously needed geometric changes, traffic flow could be greatly enhanced by careful revision of existing traffic light series (even without the advanced technology used on Expresso Norte);

Shift of stop lights to intermittents, red/yellow signals, with a switch back to standard signaling during heavy traffic hours where necessary (which means that many signals could run on an intermittent mode permanently). Change of all possible "Stop" signs to "Yield", which is the way they function in reality. Removal of all nuisance signaling (e.g., left-turn arrows: these should be replaced wherever feasible by intermittent stop-and-go signals), and perhaps still other measures. Drivers should be encouraged to suggest possible flow improvements. Simple interagency agreements and administrative actions could bring about many measures making traffic more legal and therefore favoring safety.

For example, the problem of running red lights (see the discussion on fuel efficiency on page 22) is that many drivers do not obey--or even know--the yellow-light signal requires the driver to slow down to stop. The law gives the driver too much discretion. Traffic engineers have identified it in the concept of the so-called “dilemma zone.” Most drivers face in fact no dilemma. They simply charge forward. Until a solution is worked out which is appropriate both technically and legally, a simple expedient could be worked out between traffic engineers and police, and given adequate publicity: a yellow line, painted at the proper distance from the intersection would eliminate the “dilemma” and advise the driver that, if he already crossed the line when the yellow signal comes on, he can proceed; if he didn't, he must stop. Until a functioning computer memory can quickly identify repeated violations, the police and the courts could establish a system of punching a hole in the vehicle or driver license whenever a new traffic violation is established either by paying the fine or by conviction in court.

The problem of fuel-costly heavy rush-hour traffic can be alleviated by generalizing the system of flexible working hours throughout the city. Effective enforcement of legal parking (self-liquidating through fines, towing and storage charges) adds another tool to manage traffic.

Correcting the text:

Clearing congested areas should greatly contribute to easing traffic flow, not to mention improving conditions for pedestrians. Through a simple administrative decision, knowledge of basic principles related to safe driving could be added to the requirements for learner permits and driver's licenses. Last but not least, an extensive urban public transport system in San Juan, if less crowded and operated for longer hours, would provide the fuel-efficient flexibility and decentralized private initiative that public buses cannot provide. However, it would have to be planned and coordinated, not just allowed to spring up and then legalized ex post facto. Tables 2 and 3 (pages 21 and 30 above) provide the elements and justification for numerous other measures and combined sub-scenarios of an orderly and deliberate nature. To follow or let the crisis scenario happen will not lead to a system collapse. It merely invites ad hoc, mostly spontaneous, and disorderly adjustments at a considerable human, social, and economic cost.

APPENDIX

Note on the calculation of the scrappage rate as the basis for estimating the current active fleet in

Puerto Rico:

Scrappage rate is the percentage of motor vehicles discarded in a year. An 8% rate has been used in the U.S. national statistics. In the absence of more precise figures in Puerto Rico, the 8% rate was used to estimate the active fleet in a given year, between 1971 and 1977. It has been the practice of the Bureau of Motor Vehicles (BMV) to consider a vehicle active until its license is not renewed for two consecutive occasions. (Even then, a vehicle remains in the register for an additional five years.) This means that all vehicles discarded during a given year are included in the total active vehicles until the next 30th of June. Some vehicles not renewed at the end of the preceding fiscal year may be reactivated when their owner returns to Puerto Rico, or when they are repaired/rebuilt. Experience of several years could produce...

An "expectancy rate" for this relatively national group. The key to a reliable estimate of the whole really active fleet is a reasonably accurate estimate of scrappage. In 1973, the official scrappage rate estimate was raised to 108, without any explicit or obvious rationale. When it appeared to result in a too low total of active vehicles, the rate was discretionally lowered to 5% in 1979. This is apparently the rate used in the 1980 estimate. The following Figure 8 shows the recent history of vehicle registration figures in Puerto Rico. On the basis of a preliminary draft of this Appendix, BMV began in 1981 to use the rounded trend rate of 7.5%. The "recalculated total" for FY 1980 of 1.133M vehicles, and the estimate of 1.18M for FY 1981 are, however, still gone 15% too high. To arrive at correct figures, it would be necessary to go to at least 1980 and calculate from then on, adjusting the trend rate as proposed in the formula on page 53 below:

(62) FIG. 8. VEHICLE REGISTRATION (P.R.) (000) NEW TOTAL VEHICLES REGISTRATIONS REGISTERED

105 = 1050

95 = 950

90 = 900

85 = 850

80 = 800

1977, 1978, 1979, 1980

PRIP_ Puerto Rico Planning Board

‘SP/DK PR. Treasury via PRIP

PCB VS. Census Bureau via PRIP

BPPR Banco Popular de "Progress in Puerto Rico" (yearly) and other consolidated figures.

