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Indonesia
Selected Issues of Energy Pricing Policies

(In Three Volumes) Volume II: A Supplementary Report on Energy Use in the Transport Sector

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CURRENCY EQUIVALENTS

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Annual Averages 1979-82	
1979	US$1.00 = Rp 623
1980	US$1.00 = Rp 627
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INDONESIA

SELECTED ISSUES OF ENERGY PRICING POLICIES

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A SUPPLEMENTARY REPORT ON

ENERGY USE IN THE TRANSPORT SECTOR

Table of Contents

Page No.

This supplementary report has been prepared by Dan Morrow, Indonesia Division, East Asia and Pacific Country Programs Department.

CHAPTER 1. INTRODUCTION

1.01 The basic objective of Indonesia's energy policy is to sustain the exportable surplus of petroleum in coming years through conservation efforts which will slow down the rate of growth of domestic petroleum consumption and through diversification of domestic energy consumption away from petroleum to other energy sources. The purpose of this paper is to consider policies in the transport sector which could contribute toward the basic national objectives of conservation and diversification. It is intended both to provide information about current Government of Indonesia's (GOI) policies and programs in this area which will be of interest to those outside GOI and to comment on these policies and programs.

1.02 The main report on "Indonesia: Selected Issues of Energy Pricing Policies" presents data on the pattern of energy use in the transport sector and considers issues of energy pricing policy, including issues specifically related to transport. A summary of those sections of the main report is included here in the introductory chapter. This supplementary report focuses on issues of the transport sector which are _not_ directly related to pricing policy. Chapter 2 surveys nonprice conservation measures related to urban traffic management, urban public transport, regulations affecting growth of the road vehicle fleet, road infrastructure improvements, the railway subsector, and public information and technical assistance. Chapter 3 discusses alternative energy sources for the transport sector which could contribute to the objective of diversification, and the final chapter presents a summary and conclusions.

1.03 As mentioned in the main report, available data related to energy consumption in the transport sector is generally of poor quality and are approximations only. Nonetheless, it is possible to make some judgments about many policies and programs, particularly with respect to nonprice conservation measures. This is, however, less true with respect to the potential for alternative fuels, where more precise quantification is required. Finally, it must be stressed that fuel efficiency in the transport sector is only one aspect of overall efficiency of transport services and any program to improve energy efficiency in the sector must be an integrated part of the development plans for the sector as a whole.

Pattern of Demand for Energy in the Transport Sector

1.04 Petroleum products account for virtually all of the energy consumed in the transport sector in Indonesia. The sector accounts for about 33% of total consumption of petroleum products in 1980. The percentage of each product consumed in transport in 1980 is estimated as follows: aviation fuel, 100%; gasoline, 95%; diesel (automotive and industrial), 38%; kerosene, 0%; and fuel oil, 10%. However, data on consumption are of poor quality, and the estimated percentages of diesel and fuel oil consumed by transport are not very reliable. Greater effort should be made to improve data on consumption patterns.

1.05 Road transport accounts for about 72% of fuel consumption in the sector, and therefore this subsector deserves priority in terms of conservation and diversification efforts. Trucks and buses use about 64% of fuel demanded by the road subsector. Maritime transport is the second most important mode in terms of fuel usage, accounting for about 14% of total sectoral consumption. River and ferry transport accounts for 3%; air, 10%; and railways, 1%.

Pricing Policies for Transport Fuel

1.06 During the past decade GOI has tended to maintain the domestic aviation fuel price close to its import parity price, the gasoline price above its import price, and the kerosene, diesel, and fuel oil prices well below their respective import prices. Following the domestic price increases averaging over 60% in January 1982 and about 52% in January 1983, the aviation fuel and gasoline prices are above import prices and the other fuel prices, well below.

1.07 Further adjustments in domestic prices of petroleum products must be considered in light of three general objectives: limiting budget subsidies; mitigating shocks to the domestic economy; and promoting efficiency and conservation. The estimated budget subsidy in FY82/83 for the diesel and fuel oil consumed by transport amounted to over Rp. 200 billion, and the total budget subsidy for petroleum products was projected to be about Rp. 924 billion, equivalent to 10% of the development budget. Thus, further increases in diesel, kerosene, and fuel oil prices would make substantial revenues available for public investments. The impact of such price increases on the cost of transport services would be limited (on average, about one-fourth of the percentage change in fuel prices). The impact of higher transport costs on final commodity prices is even smaller: it is estimated that the 60% increases in fuel prices in January 1982 would bring about a 2.5-5.5% increase in the overall price index. Those groups which are most vulnerable to fuel price and transport costs increases can be partially protected by measures such as subsidies for urban bus transport and for "pioneer" services to isolated areas. With respect to promoting efficiency and conservation in the transport sector, additional fuel price increases would encourage all providers and users to seek cost-minimizing changes in the pattern and use of transport services. Through myriad minor adjustments and substitutions, the energy efficiency of the sector would be improved marginally in the short run and significantly in the longer run. The data base is not adequate to permit quantification of these effects. But, given the potential magnitude of price increases for diesel and fuel oil, even low short-run price elasticities would bring about noticeable changes in demand.

1.08 Since aviation fuel and gasoline are already priced above their import parity prices, the most important issue still confronting GOI is the prices for diesel and fuel oil. For more than a decade, GOI has held the ratio of the diesel price to the gasoline price will below that in the world market as part of a conscious program of "dieselization." By distorting transport costs in favor of diesel by more than world market prices and relative technical efficiencies would otherwise dictate, Indonesia has undoubtedly encouraged a more rapid rate of dieselization of its vehicle fleet than economically desirable. The cost of this distortion will become greater when Indonesia completes its new refineries and becomes self-sufficient in some petroleum products. Without a shift in the consumption pattern away from diesel toward gasoline, Indonesia is likely to find itself in the late 1980s exporting gasoline into a weak regional market while importing diesel, thereby incurring high total transport costs. The price of diesel must therefore be increased relative to that of gasoline during coming years. This is the most important step which could be taken to conserve fuel in the tranport sector. If kerosene prices cannot be increased as rapidly as diesel prices, there may be some substitution of kerosene for diesel, but for technical reasons this will be very limited in the transport sector and will not prevent realization of budget savings from the lower diesel subsidy. Nonetheless, to limit the possible substitution of kerosene for diesel, GOI should (a) attempt to develop segregated marketing channels for the two products, initially on a limited geographical basis; and (b) conduct research on the reduced performance and increased maintenance cost associated with blending kerosene with diesel in diesel engines and disseminate this information to truck and bus companies and industrial users.

CHAPTER 2. NONPRICE CONSERVATION MEASURES

Introduction

2.01 Pricing policy is clearly the most powerful tool for encouraging efficient use of fuel and the main report has, therefore, focussed on these policies. However, there are many important nonprice measures which can contribute to the objective of conservation of petroleum products in the transport sector. Indeed, fuel efficiency in the transport sector depends partly on the transport infrastructure which is necessarily the responsibility of the public sector, and the Government must make its choices with respect to investments in the transport infrastructure with due regard to the objective of energy conservation.

2.02 This chapter will review and discuss possible nonprice measures to promote conservation. These measures are grouped into seven general categories: urban traffic management; urban public transport; regulation of road vehicle production and sales; road infrastructure; the railway subsector; public information and technical assistance; and other measures. GOI has already taken steps to identify and implement nonprice conservation measures in the transport sector, and many of the measures discussed here are discussed in a report on "Policies and Programs for the Conservation of Energy/Petroleum Products in the Transport Sector" which was prepared by the Research and Development Bureau of the Ministry of Communications in September 1981 and reviewed by BAKOREN, the interministerial board on energy policy./1 At the beginning it must be stressed that almost all of the measures discussed in this chapter involve issues which are broader than energy conservation. By approaching these issues primarily with a view toward conservation, this chapter provides only a partial analysis. Therefore, many of the ideas and recommendations put forward here must be reexamined before implementation in a broader context. For example, recommendations for urban traffic management must be evaluated in the context of overall urban planning. In such a broader context, measures which would promote energy conservation may be considered of lower priority or in conflict with other objectives.

Urban Traffic Management

2.03 Improved urban traffic management could have an important impact on fuel efficiency in the transport sector for two reasons. First, the fuel efficiency of a vehicle increases as its average speed increases up to about 40-50 miles per hour. Research in the United States indicates that fuel economy for passenger cars increases from about 9 miles per gallon (263 liters per 100 km) at an average speed of 10 miles per hour to about 17 miles per gallon (139 liters per 100 km) at an average of 35 miles per hour./2 In urban driving, lower average speeds reflect more stops and starts and greater traffic congestion. To the extent that average speeds can be increased through improved traffic management, all vehicles in the traffic stream will be operating with greater fuel efficiency. Second, a high percentage of each category of road vehicle in Indonesia is operated in urban areas. Rough estimates of the number of vehicles in 12 major urban areas of Indonesia are given in Table 2.1, which indicates that these urban areas account for about 69% of all registered cars, 43% of buses, 39% of trucks, and 47% of motorcycles. In each category over 85% of the urban-based vehicles are in the four largest cities of Jakarta, Surabaya, Bandung, and Medan. Given that the road subsector accounts for about 72% of total fuel consumption in the transport sector and about 24% of total consumption of petroleum products in Indonesia, it appears that urban driving accounts for very roughly half of fuel consumption in the road subsector, one third of consumption in the transport sector, and one tenth

/1 This report is subsequently referred to as the MOC report.

/2 See Juri Raus (April 1981). For complete citation see the "List of References Cited." Similar relationships between average speed under 35 mph and fuel economy are established for trucks and buses.

of total national consumption./1 Thus, measures to improve the fuel efficiency of urban driving could make a significant contribution to energy conservation.