Imported (new and used) & taxed (import excise tax)

Comments: Note, the discrepancy between new registrations and the increase in total vehicles registered. Vehicles taxed > vehicles Imported (by some 40,000). Comparing the rate of imports and of taxed vehicles with the official estimate of the total fleet, the gap marked is most of that part of the total fleet that was reactivated (i.e., repaired or rebuilt) after an at least two-year lapse in active registration. See the comment on page 64.

109. The estimate using scrappage trend rate (next page) is only 4,000 vehicles (0.52%) higher than the estimate of 369,500 (Pro). In 1980, the calculation is only 3,000 vehicles lower.

It is necessary to substantiate that between 35,000 and 40,000 vehicles were reactivated in 1979 after being out of circulation for over two years; and that the number for 1980 was between 75,000 and 79,000. Too high official estimates of active cars are apparently not unusual. The 1980 estimate in Puerto Rico would be 15% or more above the corrected trend estimate. In the United States as a whole, an overestimate of 12.3% was found in 1977, comparing Federal Highway Administration data with those developed at the DOT Transportation Research Center (IIs, $3-12). The difference estimated two years later was "up to 12" (18, 5-26). The FTE estimated average life expectancy (that is, the age which of a given year reach or exceed) of cars and light trucks was typically calculated to be 10 years or 100,000 miles (16,2-20, based on U.S. statistics from 1966-77). Recently, it has been raised to 125,000 by some analysts (e.g., 72,5) and up to 18.5 years (the advertised life expectancy of a high-quality midsize European car). The longer vehicle life may require major repairs in the final years. These are unlikely to deactivate the vehicle for more than two consecutive years, except in some unusual cases.

SOURCES OF REFERENCE

American Automobile Association. Your driving cost. 191 ed. Auspanaler f+ et al. The urban transportation systems: Politics and policy innovation. Cambridge (iele7.1 19% Argonne National Laboratory. Projections of direct energy consumption by motor vehicles 1973-2060. Easing the energy footprint. Perry, D. The gasoline science book. Shell Oil Co. Answer Book #5. Houston Bie 38,3 BAC. TLL. "American in transit: A message to the new on Transportation 84, Sunace 1575 bb, Brom Ti8:,0t,1: Running on empty: The future of the automobile in an oil-scarce world. How to drive smarter and save gas (Five-part series). vss. B08 (Office of Public Interest). Issue 1588, Cappel 3.. 4 D.¥. Reinfurt. Relationship between driver crash injury and passenger car weight. Chapel Gill Woe Neeeeee TeeS Chapter Lis. The big.

"Shortfall in auto fuel economy," according to Zg, 13236 TIPO, Cooper Mik, and J.O. Wildinger. "Integration of air quality and transportation planning." Report, Air Pollution Control after Heating, Cincinnati of Sins $3568 Energy Research Council. The report by the Federal Task Force on motor vehicle goals, Bovemisel, Washington (D.C.) Ford Foundation Energy Policy Project. A time to choose America's energy futures, Gadelage Bas. 4.1, Bishop. Analysis of fuel savings through reduced speed limits, Washington (D.C.): Dec A595. Sey Turn, "Report on the cost of owning an automobile in 1979, New York. July 1978." "Envy Loss Data Institute, claim frequency results for 1977 and more models," Washington, statistics USNS. "Insurance losses collision coverage. Initial results for 1980 models and ESSE," Insurance Institute for Highway Safety. The Highway loss reductions status report, KIV/S, Washington, D.C. Rupp G.08,91. Transportation energy conservation data book Edition, Frida ois. "RIEL Oh sE5hs, option for 1980 models eke Energy Transfers HH. (ed., Resources for Future). Shortage, Yearly, Cambridge Har Eg35. Mayda J. Environment & resources pro conservation, Piedras Rr 1367, 1979." Gent (economically), "Institutional framework for environmental management (guarantee). (1976). The legal protection of the environment in developing countries, 11725. Wéxles Behe 1st6. 3. 'The next twenty, to eco management.

Mayda J. "Ecology of change" [29/47. In Creating the Future's Agendas 182, Loncrsins, "Columbus SH (Satellite Inst.) 1973. San Juan Transits. Outline of a policy analysis for decision making. GE5R, October 1977. Energy conservation in transportation in Puerto Rico, policy study. ce8Ne9, October 1978 [CEER-X-72, June 1979]. Policy #4. Outline of a methodology with reference to decision making in the fields of energy, transportation, and environment. REN Aou9, August 1979. "Environmental impact assessment as an instrument of public policy," in Impacto.

Department of Natural Resources. San, 1980, pp. 1-2. (U.S. Motor Vehicles Manufacturers Assn. Motor Vehicles Facts and Figures, 1978. National Academy of Science. See U.S. National Academy of Science. National Safety Council. Accident Facts - 1979. Chicago, IL. Factors contributing to the decrease in motor-vehicle fatalities from 1973 to 1977. May 1979. National Transportation Policy Study Commission. National Transportation Policies through the Year 2000, Washington, June 1979. New Jersey. Department of Transportation. New Jersey Transportation Plan. September 1979 (draft). New York Times (file) O'Connor, T.P. & A.S. Toebel. "Data requirements for transportation energy conservation research." Conference on Technology for Energy Conservation, Albuquerque, NM, January 1978. Organization for Economic Cooperation and Development. Environment Directorate, Policy toward the creation of vehicle-free areas in cities. Paris, 1972. Management-oriented urban transport policies to improve the environment. Doc. ENV(78)18. Paris, 1978. O'Neill, B. et al. “Relationships between car size, car weight and crash injuries. An ear-to-ear study.” III. International Congress on Automotive Safety. San Francisco, 1976. "The effects of vehicle size on passenger car occupant death rates," Passenger-Car Meeting, Society of Automotive Engineers. Detroit, September 1977. Page, S., G. "Speed is the name of the game." Technology Review, August-September 1960. Pollard, J. et al. A summary of opportunities to conserve transportation energy, Washington (U.S. DOT, Office of Transportation Energy Policy) August 1975. Portland, OR Energy Conservation Project (various materials), 1979. Puerto Rico. Administration of Economic Development. The mobility of Labor in Puerto Rico, San Juan, May 1971.

Puerto Rico; Department of Consumer Affairs. Office of Education. The automobile and fuel savings. “Guidelines for ten lectures to youth leaders.” San Juan, ed. (1969), Free-interpretation

"Department of Transportation and Public Works. Highway Authority. Statistics related to highways. Act 579.80. Highway Authority. Transportation system Management for the period 1976-80. April 1975. 32 SERPS from the rapid collective transportation project for the Metropolitan Area of San Juan. (Draft) Super Layer Firm. Metropolitan Bus Authority. Emergency Energy Contingency Plan. November 1979. Energy Timeline. Energy conservation: A commitment to the future of Puerto Rico. July 1978. Energy Policy of Puerto Rico: the first step. May 1979. The energy situation in Puerto Rico in 1978. June 1979. Energy statistics for 1980. Petroleum and its products: Annual report.

Monthly energy indicators of Puerto Rico, December 1980. Gasoline prices at the consumer level (Oct. 1980 - July 1981). Save gasoline, save money [Information folder]. Nov. (1980). Planning Board. Socioeconomic report. Fiscal years 1970 to 1980. Statistics on petroleum products and motor vehicles. Social report 1980. Robertson J.S. & S.P. Baker, "Motor vehicle sizes in fatal crashes." Accident analysis and prevention (London), March (1976). Ruiz A&P, "Energy in Puerto Rico: An input-output approach." Economic development in Puerto Rico. Caribbean Studies, 17(1981)115, San Juan STAR (file). Jackson RH. Assessment of opportunities for conservation in the transportation sectors and strategies for implementation. Papers Prepared for Energy in Puerto Rico's Future. See 12 below. Schurr S-H. et al. Energy in America's future: The choices before us. Baltimore (Johns Hopkins) "1979. Stanford Research Institute International (by R.H. Thulllier et al.) A methodology for making a quantitative assessment of passenger transportation alternatives. April 1973. Waste Test. Stobaugh R. & D. Yergin (eds). Energy future: Report of the Energy Project at the Harvard Business School. New York 1995. System Design Concepts (by I. Petorelli et al.)."

Operating Multi-Boda Urban Transportation Systems, Washington, 1977.

GB SP SS 62, 2. De BR cm 2 Ds he cry 2B 2 Au ey aa 2, eh 2B cy MultSystem, Inc. (for International Taxicab Association). Taxis, the public, and paratransit: A coordination primer. Distributed by B'S, Bot/Technology Sharing Div., August 1978.

Road Information Program, The [TRIP]. The effect of substandard roads on vehicle operating cost in Colorado, Washington, June 1980. The effect of substandard roads on vehicle operating cost in Massachusetts. Washington, August 1980.

U.S. Congress. Congressional Budget Office. Urban transportation energy, the potential savings of different modes. December 1977.

Transportation finance: Choices in a period of change. March 1978.

Guidelines for a study of highway cost allocation (As required by Public Law 95-599). February 1979.

The decontrol of domestic oil prices: An overview. May 1973.

The world oil market in the 1980s: Implications for the United States. May 1980.