Table 2.1: ESTIMATED VEHICLES IN MAJOR URBAN AREAS IN 1978 /a
('000)

	Cars	Buses	Trucks	Motorcycles
DKI Jakarta	190.6	17.1	58.4	369.4
Yogyakarta (1977)	8.1	0.3	1.5	41.3
Surabaya (1979)	46.3	2.1	14.4	123.2
Bandung (1975)	74.7	2.2	32.8	220.0
Medan (1976)	18.7	0.3	5.4	69.4
Semarang	8.3	0.6	4.1	8.3
Palembang	5.4	0.2	0.7	22.1
Ujung Pandang (1980)	4.4	0.9	3.4	7.9
Surakarta (1979)	3.7	0.3	2.7	23.0
Malang	5.8	0.3	2.0	21.7
Padang (1980)	3.6	0.7	2.9	18.1
Manado (1979)	1.0	0.1	2.0	5.4
Subtotal	370.6	25.1	130.3	929.8
Total Indonesia	534	58	333	1,974
Percent in major urban areas	69	43	39	47
Percent in four largest cities /b	62	37	33	40

/a Base data provided by Subdirectorate for Urban Roads, DGH. Assumes annual growth rates of 11% for cars, 12% buses, 16% trucks, and 21% motorcycles as per BPPT, Table 2.9. Year of base data given in parentheses if other than 1978.

/b Includes DKI Jakarta, Surabaya, Bandung, and Medan.

/1 These estimates assume that fuel consumption per vehicle per year are the same in urban and nonurban areas. Since fuel consumption per mile is undoubtedly lower in urban areas but miles travelled per year may also be lower, it is not clear how accurate this assumption is.

2.04 Types of Measures. The recent experiences in Bangkok and Manila confirm that traffic management measures, especially coordinated traffic signals, can increase average speeds, reduce vehicle operating costs, and provide high economic rates of return. Installation of a computer-controlled traffic signal system in central Bangkok promises to reduce traffic delays by 25% compared to unlinked signals and provide savings to vehicle operators in each year equal to over 100% of the system's capital cost./1 A study in Manila indicated that installation of traffic signals on two major streets increased average travel speeds by about 20% despite a 10% increase in traffic./2

2.05 The MOC report mentions several measures which could improve traffic flow, increase average speeds, and thereby improve fuel economy in the major urban areas of Indonesia. These include building overpasses at level crossings between major roads and railway, building pedestrian overpasses, improving parking systems, encouraging carpooling, and introducing traffic restraint measures in the central cities. Of these, the report attaches priority to building overpasses at level crossings of roads and rail and building pedestrian overpasses./3 The MOC report further notes that

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/1 See Jamieson Mackay and Partners (1980).

/2 See Philippine Ministry of Public Highways (1981).

/3 It is reported that there are about 3,000 level crossings of road and rail in all of Indonesia, of which about 400 involve major roads carrying over 1,500 vehicles per hour. Most of these high-volume crossings are in urban areas. It is calculated that the fuel wasted by vehicles waiting for trains to pass at these 400 locations was 243,000 kiloliters (1.5 million barrels) in 1980, amounting to about 3% of gasoline and diesel consumption in the transport sector. Although this calculation is based on very rough assumptions and, even using these assumptions, is in error by a factor of three (i.e., the correct calculation yields 81,000 kiloliters per day), it correctly highlights the fact that level crossings of major roads and rail constitute serious impediments to traffic flows in both urban and nonurban areas which involves not only wasted fuel but also lost time. Among the many assumptions required for this calculation is the behavioral assumption that drivers will not stop their engines while waiting for a train to pass, even if the wait will obviously be long. This does in fact appear to be the case not because Indonesian drivers are not conscious of fuel economy but because they fear that they would not be able to restart their engines due to weak batteries and generally poor engine maintenance. Similar behavior can be noted among diesel taxis in Jakarta, which will not stop their engines during a long wait at a hotel taxi stand.

pedestrians crossing urban arteries slow down traffic flows and that construction of pedestrian walk-overs at sites near shopping centers, schools, etc. would contribute significantly to higher traffic speeds and hence fuel economy.

2.06 It is certainly true that there are innumerable small investments throughout the urban areas of Indonesia which have high benefit-cost ratios. These are good investments not because they result in fuel conservation *per se* but because the value of reduced vehicle operating cost, including the value of reduced fuel consumption, and of reduced travel times exceeds the cost of the infrastructure. Most of the ideas mentioned in the MOC report are certainly worth pursuing, although the emphasis on overpasses at railway crossings is probably too great since improved signals (such that crossing is blocked only when the train is nearby) would likely be a more cost-effective way to reduce vehicle waiting times at many crossings.

2.07 Implementation Strategy. The difficult question is what should be GOI's strategy to identify and implement specific investments. In addressing this question, it must first be noted that any strategy for improving urban traffic management is closely related to issues of urban public transport, control of the growth of the vehicle population, and urban planning in general. Therefore, in Jakarta for example, such measures should be reviewed by a multi-sector team responsible for overall JABOTABEK planning. In considering a strategy for improving urban traffic management, three additional factors should be borne in mind. First, the investments required for improved traffic management are primarily small and widely scattered within many urban areas of the country. Second, an urban road network and traffic flow pattern is complex, and designing a plan for improved traffic management which draws effectively upon the many alternative measures available requires some expertise. Third, traffic engineering requires attention both to the construction of new roads, bridges, and related infrastructure and to the equipment (such as traffic signals) and regulations governing how old and new infrastructure is used. Taken together, these factors suggest that (a) primary responsibility for the urban road networks must rest with the city governments, and the division of responsibility between the city government and national agencies, e.g., with respect to national roads through urban areas, must be clear; (b) it is necessary to build up a small core of experts in traffic management in each of the major urban areas of Indonesia; and (c) any division of responsibility for road construction and traffic engineering must be either overcome through close coordination or, preferably, eliminated. Several steps along these lines are already in progress. Under the Bank's Fifth Highway Project, urban transport specialists have been assigned to the Regional Betterment Offices (RBOs) in Medan, Bandung, Palembang, and Surabaya and the Sub-Directorate for Urban Roads within the Directorate General of Highways (Bina Marga) in Jakarta. Assignment of these specialists, starting in mid-1982, should help develop traffic management programs for these major cities and help train local personnel for such future work. Also, the Bank has financed under the Second Urban Project a consultant study, prepared in close cooperation with city officials, of traffic management needs in Jakarta; this report by Colin Buchanan was finalized in early 1983 and merits close study. However, in addition to this technical assistance, GOI should take steps to ensure that at least one or two urban traffic engineers from (or to be assigned to) each of the major urban areas of Indonesia receive advanced training either overseas or, if appropriate, at the newly established graduate program for transport planning at the Bandung Institute of Technology, which is partly financed under the Fifth Highway Project. Second, to clarify division of responsibilty, regulations are being finalized to further clarify the provisions of the National Road Law of 1980 regarding relationships between Bina Marga, MOC, and the agencies of city governments. GOI should review these draft regulations to ensure that responsibility for traffic management measures are clearly assigned. Looking beyond the scope of regulations now under consideration, GOI might also consider the possible reorganization of the Ministries of Public Works and Communications so that responsibility for road infrastructure and for traffic engineering rests with a single Director General who can bring about greater coordination of these two facets of development of road capacity. At present responsibility is divided between Bina Marga and the Directorate General of Land Communication. In any case, close coordination between these agencies must be maintained through the ongoing quarterly working meetings.

2.08 A program to identify and implement measures to reduce road traffic delays at railway crossings is probably easier to implement than improved urban traffic mangement in general because it primarily involves only two GOI agencies - Bina Marga and PJKA - and the technical alternatives are more limited. Given the large number of such crossings (about 3,000, of which about 400 involve major roads according to the MOC report), it would not be cost effective to evaluate alternative measures for each crossing individually. Instead, guidelines must be developed which can be applied quickly to determine an appropriate investment, if any, at each crossing. Such guidelines should first indicate under what circumstances PJKA should invest in improved signalling to reduce the time during which road vehicles must wait for an oncoming train. The guidelines should also provide standard parameters for the economic evaluation of possible railway overpasses or road realignments which bypass railway crossings./1 It is recommended that a working group comprising representatives of MOC, PJKA,

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/1 Such guidelines should provide standard parameters for estimating the benefits associated with given traffic counts and frequency and duration of train interruption of traffic flows, standard parameters for estimating the cost of the overpasses, and hence a standard procedure for estimating the benefit-cost ratio of the possible investment.

and Bina Marga be established first to develop such guidelines and then to survey major crossings utilizing the guidelines in order to identify a program of investments. GOI should then ensure that the necessary budget allocations are made to PJKA and Bina Marga for implementation of this program. In addition, Bina Marga should give general instructions to its design consultants that preparation of construction or betterment projects on arterial roads must include consideration of construction of overpasses at rail intersections utilizing the guidelines. It should be noted that this would not constitute an entirely new effort by Bina Marga. For example, in the case of the Jakarta-Cikampek highway project, partly financed by the World Bank, the betterment of the existing highway includes construction of one overpass as well as realignment of a segment of the road to eliminate two at-grade rail crossings.

Urban Public Transport

2.09 The potential contribution of improved urban public transport services to energy conservation is due to three, interrelated factors. First, the load factors of public transport vehicles are high relative to those for private vehicles. In other words, public vehicles such as buses can carry more passengers per vehicle and per unit of road space than private vehicles. Second, the availability of good public transport services reduces demand for private vehicles. Conversely, more people will feel compelled to make the investment in private cars if their transport requirements cannot be adequately met by public transport services. And, third, the fuel efficiency of the existing private vehicles can be improved by the provision of good public transport services. To the extent that the public services reduce the growth in the number of private cars, traffic congestion is reduced, the problem of urban traffic management can be handled more easily, and the fuel efficiency of the whole urban transport system is increased.

2.10 Existing Services. Public transport services in Indonesia cities are provided by several different means ranging from large, publicly-owned buses to human-propelled pedicabs (becak). A classification of the main types of such vehicles is given in Table 2.2, and the approximate numbers of these vehicles in Jakarta, Surabaya, and Malang in 1979 is shown in Table 2.3. In general, only Jakarta is serviced by a very large bus fleet. The Jakarta bus services are provided now by the publicly owned P.T. PPD (Perusahaan Pengangkutan Jakarta). Large bus services in Surabaya and about 15 other large cities are provided by the publicly-owned P.T. Damri. But, except for Jakarta, most urban public transport is provided by privately owned bemos and other small vehicles and by pedicabs (becak).

Table 2.2: CLASSIFICATION OF MAIN TYPES OF URBAN PUBLIC TRANSPORT VEHICLES

Service	Vehicle type	Passengers
Fixed route; set fares; fixed stops	Bus	50 minimum (seated)
	Minibus (Bis Mikro)	20 (seated)
Fixed route; set fares; stops on demand (jitneys)	Bemo (4 wheel) /a	4-11
	Bemo (3 wheel)	7
	Opelet	7-9
Inter-city (Colt)	Pick-up (pikap) /b	13
Door-to-door; negotiated fares	Taxi	
	Bajaj (3 wheel) /c	4
	Becak (pedicab)	2
	Pony cart /d	2

/a Also known in Malang as Daihatsu (9 passengers), in Surabaya as Daihatsu or Honda (11 passengers) and in Salatiga as Kolt (see also /b below).

/b The term applies officially to any partially enclosed four-wheel bemo (c.f. mikrolet = fully enclosed) but is also used specifically for the 13-passenger model on rural/urban routes.

/c Bajaj has 150 cc/4-stroke Vespa (India) engine. Also similar Minicar (105 cc/2-stroke Honda-Benley) and mebea/bingo (50 cc/4-stroke Surdrop). The modern helicak is a larger 3-passenger vehicle. The original helicak was in effect a Vespa motorcycle with an enclosed cabin for 2 passengers in front like a becak.

/d Known variously as dokar, bendi, delman and sado. The larger 4-wheeled carriage common in Yogyakarta is known as an andong.

Source: Howard Dick, "Urban Public Transport Part I", Bulletin of Indonesia Economic Studies, July 1981.

Table 2.3: URBAN PUBLIC TRANSPORT FLEETS, JAKARTA, SURABAYA AND MALANG, EARLY 1979

Type of vehicle	Number of vehicles Jakarta	Surabaya	Malang /a
Buses	2,400/b	190	-
Minibuses	1,000	-	-
Opelet	3,000/c	-	-
Bemo	1,100/c	2,000	800
Taxi	5,800/c	n.a.	-
Bajaj, etc.	10,350/d	1,000	-
Becak /e	n.a.	40,000	-

/a Figures apply to early 1978 but are unlikely to have varied significantly by early 1979.
/b Excludes unroadworthy vehicles.
/c Registered vehicles only.
/d Class IV vehicles bajaj (8120), minicar (1390), helicak (540), superhelicak (170), mebea/bingo (140).
/e Estimated numbers. Officially registered 30,000 becak in Surabaya and 20,000 in Malang.

Source: Regional Offices of Dinas Lalulintas dan Angkutan Jalan Raya and Traffic Police as reported in Howard Dick, "Urban Public Transport, Part I," Bulletin of Indonesian Economic Studies, July 1981.

2.11 In its report on energy conservation in the transport sector, MOC focussed on the need to expand and improve public bus services and to develop commuter rail services. Specifically, the report proposes a program of bus procurement during the remainder of Repelita III (through 1983/84) which would involve the purchase of an additional 2,669 buses at an estimated cost of $122 million. Following this procurement program, which is likely to be scaled down due to the budget cuts in mid-1983, the total publicly-owned urban bus fleet would be as shown in Table 2.4. The most striking feature of this proposed program is the rapid increase in public bus service in cities outside of Jakarta. In addition to this expansion of large bus operations, the report proposes that the commuter rail system of Jakarta be expanded from its present service along the Bogor-Kota line which accounts for under 3% of total public transport services in the city to a system which could provide 30% of total public transport services by the year 2,000. In fact, GOI has decided to implement a program of improvement and expansion of the commuter rail system as discussed below.

Table 2.4: PROPOSED PROGRAM OF EXPANSION OF PUBLIC URBAN BUS FLEET

City	Total buses at end of Repelita II (78/79)	Total buses at end of Repelita III (83/84)
Jakarta	2,710	3,110
Surabaya	170	500
Semarang	120	140
Bandung	88	450
Medan	95	200
Others	25	725
Total	3,208	5,125

2.12 Policy Issues. While there can be no doubt about the importance of improving urban public transport not only because of its energy efficiency relative to private cars but also because of its vital contribution to the growth of urban economies, there are several difficult questions with respect to how that general objecive can best be realized. These questions are: (a) what should be the role of large buses relative to smaller vehicles such as bemos? (b) how can the bus services provided by the public corporations PPD and Damri be operated more efficiently and to what extent should GOI subsidize these operations? and (c) how much should be invested in the commuter rail system in Jakarta rather than in bus or other public transport services? These issues are discussed more fully in the following paragraphs.

2.13 GOI policy in Jakarta and to some extent in other cities over the last decade or so has tended to promote expansion of the publicly owned bus companies at the expense of privately owned bus companies and of other public transport services such as bemos and becaks. In Jakarta, official bus fares had been held constant at Rp 50 per passenger from 1977 through 1982, despite substantial increases in fuel and other costs, and as a result the several private bus companies have been unprofitable and have sold out to PPD./1 These fares were increased to Rp 100 following the January 1983 fuel price increases. In both Jakarta and Surabaya, becaks have been banned from the central city during most daylight hours, and GOI has expressed its intention to eventually ban becaks throughout Indonesia not only because they can interfer with the flow of motorized traffic but because such labor is said to be an offense to human dignity. Also, in Surabaya and

/1 Following the January 1982 fuel price increases the last three private bus companies (Gamadi, Pelita Mas Jaya, and Mayasari Baru) have asked to be taken over by the government. PPD had previously taken over nine bus companies. See Kompas, February 9, 1982.

other cities where public bus service has been introduced, services by bemos or other such small, private vehicles along some bus routes has been restricted in order to reduce competition and hence improve the financial returns to the bus company. Such policies involve the risk that large bus services will be provided even where other forms of public transport are more desirable from the point of view of the consumers of those services. In particular, suppressing existing services such as bemos and becaks by regulation for the sake of introducing large bus service may reduce the quality and/or increase the economic cost of total transport services. To avoid this, bus services by the public corporations should be introduced only along main routes where they clearly have an advantage, and any restrictions on other forms of transport along those same routes should be carefully considered. The policy to eliminate becaks will also have the effect of reducing employment opportunities for the unskilled. While government officials may regard driving a becak as offensive labor, it may still be preferred by some men as an alternative to lower paying work or unemployment. Except in those urban areas where becaks significantly interfer with other traffic flows, it may be more prudent to let the level of becak services be guided by the labor market. As labor demand grows in other sectors, the number of men willing to drive becaks will naturally decrease.

2.14 The GOI policy of subsidizing the public bus companies may be defended on the grounds that it reduces demand for private vehicles and thereby reduces the cost of congestion and that it provides a subsidy primarily to the urban poor. However, it must be noted that higher taxes on the import and purchase of private cars (as discussed below) and on gasoline are also instruments for suppressing demand for private vehicles, and these taxes would be borne primarily by urban car owners. Also, many users of public bus services are certainly from middle-income families, and therefore alternative investments such as Kampung Improvement Programs may be more effectively targeted on the urban poor than bus subsidies. Finally, the subsidy policy does involve significant financial costs. GOI budget outlays to cover operating losses by PPD grew from almost zero in 1979 to Rp 1.3 billion ($2.1 million) in 1980 and an estimated Rp 5.7 billion ($9.1 million) in 1981. Following the takeover of the remaining private bus companies the 1982 subsidy is estimated at Rp 11.8 billion ($18.9 million)./1 Even these outlays were inadequate to cover the depreciation of assets and thus provide adequate resources for maintenance, much less expansion, of the bus fleet. Also, the subsidies imply a distortion in the pricing of transport services which favor the large buses over other forms of services. Nevertheless, assuming that a subsidy for the public bus companies is continued, it remains important that these services are provided as efficiently as possible. Toward this end, several steps should be considered by GOI.

/1 Based on statement to press by Ministry of Finance official as reported in Kompas, February 15, 1982.