Office of Technology Assessment. Energy, the economy, and mass transit. December 1975.

Technology assessment of changes in the future use and characteristics of the automobile transportation system. 1979.

Council on Environmental Quality. Regulations for implementing the procedural provisions of the National Environmental Policy Act. 43 FR 55972-56007, 29 Nov. 1978; 40 CFR Parts 1500-1508,

U.S. Department of Commerce. Census of the United States. 1980.

U.S. Department of Energy. Environmental development plan: Transportation programs. April 1979.

How to save gasoline and money. May 1979.

A technology assessment of productive conservation in urban transportation: Project description (Doc. DOE/BV 0070). Dec 1979.

Securing America's energy future: The national energy policy plan (Report to Congress). July 1981.

Energy Insider (biweekly).

Statistical abstract

Energy Information Agency. End-use energy consumption data. Series E1 Tables. June 1978

Annual Report to

Congress, 1979. A comparative assessment of five long-run energy projections by A.S. Kydes et al., Brookhaven National Laboratory, Dec. 1977. Huge energy consumption data bases: Transportation sector by J.N. Hooker et al., ORNL, February 1980. Energy Facts Sheets, August 1980. Monthly Energy Review, February 1981. Executive summary of preliminary 1980 data. U.S. Department of Transportation. Parking management policies and auto control zones by Metropolitan Washington Council, Feb. 1976.

69 U.S. Department of Transportation, Potential of non-construction methods and their implications to reduce congestion and save energy at major U.S. airports with S. DOB, 1977. Transportation energy initiatives Summary, August 1979. Trucker's guide to fuel savings (Publ. HS-805-256), Mar. 1980. The car book: A common guide to car buying, 1981. Federal Highway Administration. Right-turn-on-red, Vol.T1 technical report by He. Tegen et al., May 1978. Highway Statistics 1978. 1977 Nationwide Personal Transportation Study: Report No.1 Characteristics of 1977 licensed drivers and their travel, October 1980. Rep. No. 21 Household vehicle ownership, December 1980. Rep. No. 3: Purposes of vehicle trips and travel, Dec. 1980. Rep. No. 4: Home-to-work trips and travel, December 1980. National Highway Traffic Safety Administration. Another look at car size and safety, October 1973. Three rules for maximizing tire life, including load and friction tables (fact sheet), March 1975. A statistical relation between car weight and injuries, February 1973. The life-saving benefits of the 55 mph national speed limit report, NHTSA/FHWA Task Force, September 1978. Energy conservation opportunities for the in-use automobile fleet: Draft Taskforce report by transportation systems Cambridge MA, January 1985. Driver energy conservation program (Prospectus) by J.W.

"Boothird, Ed. (1985), 'Urban Mass Transit Administration, Guidelines to Reduce Energy Consumption through Transportation Actions' (City-Wide Research). Also see Bone et. al, 'Transportation System Management: The Record and a Look Ahead', January 1985. 'Transit Actions: Techniques for Improving Productivity and Performance', a workbook by Public Technology Inc., September 1979. Office of the Secretary. 'Changing America', February 1993.

U.S. Emergency Energy Conservation Act of 1979. 'Transportation Policy for 1980'. U.S. Environmental Protection Agency. 'The Need for and Benefits of Inspection and Maintenance of In-Use Motor Vehicles' (B.P. Walsh, Ed.), November 1974. 'Parking Management Strategies for Reducing Automobile Emissions', September 1976. 'Research Outlook 1978' by Office of R & D, June 1978.

U.S. Environmental Protection Agency. 'Hydrocarbon Control Strategies for Gasoline Marketing Operations', December 1978. 'The Alternative is Conservation', August 1980. 'EPA/DOB 1981 Gas Mileage Guide'. U.S. Energy Policy Conservation Act of 1975, P.L. 94-163.

U.S. Energy Research and Development Administration. 'Transportation Energy Conservation Data Book', Ed. 1 (D-3. Shonka et al.), October 1976. Supp. II (U.S. Loebl), May 1977. U.S. Surface Transportation Assistance Act of 1978, P.L.95-599.

U.S. National Academy of Science/Transportation Research Board. 'Transportation Programming, Economic Analysis and Evaluation of Energy Constraints' (TRR 599), Washington 1976. 'Urban Transportation Alternatives: Evaluation of Federal Policy', Special Report 1977.

Committee on Nuclear and Alternative Energy Systems (CONAES). 'Energy in Transition: 1965-2010', Washington 1980. Energy Engineering Board. Committee on Future Energy Alternatives for Puerto Rico, 'Energy in Puerto Rico's Future'. Wohl M. 'Increasing the Taxi's Role in Urban America', Technology Review, July-Aug. 1978, 45-53."

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