First, the subsidies provided by GOI should be large enough to allow sound management, including maintenance and planned replacement and expansion of the bus fleet. Second, the operations of Damri, which now encompass all of the major cities of Indonesia other than Jakarta, should be decentralized, perhaps by creating subsidiary public corporations as separate accounting entities in the various regions, to ensure that its management in each city can be held accountable for their performance and is more sensitive to the conditions and needs in each city in which it operates./1 Such decentralization is increasingly important if public bus operations are to be initiated in all of the 24 cities identified by GOI as requiring such services. Third, GOI should support a program of technical assistance to the two bus companies to help them improve their technical operations and financial management. Fourth, GOI should plan for a phased increase in fares for the large, publicly-owned buses so as to limit the differences between these fares and the fares charged by other providers of urban public transport. If these differences become too great, the public bus companies will be faced with demand for its services beyond their capacity and the development of the private services will be retarded. The doubling of public bus fares in Jakarta in January 1983 is an important step in this respect. Finally, to avoid unnecessary displacement of private transport services by the public bus services, GOI should prepare regulations or guidelines for PPD and Damri which define those types of services which they should and should not provide./2

/1 The disadvantage of a single company operating throughout Indonesia is well illustrated by a recent incident in which the mayor and traffic authorities of Ujung Pandang objected to Damri's plans to send 10 double-decker buses to the city on the grounds that these buses would require removing existing pedestrian walkovers and trees. See Kompas, December 7, 1981. These plans are now being reviewed. See Kompas, February 1, 1982.

/2 The potential problems of displacement of private services by subsidized bus services are illustrated by a recent press report from Banda Aceh. Following the increase in fuel prices in January 1982, local minibus drivers doubled their fares to Rp 100, including fares to school children. The regional government decided that Damri should provide bus services to school children at the Rp 50 fare. This prompted a protest demonstration by the minibus drivers, who were then threatened with revocation of licenses. See Kompas, January 22, 1982.

2.15. Jakarta Commuter Rail Service. In order to supplement the public transport services provided by road vehicles in the Jakarta area, GOI has decided to begin implementation of a program to improve and expand the railway network in the Greater Jakarta Metropolitan Area (Jabotabek). The existing rail network, which is poorly maintained and operated, accounts for an estimated 0.09% of passenger traffic within DKI Jakarta, 8.9% of traffic between the surrounding communities (Botabek) and the central city (DKI) and 1.6% of total Jabotabek traffic. The Master Plan for expansion of the network envisions that by the year 2000 the railway will handle 9.6% of passenger trips during peak hours, i.e., about 300,000 passengers during the peak two hours./1 Total investment for the Master Plan was estimated to be Rp 744 billion ($1.19 billion) over three phases between 1984 and 2000. The economic rate of return for the entire plan is estimated by consultants at 10.2% assuming that road traffic is divided between buses and cars in the ratio of nine to one./2 It is also estimated that these rail services will generate operating profits for PJKA and given a 30% fare increase could even generate sufficient revenues to repay the necessary concessional financing. Finally, it is calculated that, by diverting traffic from road to rail, the annual fuel savings would be about 54 million liters (.34 million barrels) of diesel. The feasibility study of priority elements of the Master Plan calls for investments of Rp. 146 billion ($233 million) during 1984-87, for which the rate of return is estimated at 26.3%. Construction of the first phase, including an elevated track between Manggarai and Jakarta Kota and double tracking between Manggarai and Bogor, is targeted to begin in 1983.

2.16 The economic viability of the proposed rail system for Jabotabek depends on untested assumptions about consumer demand for rail rather than bus services, about the impact of the rail services on road traffic, and about the ability of PJKA to operate efficiently. Given that a decision has already been made to begin implementation of the program for improvement and expansion, although the schedule may be slowed down following the mid-1983 budget cuts, it remains essential that GOI closely monitor results of the early phases of the program in order to check the validity of these assumptions. Specifically, it would seem prudent for GOI not to commit itself beyond the first phase of the program, costing about $233 million, before thoroughly reviewing the economic and financial results of that first phase. Reconsideration of further investments in this capital-intensive project is particularly necessary in the present circumstances of reduced financial resources.

/1 See Japan International Cooperation Agency (February 1981), p. M/P51, M/P77.

/2 Assuming the share of road traffic handled by buses increased from the present 60% to only 70%, the estimated rate of return increases to 17.6%. See JICA (February 1981), p. M/P-206.

Regulation of Road Vehicle Production and Sales

2.17 The objective of energy conservation in the transport sector could be served by improving the fuel efficiency of the road vehicle fleet and by shifting demand for transport services from less to more fuel efficient vehicles. Through its regulation of the vehicle production industry and its tax policies as discussed below, GOI already has in place policies which promote these goals, although the appropriateness of these policies will have to be examined continuously as the domestic vehicle industry develops.

2.18 Vehicle Production. GOI has sought to develop the domestic industry for vehicle production by initially banning the importation of assembled vehicles and progressively banning importation of various components as domestic manufacturing of those components develops. Most of the production to date involves assembly of imported Completely Knocked Down (CKD) vehicles. The growth of domestic vehicle production since 1976 is shown in Table 2.5. This development of the domestic industry has involved very high levels of protection and high economic costs./1 The crucial question with respect to the limited issue of fuel efficiency is whether or not the vehicles produced domestically are as fuel efficient as imported vehicles would be; i.e., whether or not Indonesia is taking full advantage of technological advances in other countries which have increased the fuel efficiency of vehicles. At present GOI policy to develop the domestic vehicle industry has involved production of vehicles which are fuel efficient by world standards since the engine and other major components of the vehicles are the same as the new models in the producing country, which is predominantly Japan. In fact, because the models assembled in Indonesia usually do not have features such as pollution control devices, power brakes, and other add-ons which increase vehicle weight, they are probably somewhat more fuel efficient (in new condition under equal driving circumstances) than the same models produced in Japan or Europe. However, GOI has increasingly moved to require use of domestically produced components and has begun to implement a plan which would require all engines to be produced in Indonesia./2 This involves the possible risk that the Indonesian vehicle industry could lag behind technological developments in the world automotive industry and in the future produce less fuel efficient vehicles than could be imported. Clearly this would have a very negative impact on the effort to conserve energy and therefore great care must be taken that policies which restrict or limit imports of vehicles and components do not bring about a technological gap with respect to fuel efficiency.

/1 The effective rate of protection on motor vehicles in 1975 was estimated to be 718%. See World Bank (July 1981).

/2 In a statement of this basic objective, the Director General of Basic Industries told the press that by 1985/86 almost all components of commercial motor vehicle would be made domestically. See Kompas, January 26, 1982.

Table 2.5: PRODUCTION OF FOUR-WHEEL MOTOR VEHICLES IN INDONESIA (1976-80)

	1976	1977	1978	1979	1980
Sedans	23,498	12,853	15,373	14,610	22,607
Commercial vehicles /a	44,517	74,333	84,191	75,268	134,794
Multipurpose vehicles /b	6,759	6,049	6,049	9,023	17,561
Total	75,574	93,235	108,667	98,901	174,962

/a Includes pickups, minipickups, minibuses, buses, delivery vans, and trucks.
/b Jeeps.

Source: Directorate General of Basic Industries.

2.19 In implementing its programs for domestic manufacture of all vehicle components, GOI has developed plans to standardize engines. It is intended that there will be only four sizes- 900 cc, 1300 cc, 1600 cc, and 2000 cc - of gasoline engines and three sizes - 2500 cc, 4000 cc, and 5600 cc- of diesel engines. The purpose of this regulation is to rationalize production of engines, not to reduce the average size of engines and hence increase average fuel efficiency of the fleet. Indeed, the existing distribution of engine sizes, as shown for passenger cars in Table 2.6a and for trucks in Table 2.6b, includes very few either above or below the proposed range for future engines. Thus, the proposed regulation will not be directed toward fuel conservation and, assuming that fuels are eventually priced at their economic costs, should not be used for this purpose since consumer preferences should dictate the number of each engine size produced within a range consistent with an efficient industry structure.

Table 2.6a: DISTRIBUTION OF ENGINE SIZES AMONG SEDANS (1980)

Engine size	Percentage of production
Over 2000 cc	9.4
2000 cc ± 10%	28.8
1600 cc ± 10%	17.7
1300 cc ± 10%	34.8
Under 1000 cc	9.3

Table 2.6b: DISTRIBUTION OF ENGINE SIZES AMONG TRUCKS (1979)

Engine size	Percentage of production
Over 6400 cc	11.5
5600 ± 15%	11.0
4000 cc ± 15%	12.1
2500 cc ± 10%	64.0
Under 2250 cc	1.5

Sources: Directorate General of Basic Industries and Research and Technology Board.

2.20 Taxes on Vehicles. GOI taxes on vehicles are already designed to discourage purchase of private cars. The tax component of the total "on-the-road" price for a sedan is about 60% compared to 10-13% for various commercial vehicles. This basic tax policy seems entirely appropriate in order to retard the growth in the number of private cars and thereby limit the problems of urban traffic management and encourage use of public transport. However, further refinement of the tax structure might be considered. Specifically, consideration should be given, as suggested in the MOC report, to differentiation of the taxes on sedans in order to penalize larger engines and use of air conditioners. Also, the taxes on commercial vehicles should be reviewed in light not only of fuel conservation objectives, including the need to limit growth demand for diesel, but also of the objective of charging road users enough to cover at least maintenance of the road network./1 A useful step in this direction was taken in October 1982 when sale taxes on sedan, station wagons and multipurpose jeeps which have diesel engines were increased from 20% to 40% and on light commercial vehicles which have diesel engines, from 0% to 20%.

Road Infrastructure Improvements

2.21 Improvements in road and bridge infrastructure, including routine maintenance, rehabilitation, and pavement and bridge strengthening, can improve the fuel efficiency of the road subsector in two important ways: improving fuel efficiency in the operation of existing vehicles and enabling use of larger, heavier vehicles which carry more cargo per unit of fuel consumed.

/1 A consultant team financed by the World Bank under the Fifth Highway Project has been working with MOC on the issue of road user charges to identify measures to correct the apparent undertaxation of commercial vehicles. See Halcrow Fox and Associates, Inc. (1982).

2.22 Road improvements permit higher average speeds and thereby increase fuel efficiency up to about 40-50 miles per hour. The possible improvements in fuel efficiency from various categories of improvement can be estimated from the Vehicle Operating Cost model recently completed for GOI by consultants financed under the Bank's Fifth Highway Project./1 It is clear from this and similar research not only that the overall economic returns to investments in road infrastructure improvements can be quite high but also that a part of these returns is attributable to increased fuel efficiency. Since a substantial part of Indonesia's road network is in poor condition, significant benefits can be realized through a large program of improvements. Because most roads cannot now permit average speeds close to 40-50 mph and, following improvements, average speeds would approach but not exceed this level,/2 such improvements would (in addition to other benefits such as reduced vehicle depreciation and time savings) increase average fuel efficiency and generate net savings in fuel consumption by the vehicles using the road. Thus, a large investment in road improvements (especially the categories of "support works" and "betterment") should be viewed by GOI as an important part of its fuel conservation effort.

2.23 Road improvements which strengthen the capacity of pavements and bridges can increase fuel efficiency not only by increasing average speeds but also by making it economically feasible to permit heavier trucks which carry more cargo per unit of fuel consumption. Generally, because of legal regulations affecting vehicle importation, assembly and operation, the types of vehicles operating in Indonesia are small to medium sized. By comparison with other countries, the legal limits on axle loads, payloads, and gross vehicle weights are very low. Detailed studies have indicated that the economic value of reduced vehicle operating costs (including fuel consumption) would more than offset the cost of the necessary road improvements and maintenance./3 In other words, a concerted GOI effort both to encourage larger vehicles and to allocate the necessary resources for development and maintenance of an arterial road network to accommodate those larger vehicles would yield net economic benefits, including reduced fuel consumption. Detailed proposals for development of such a "strategic highway network" and corresponding changes in regulations affecting vehicle weights and dimensions have been prepared by GOI and consultants /4 and now require implementation. Development of this network and introduction of larger trucks would be a very important step toward improved fuel efficiency in the transport sector.

/1 Halcrow Fox and Associates, Inc. (1982).

/2 For some roads design speeds will exceed the level of maximum fuel efficiency, but even in these cases average operating speeds will be limited by roadside friction and safety considerations.

/3 See W.D. Scott and Co., etc. (June 1978) and Halcrow Fox and Associates, Inc. (1982).

/4 Halcrow Fox and Associates, Inc. (1982).

Development of the Railway Subsector

2.24 At present the railway subsector accounts for about 5.5% of nonlocal passenger travel and 4% of freight traffic on Java and less than 5% of passenger traffic and about 22% of freight traffic on Sumatra. It consumes only about 1% of the energy used in the transport sector as a whole. Because of the relative fuel efficiency of railways (estimated at 8.5 grams of fuel per ton-kilometer compared to 70 grams per ton-kilometer for trucks), fuel could be conserved if passenger and cargo were shifted from other modes, especially road, to rail.

2.25 The MOC report recommends that the role of the railways be stabilized and then expanded for both long-haul and commuter services through a program of improved services, rehabilitation and expansion of facilities, and better management. More specifically, it recommends double tracking of the main line between Jakarta and Surabaya in order to increase the volume and frequency of train traffic. To date, double tracking exists only for the approximately 75 km from Jakarta to Cikampek; engineering is underway for the portion from Cikampek to Cirebon; and feasibility studies are being done on the remainder of the route to Surabaya. The report notes that completion of the double tracking to Cirebon, assuming a diversion of 25% of the road traffic to rail, would save about 1.9 million liters of diesel per year. In addition to its focus on double tracking, GOI has been giving increasing consideration to electrifying the major rail lines.

2.26 With respect to the contribution of railways toward the goal of energy conservation, several general observations can be made. First, the relative attractiveness of alternative transport modes for specific cargos depends on many factors in addition to relative fuel efficiency. Railways may be an attractive mode for passengers or cargo whose origin and destination are relatively close to the rail line and which do not have special handling problems which require door-to-door delivery without transfers from truck to rail and back again. This is more likely the case for longer haul traffic. But the volume of such traffic for which rail is more attractive than road or other modes is not likely to change very much simply because fuel price increases shift transport costs slightly in favor of rail. In fact, the relative attractiveness of rail depends very much on the reliability and quality of service. The inability of the Indonesian railway PJKA to increase its share of passenger and freight traffic has been due not to the level of rail tariffs relative to those for road but to its poor service, and this is largely attributed to weak management. For this reason, the MOC report has focussed on the right problem: the railway can make its full contribution to energy conservation only when its management and hence its quality of service can be improved. Such measures must accompany, if not take precedence over, capital investment to expand the capacity of the railway network. Second, as in the case of any investment, investments in the railway cannot be evaluated solely in terms of fuel savings but must be justified by the overall economic rate of return. For example, the calculation of fuel savings from double tracking of the Cikampek-Cirebon line is rather useless information; it reveals very little about the total economic benefits of the investment or, more importantly, the benefit/cost ratio. It can be especially misleading to focus on the potential savings in petroleum consumption due to electrification of the rail line; electrification is a very capital-intensive investment which yields adequate rates of return only on very high-volume routes. Third, in the Indonesian setting, sea transport is often an alternative to both road and rail, and, by the simple measure of fuel consumption per tonkilometer, it is often more fuel efficient than either. Thus, in considering transport infrastructure investments which could contribute to fuel conservation, attention must also be given to developing sea transport capacities. For example, some freight movement along the northern coasts of Java or North Sumatra could perhaps be handled more economically by ship rather than rail provided that port facilities were adequately developed. The immediate implication of these possibilities is that GOI agencies and their consultants who are evaluating possible investments in port and railway infrastructure in these two areas, e.g., the feasibility for double tracking the northern railway line on Java, should develop mutually consistent expectations about the division of traffic among the alternative modes. This general approach has already being taken in the study of the transport requirements for estate products in North Sumatra which is being financed by the Bank. Fourth, fuel conservation can also be achieved by improved operations of the existing railway infrastructure. Specifically, unit trains are generally more fuel efficient than ordinary car loads. PJKA should therefore evaluate the use of unit trains (also called block trains) not only for fertilizer, as planned under the Bank-assisted National Fertilizer Distribution Project, but also for other bulk commodities such as cement. A study of the use of unit trains for such commodities, to be financed from the Fifth Technical Assistance Credit, has been agreed to between GOI and the Bank. Finally, it must be recognized that the railways are a very small part of the total Indonesian transport system, account for only 4% of Java's freight traffic, and consume less than 1% of energy in the sector. Even given optimistic assumptions about the shift in cargo from other modes to rail and about increasing the general efficiency of PJKA operations, the subsector can contribute very little to the general objective of fuel conservation.

Public Information and Technical Assistance

2.27 The fuel efficiency of road vehicles depends significantly on driver behavior and quality of vehicle maintenance, and there is therefore considerable potential for energy conservation through better operation of vehicles. Fuel can be saved by avoiding rapid acceleration and deceleration, keeping engine speeds (rpms) down, minimizing gear shifting, turning off the engine when appropriate, and not overfueling and thus spilling fuel. Experiments in France have indicated savings of up to 15% due simply to better driving techniques. Finally, proper maintenance contributes significantly to fuel efficiency. Tuneups can improve average fuel efficiency by 11%. Changing air filters can reduce fuel consumption by 1 to 15%; maintaining tire pressure, by 5 to 6%; and using better lubricating oil, by up to 8%./1 Changes in equipment or add-ons, e.g., radial tires and wind deflectors, can also increase fuel efficiency. As a whole, better operation of vehicles, which can often be achieved at relatively low cost, probably offers the most cost-effective means for energy conservation in the transport sector in Indonesia. The question is whether or not vehicle owners and operators are adequately aware of these potential savings and can therefore make cost-minimizing decisions about speeds, driver behavior, and maintenance. To the extent that they are not adequately aware of such possibilities, there is a need for government programs of information and technical assistance, which would be a useful complement to further increases in diesel prices.

2.28 The MOC report recommends an expanded program of instruction and information of both a general and technical nature directed toward vehicle owners, drivers, users of transport services, and the general public. It recommends that this program should be conducted through various media, including television, radio, stamps, newspapers, and billboards. Such a program has in fact been started through cooperation among the Ministries of Information, Mining and Energy, and Communications, but the report notes that it has not yet been institutionalized and needs to be expanded. It is also noted that Damri, the public bus company mentioned above, has begun a course to instruct its drivers on fuel-saving measures.

2.29 In designing and implementing such a program of information and instruction, it would seem essential to provide specific advice and information to well-defined "target groups." General advice to the public through TV, stamps, and billboards to conserve energy by driving properly, as suggested in the MOC report, will probably be quite ineffective, except to sensitize the public to a general policy problem. Instead of such a general, mass media approach, GOI should consider a program of providing detailed technical information to the most important target groups, i.e., owners and operators of commercial vehicles. As shown in the main report, trucks, buses, and commercially-operated passenger vehicles account for at least two thirds of fuel consumption in transport, and these commercial operators are probably more responsive to opportunities for fuel savings than owners of private passenger vehicles. In order to reach these target groups with useful information about cost-effective fuel saving measures, GOI should establish a team under the authority of BAKOREN which would:

(a) Undertake a survey of truck, bus, and taxi firms to determine their awareness of fuel saving measures and identify areas in which additional information and technical assistance might be useful; in this connection, it should be noted that consultants

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/1 These figures are cited in World Bank (1983).

(Halcrow Fox and Associates) working for the Ministry of Communications with financing from the World Bank have recently completed an extensive survey of truck and bus companies and this information, including addresses and background information on firms, should be utilized. The national association of trucking companies, Organda, should be involved in this effort from the beginning.

(b) Subject to the results of such a survey, prepare one or more technically oriented brochures for free distribution (especially through direct mailing) to commercial road transport firms which document possible fuel saving measures. Information should be as detailed as possible. For example, it might include specific maintenance procedures, their likely cost, and estimated benefits in terms of fuel conservation and reduced vehicle depreciation. It should not only detail the changes in driver behavior which can save fuel but also describe possible training and incentive programs which firms might undertake among their own drivers./1 It might include data on sources of supply and costs of add-ons such as wind deflectors and their potential fuel savings impact.

(c) It should consider establishing a small team of technical experts who would work with firms at their request to help implement driver training and improved maintenance programs. To ensure that the services of such a team are useful and desired by firms, its services should only be provided at a fee which covers its costs.

Other Conservation Measures

2.30 The MOC report mentions a number of other ways in which fuel conservation in the transport sector could be promoted. The proposed

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/1 It is important to give attention to the incentives for drivers to improve fuel efficiency. Better incentives may require changes in common industry practice. For example, trucking companies sometimes pay the driver (and crew) a commission of about 40% of the total transport tariff for a given shipment, and from this commission the driver pays for fuel himself. Similarly, taxi drivers often pay a fixed rental fee each day for use the taxi and must pay for fuel from their own earnings. In both cases, the firms which is responsible for maintenance would not be able to take advantage of any fuel savings from either improved maintenance or better driver behavior, and the drivers who could benefit from increased fuel efficiency do not have control over the maintenance program (except perhaps for tire pressures or other low-cost measures). This perverse incentive structure could only be changed if an agreement could be reached between firm owners and their drivers on a fair division of the savings from greater fuel efficiency.

measures are clearly important for many reasons in addition to their potential contributions to fuel conservation. These are: (a) extending the telephone network, which would allow some substitution of telephone communication for transport services; (b) improving the productivity of ports and thereby reducing the number of days in which ships must wait in port, during which time they continue to consume fuel; (c) preserving the role of traditional transport modes, including sailing vessels and animal-drawn carts in rural areas; and (d) planning urban growth with a view toward rationalizing the centers of activity and utilizing high rise buildings in order to reduce the need for urban transport.

2.31 Development plans for expansion of the telephone network and for improvement in port operations are already well underway in the ministries concerned. With respect to the latter two areas, there is need for clear definition of practical steps to be taken. Regarding promotion of traditional modes of transport, the MOC report notes that there is now underway work on appropriate technologies for rural transport and work within BPPT on the design of a large (about 2,000 DWT) sailing vessel. In addition to these efforts, GOI might consider the following: (a) severe limitation of the Perintis shipping services to those routes which cannot be served adequately by motorized sailing vessels; the substantial subsidy to the Perintis services could otherwise undercut the role of traditional craft; and (b) review among Bina Marga, the Directorate for Urban and Regional Planning, and the Directorate General of Land Communications of the current standard designs for both urban and nonurban roads with regard to their capacity to carry traditional, nonmotorized vehicles without undue interference with the motor vehicle traffic. Such a review should consider the standards for road shoulders and the possibilities for dedicated lanes for bicycles, becak, or other nonmotorized traffic in urban areas. Regarding the implications of urban planning for energy conservation, GOI should consider organizing a seminar under the joint leadership of the Director for Urban and Regional Planning and the JABOTABEK planning team to consider papers on this topic from Indonesian and international specialists. Such a seminar might generate ideas which could be used in future planning of urban growth in Jakarta and elsewhere to enhance the fuel efficiency of Indonesian cities. In fact, such a seminar was held at the Bandung Institute of Technology in May 1982 and the work of the seminar should be reviewed within GOI.

Conclusion

2.32 There are two final observations which should be highlighted. First, many of the investments which would encourage fuel conservation in the sector - urban traffic management, urban public transport, road infrastructure improvement, railway development - must be evaluated and justified in terms of overall economic rate of return, not in terms of fuel savings alone. In some cases, an investment might result in fuel savings but still _not_ be worthwhile economically. This would seem especially likely for certain elements of railway development. In other situations, fuel savings will be only one of the benefits derived from an investment, and, given that the value of such savings is correctly determined based on economic prices for fuel, such savings need not be given any special weight in the evaluation of these investments. In summary, despite the importance of fuel conservation for Indonesia, an "energy standard" must not replace economic criteria for investment decisions. Second, many of the measures to conserve fuel in the transport sector involve rather difficult implementation problems. Improving urban traffic management will require more than a policy decision at the national level; it will involve building up the technical and financial capacity of several city governments to identify and carry out investment programs. Realizing the potential for greater fuel efficiency in truck and bus operations will require a well organized program of information and technical assistance to at least hundreds of private companies. Expanding urban public transport will demand improved management of the public bus companies. Developing a highway network suitable for larger trucks and building those trucks will require close cooperation among several ministries and the private sector. Therefore, now that GOI has identified broad measures for conservation, as summarized in the MOC report, detailed attention must be given to defining an implementation strategy for these measures.

CHAPTER 3. ALTERNATIVE FUELS FOR THE TRANSPORT SECTOR

Introduction

3.01 Diversification of Indonesia's sources of energy is a major GOI objective. This is motivated by recognition that, given the current growth rate of domestic consumption of petroleum products and the likelihood of a relatively constant level of petroleum production, the exportable surplus of petroleum will decrease through the 1980s. Indonesia has abundant potential for other energy sources, including coal, natural gas, hydro power, fuelwood, and biomass. By greater exploitation of these sources, GOI seeks to satisfy domestic demand for energy while maintaining a high level of petroleum exports.

3.02 The transport sector requires liquid fuels suitable for internal combustion engines./1 For this reason, the number of technically feasible substitutes for petroleum products is smaller in the transport sector than in the household, power, and industrial sectors, which can utilize coal,

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/1 Possible exceptions are railways which could be electrified and locomotives and ships which could use coal for steam engines. However, the railway accounts for a small part of energy use in Indonesia, and electrification of a rail line is economically justified only for very high volume routes. Also, conversion of locomotives and ship engines to coal-fired steam engines is not considered a viable option.

hydro or geothermal power, natural gas at atmospheric pressure, and/or fuelwood. Alternative fuels which might be feasible in the transport sector are liquefied petroleum gas (LPG), ethanol, methanol, and gasoline from natural gas liquids (NGL)./1 This chapter will examine the economic attractiveness of these alternative fuels. It must be emphasized that there is considerable uncertainty about the economic aspects of these fuels. The estimates and assessments included here are preliminary and are therefore useful primarily to help establish priorities and issues for detailed study. Discussion of the technical aspects of these fuels is minimal, as this information can be found in many other documents./2

General Framework for Evaluation of Alternative Fuels

3.03 The objective of energy diversification must not be interpreted to mean that any technically feasible substitute for domestic uses of petroleum should be utilized. Alternatives should be exploited only if and when they make possible a lower cost transport system than petroleum products. The system cost involves not only the fuel itself but also the associated vehicles and fuel distribution and marketing system. For each of the alternative fuels, it is therefore necessary to consider two questions. First, what is likely to be its economic price in the medium to long run relative to the economic price of the petroleum product(s) it could replace? To the extent possible, prices must be defined with respect to location, i.e., taking into account transport costs, since this factor varies among the fuels considered. Second, what costs (or savings) are involved in adjustments, conversion, or replacement of vehicles to use the alternative fuel and in the creation of a distribution system for the new fuel? Such costs will vary depending on the categories of vehicles involved. In addition to these economic questions, it is necessary to consider what institutional arrangements are required to develop and introduce the alternative fuel. Finally, in view of the current GOI pricing policies which involve substantial subsidies for some petroleum products, consideration must be given to an appropriate domestic pricing policy for each alternative fuel.

LPG

3.04 Technical Aspects./3 LPG is a mixture of propane and butane, which can be easily liquefied by compression and/or cooling. LPG is produced in two ways: when processing crude oil in refineries and by extraction from

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/1 Compressed natural gas (CNG) is a technically feasible transport fuel and shows considerable economic promise for areas served by natural gas pipelines. Therefore, the potential for CNG as a transport fuel should be considered in any studies of the economic viability pipelines in Indonesia.

/2 See especially World Bank (November 1981b), World Bank (September 1980) and World Bank (April 1982).

/3 See World Bank (November 1981b).

natural and associated gas. Vehicles with spark-ignition, gasoline engines are easily modified for LPG use by addition of a pressurized tank, a fuel shut-off solenoid value, and an evaporator-pressure regulator and by adjustment of the gas-air mixture in the carburetor. Vehicles with diesel engines can use LPG only as an extender, replacing about 35% of the diesel fuel. Compared to gasoline and diesel fuels, LPG produces very low emissions, which is especially valuable in cities with air pollution problems, and reduces engine wear. Distribution requires specialized refueling stations consisting of a bulk pressure storage tank, a metering system, service or filling lines, and auxiliary equipment such a fire protection equipment. LPG can be transported overland by tank truck or rail car. For ocean transport, it is most economical to transport large quantities (over 35,000 tons) at atmospheric pressure in refrigerated storage tanks.

3.05 Economic Aspects. Indonesia has the potential to become a substantial producer and exporter of LPG. Current production of LPG from Pertamina's refineries and gas plants is about 8,950 thousand barrels per year, of which all but about 700 thousand barrels are exported. Given GOI plans to expand domestic refinery capacity, the domestic production capacity for LPG will grow very rapidly in the coming years. Table 3.1 provides estimates of LPG production from Pertamina's refineries and gas plants. The LPG output from the new refineries - about 5,200,000 barrels (beginning in 1985) - has apparently been committed for export to Japan./1 In addition, there is a very large potential for LPG from separation plants associated with the existing and new LNG trains. The World Bank (November 1981a) estimates that LPG output from such plants in 1988 could reach 35 million barrels, while BPPT (1980) estimates that output in 1984 could be 105 million barrels and in 1993, 175 million barrels (including 70 million barrels from the Natuna field).

Table 3.1: PLANNED LPG PRODUCTION BY PERTAMINA /a
(Thousands of Barrels)

Year	From existing refineries	From Rantan, P. Brandan, and Mundu gas plants	From three new refineries /b	From Santan & Arjuna gas plants (for export) /c	Total production
1980	431	397	-	8,122	8,950
1982	528	1,860	-	5,542	7,931
1985	528	1,860	5,209	2,982	10,579
1990	528	1,860	5,209	950	8,547

/a Source: BPPT (1980), Table 5-6.
/b At Balikpapan, Cilacap, and Dumai.
/c These quantities are committed for export.

/1 See The Jakarta Post, May 24, 1983.

3.06 The future export price of LPG (fob Indonesia), which would be the opportunity cost for domestic use of LPG, is somewhat uncertain. World LPG production is expected to increase dramatically during the 1980s, with world export availabilities increasing from about 15 million tons (174 million barrels) in 1978 to as much as 55 million tons (638 million barrels) in the late 1980s, of which the largest quantities will come from the Middle East./1 Thus, the future price of LPG relative to other petroleum products will depend on how quickly this increased production can be absorbed both in traditional uses (residential heating and cooking, chemical feedstock, gasoline blending, and industrial uses) and in transport.

3.07 However, it is reasonable to expect that, based on its substitutability for naphtha as a petrochemical feedstock, the LPG price in major importing countries such as Japan will not fall below 90% of the price of naphtha./2 In fact, in the first six months of 1982 when LPG prices have been relatively weak, the average import price of LPG in Japan ($273/ton) was 91% of the average cif price for naphtha ($301/ton) on a weight basis. Under the most favorable scenario with respect to the development of LPG marketing systems for use as a heating fuel, its price could not rise above that of gas oil on an energy equivalent basis. Based on the price of gas oil in Japan in the first half of 1982, this ceiling price for LPG could be $389/ton. More realistically, the future price of LPG cif Japan is assumed to be in the range of 90-110% of the naphtha price on a weight basis, i.e., $271 to $331 per ton in mid-1982. Given that Japan is the likely market for Indonesian LPG exports and that LPG transport cost from Indonesia to Japan is approximately $35/ton, this implies an LPG price f.o.b. Indonesia in the range of $236 to $296 per ton, which is equivalent to $0.128 - $0.160 per liter. Assuming that upon completion of the new refineries, Indonesia becomes a marginal exporter of gasoline and remains an importer of diesel, and assuming that real prices for petroleum products and the relative product prices at that time are the same as those in mid-1982, it is estimated that the f.o.b Indonesia gasoline price will be $0.25/liter and the c.i.f. Indonesia diesel price, $0.29/liter./3 Thus, on a volume basis, LPG is likely to be considerably cheaper than gasoline or diesel.

/1 See Shell Briefing Service (October 1979) and World Gas Reports (November 9, 1981).

/2 See Chem Systems International, Inc. and Davy McKee, (March 1982).

/3 It is assumed that f.o.b. Indonesia gasoline price is equal to fob Singapore price for regular gasoline, and that cif Indonesia diesel price is 5% above f.o.b. Singapore price.

3.08 However, one liter of LPG cannot substitute for one liter of gasoline or diesel in automotive use. On a performance basis, 1.15 liters of LPG is equivalent to 1 liter of gasoline and 1.33 liters of LPG, to 1 liter of diesel fuel./1 Thus, based on the projected price relationships discussed above, the quantity of LPG necessary to replace 1 liter of gasoline for transport (i.e., a liter equivalent) will cost roughly $0.07 - 0.10 less than gasoline, and the quantity of LPG necessary to replace 1 liter of diesel, roughly $0.04 - 0.07 less than diesel.

3.09 The lower cost of LPG as an automotive fuel would appear to justify the necessary investments in new vehicles and LPG refueling stations only for fleet vehicles such as taxis and buses which are heavily utilized and can make use of a few, centrally-located refueling stations. For illustration, Table 3.2 shows very rough estimates of the costs and benefits associated with replacement of 1,000 gasoline taxis and 1,000 diesel buses in Jakarta by LPG vehicles. The key assumptions are that (a) LPG-fueled vehicles are used to replace fully depreciated vehicles which have no salvage value;/2 (b) a new LPG-fueled taxi can be purchased in Japan for $500 more than a comparable gasoline-fueled taxi;/3 (c) a new LPG-fueled bus can be purchased for $1,000 more than a comparable diesel bus;/4 (d) all vehicles have a life of 7 years; (e) LPG refueling stations can be constructed at a cost of $3 per liter/day capacity for stations over 1,300 liters/day capacity and can be operated for the same cost as conventional refueling stations;/5 and (f) the additional costs of training mechanics and others to

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/1 See Chem Systems International, Inc., (June 1982 Revised). On an energy equivalent basis, about 1.35 liters of LPG is equivalent to 1 liter of gasoline and about 1.47 liters of LPG, to 1 liter diesel fuel. However, because of other characteristics, LPG is more efficient than its relative energy content suggests.

/2 In fact, a substantial part of the taxi and bus fleets in Jakarta are old and will need to be replaced rather soon.

/3 World Bank (November 1981b) indicates that Nissan, Toyota, and Mazda are marketing o.e.m. passenger vehicles at price differences from 1% to 9% above the comparable gasoline version. Thus, the extra cost of LPG taxis may be lower than the $500 figure used here.

/4 World Bank (November 1981b) indicates that International Harvester offers o.e.m. LPG systems for medium trucks and school buses for an extra cost of $1,300-1,400 (retail). Other sources indicate that LPG-fueled buses are available from European producers at no more than the price of a comparable diesel bus.

/5 See World Bank (November 1981b).

operate the LPG system is just offset by savings due to reductions in lubricating oil consumption and in frequency of maintenance associated with LPG vehicles./1 Under these assumptions, the economic rate of return on replacement of old taxis and buses by LPG-fueled vehicles appears to be very high (40%-80% as shown). However, the potential consumption of LPG among urban taxi and bus fleets in Indonesia would not be large relative to projected domestic production. For 1,000 taxis, annual consumption would be about 34,000 barrels per year; and for 1,000 buses, 105,000 barrels per year. Even if the entire taxi and urban bus fleet of Indonesia were eventually replaced by LPG-fueled vehicles (about 6,000 taxis and 5,000 buses by 1983/84; see Tables 2.3 and 2.4), their LPG consumption would be only about 7% of the projected production of Pertamina refineries alone.

3.10 Significant expansion of LPG use beyond the commercial vehicle fleets in the major urban areas would not, however, show such high rates of returns because the fuel savings for a reduced number of kilometers per vehicle-year would be smaller and the cost of establishing and supplying a more dispersed network of refueling stations would be higher. For example, replacement of private passenger cars by LPG-fueled vehicles which travel only 20,000 km/year would have a rate of return of about 17%./2 Conversion of existing vehicles to LPG use would show significantly lower rates of return, i.e., about 10%, because the cost of conversion is likely to be much higher (perhaps $1,000 per vehicle) than the additional cost for LPG equipment on a new vehicle./3 As replacement vehicles alone would not be enough to justify establishment of a widely dispersed distribution system, and conversion of vehicles is not economically attractive, it appears that LPG use as an automotive fuel should in the coming years be economically attractive only for some commercial, urban fleets.

/1 It is estimated that lubricating oil costs for LPG engines may be reduced by as much as 80% compared to gasoline fueled engines, that spark plugs will last four to five times longer than with gasoline engines, and that maintenance time and hence downtime is reduced due to less engine wear. See Joyce (1980).

/2 This assumes that the per vehicle cost of refueling stations is three times that shown in Table 3.2 and the gasoline-LPG price differential is $0.07 per liter equivalent.

/3 Typical equipment cost of conversion of a small passenger vehicle to a dual fuel system are $750± 100, and installation costs would add several hundred dollars per vehicle. See World Bank (November 1981b).

Table 3.2: ECONOMIC ANALYSIS OF LPG TAXI AND BUS FLEETS
($'000)

	1,000 taxis	1,000 buses
	------ $'000 ------	
Incremental Capital Costs ($'000)		
Vehicles /a	500	1,000
Refueling stations /b	48 /c	150 /d
Annual Reduction in Fuel Costs ($'000)		
For gasoline substitution		
at $.07/liter equivalent savings	329	-
at $.10/liter equivalent savings	470	-
For diesel substitution		
at $.04/liter equivalent savings	-	500
at $.07/liter equivalent savings	-	875
	------ percent ------	
Internal Rate of Return (%) /e		
For gasoline substitution		
at $.07/liter equivalent savings	57	-
at $.11/liter equivalent savings	84	-
For diesel substitution		
at $.07/liter equivalent savings		39
at $.11/liter equivalent savings		74

/a Assumes that LPG-fueled taxis cost $500/vehicle more than gasoline-fueled and LPG-fueled buses cost $1,000/vehicle more than diesel-fueled. See World Bank (November 1981b).

/b Assumes that new refueling station costs $3 per liter/day capacity for stations with capacity over 1,300 liters/day. See World Bank (November 1981b).

/c Assumes that each taxi travels 40,000 km per year and consumes the equivalent of one liter gasoline per 8.5 km. This implies 4,705 liters equivalent or 5,412 liters LPG/ year/taxi or (given 330 days of operation per year) about 16 liters/day/taxi or 16,000 liters/day for a fleet of 1,000 taxis.

/d Assumes that each bus travels 50,000 km per year and consumes the equivalent of one liter of diesel per 4 km. This implies 12,500 liters equivalent or 16,625 liters LPG/year/ bus or (given 330 days of operation per year) about 50 liters/ day/bus or 50,000 liters/day for a fleet of 1,000 buses.

/e Over 7 year life of vehicles and neglecting remaining value of refueling stations.

3.11 Institutional and Pricing Issues. GOI and Pertamina have regarded LPG as a "luxury" fuel consumed by upper-income groups and hence subject to a substantial implicit tax. In 1982 the official domestic price of LPG was about equal, in terms of energy content, to that of premium gasoline and is far above the prices for automotive diesel and kerosene, as shown in Table 3.3. Following the January 1983 price increases for other products, at which time it was decided to leave the LPG price unchanged, LPG is still more expensive than kerosene but less expensive than gasoline. Total domestic sales at this price in 1981 were about 71,000 tons (823,000 barrels). To the extent that future production increases exceed irrevocable long-term commitments for export, it will be necessary to make a policy decision about how to utilize these additional quantities. Considering the relative prices estimated in para. 3.07 above, it would be economically desirable to substitute LPG for other petroleum products, and this would require lowering its domestic price. The key issue is where to set the LPG price relative to the prices for gasoline, diesel, and kerosene for which it is a potential substitute. Specifically, should it be priced competitively with kerosene in order to penetrate the household market, competitively with diesel in order to promote its use among vehicles now using diesel engines, or competitively with gasoline? Before discussing the issue in detail, it is important to recognize that the issue arises only because the relative prices in the domestic market are now far out of line with those in the world market. Until that situation is corrected, it will necessarily be impossible to select a domestic LPG price which provides the correct incentive for substitution of LPG in uses for which it is economically advantageous, and at the same time discourages uses for which it is not economically advantageous. Furthermore, it must be noted that the subsidies now given to diesel and kerosene are likely to be reduced in coming years, and therefore decisions about LPG pricing must be taken with a view toward likely changes in the domestic prices of its substitutes.

Table 3.3: 1982 DOMESTIC PRICES FOR LPG AND ITS SUBSTITUTES
(Rp)

	Official price per liter		Price per million BTU	
	1982	1983	1982	1983
LPG /b	179	179	7,068	7,068
Kerosene				
Wholesale	60	100	1,705	2,841
Estimated retail	100	160	2,841	4,546
Automotive diesel /a	85	145	2,428	4,142
Premium gasoline /a	240	320	7,176	9,568

/a At retail level.
/b Derived from Rp 4, 300/13 kg bottle.

3.12 Because the potential market for LPG as an economical substitute for kerosene is so large, it is probably most desirable to price LPG competitively with kerosene. Based on the methodology and assumption discussed above in para. 3.07, the projected import price of kerosene in the mid-1980s is $370/ton, compared to the projected LPG fob price of $271-296. Even if the distribution costs for LPG in urban markets is several times that for kerosene, LPG promises to be the more economical household fuel./1 The quantity which could potentially be absorbed in the urban household market is quite large. For example, if LPG could replace only 10% of kerosene consumption in the six major cities of Jakarta, Surabaya, Medan, Palembang, Semarang and Ujung Pandang, total sales would be about 489,000 tons (5.7 million barrels)./2 This is almost equal to total projected domestic production by Pertamina in the mid-1980s and about ten times the most optimistic forecast of economically attractive uses in the transport sector (see para. 3.09). Furthermore, the budget implications of substituting LPG for kerosene would be quite favorable. Even if LPG had been priced at Rp 70/liter at the retail level to match the 1982 subsidized price of kerosene, it could probably incur no financial loss, compared to the financial loss of about Rp 76/liter of kerosene./3 Thus, the net gain to the public treasury for replacing kerosene by LPG would have been at least Rp 76/liter of kerosene, and, if total sales of LPG equaled 489,000 tons as noted above, the total gain to the public treasury would have been about Rp 36 billion, equivalent to about 5% of the 1982/83 budget subsidy for kerosene and about 4% of the subsidy for all petroleum products. Of course, these budget savings from LPG would decrease as the subsidy on kerosene is reduced.

/1 See World Bank (November 1981a).

/2 See LEMIGAS (1981).

/3 As of January 1982 the kerosene price at the wholesale level is Rp 60/liter. It is assumed that average retail price is about Rp 100/liter. Since 1.4 liters of LPG is required to replace 1 liter of kerosene, the equivalent LPG retail price would be about Rp 70/liter. The budget subsidy per unit of kerosene is based on the aggregate budget subsidy and sales data from the main report. Note that for each liter of kerosene displaced, 1.4 liters of LPG would be sold. On the domestic production and marketing cost of LPG, LEMIGAS (1981) reports these costs to be Rp 51/liter, indicating that LPG would be financially profitable even at Rp 70/liter. But this estimate seems unrealistically low.

3.13 However, if LPG is priced competitively with kerosene at the 1983 subsidized levels, i.e., at about Rp 115/liter, this would likely encourage greater substitution of LPG for gasoline in the transport sector than would be economically advantageous. Given Premium gasoline at Rp 320/liter, replacement of gasoline-engine commercial vehicles by LPG-fueled vehicles in some urban areas would probably be financially attractive if LPG were priced at about Rp 275/liter./1 However, if LPG were priced to substitute for kerosene in household use, and given the impossibility of operating a discriminatory pricing system with such wide differentials among users, then it would become financially attractive to use LPG-fueled vehicles even in cases in which it is not economically advantageous to the country. Therefore, if GOI chooses in the mid-1980s to price LPG competitively with kerosene and the kerosene subsidy remains large, it should consider steps to prevent the uneconomic use of LPG for transport. Such steps might include: (a) a high import duty or annual registration fee on LPG-fueled vehicles or conversion kits designed to limit LPG use to those situations in which it is economically as well as financially attractive; (b) a limit on permits to establish LPG refueling stations (which would necessarily have to be licensed in order to enforce safety standards) which would discourage such establishment for fleets which cannot economically utilize LPG; and (c) a clear policy announcement that prices of LPG will be progressively increased as kerosene prices are increased up to estimated medium-term border prices.

3.14 With respect to the possible substitution of LPG for diesel, there is not necessarily a problem. Given the 1983 automotive diesel price of Rp 145/liter, replacement of diesel-engine commercial vehicles in urban areas would probably be financially attractive if LPG were priced at no more than about Rp 100/liter. Thus, an LPG price at Rp 115/liter designed to promote household use would not provide enough incentive for substitution of LPG for diesel. If the current ratio of diesel to kerosene prices is maintained and if LPG is priced competitively with kerosene, then, even as the subsidies for kerosene and diesel are reduced, there will still be insufficient incentive for LPG use to replace diesel. However, if the diesel price is increased more rapidly than the kerosene price, as recommended in the main report, LPG priced competitively with kerosene would also become attractive as a substitute for diesel. Given the limits on increasing the diesel to kerosene price ratio, it seems unlikely that LPG could be priced so cheaply relative to diesel to encourage uneconomic substitutions as suggested above with respect to gasoline.

3.15 In addition to pricing issues, GOI must consider appropriate institutional arrangements for utilization of LPG in the transport sector.

/1 This Rp 45/liter differential is equivalent to $0.07/liter, which, based on the assumptions used in Table 3.2, should generate sufficient savings in fuel costs to justify the additional investments in vehicles and refueling stations.

Among the questions which must be addressed are: should Pertamina build and operate refueling stations or should this be done only by the owners of commercial fleets which plan to utilize LPG? should GOI provide multi-year price guarantees to fleet operators who plan to use LPG-fueled vehicles? should LPG-fueled vehicles be exempted from the ban on the importation of assembled vehicles? Detailed consideration of such questions is beyond the scope of this paper and, in any case, need not be finally answered until large quantities of LPG will become available for domestic use. In the meantime, a detailed study of the possibilities for LPG can be undertaken. A study of the feasibility of LPG in Indonesia, which will be financed from the Fifth Technical Assistance Credit, is now underway.

Ethanol

3.16 Technical Aspects./1 Ethanol (or alcohol) can be produced from three main types of biomass raw materials: (a) sugar-bearing materials (such as sugarcane, molasses, sweet sorghum, etc.) which contain carbohydrates in sugar form; (b) starches (such as cassava, corn, potatoes, etc.), which contain carbohydrates in starch form; and (c) celluloses (such as wood, agricultural residues, etc.) for which the carbohydrate molecular form is more complex. Production of ethanol from these materials includes first (except in the case of sugars) conversion of carbohydrates into water soluble sugars, then fermentation of these sugars into ethanol, and finally separation of ethanol from water and other fermentation products by distillation. Ethanol can be used as automobile fuel either as "gasohol" in which case anhydrous ethanol (99.8%) is mixed with gasoline up to 20% ratio, or as hydrous or straight alcohol, in which case 94% ethanol (6% water) is used alone. As gasohol it can be used in existing internal combustion automobile engines without any modifications; cars obtain substantially the same mileage performance whether they are run on gasohol or on regular gasoline. For use as a straight fuel in spark-ignition engines, modifications to the cylinder head, calibration of the carburetor, changes in the pre-heating and ignition system as well as materials of construction of the fuel system are required. At present, it does not appear technically feasible to blend ethanol with diesel for compression-ignition engines.

3.17 Economic Aspects. The economic value of ethanol blended in gasoline (i.e., in gasohol) is the equivalent of the economic value of the gasoline since existing spark-ignition engines can use it without any modification and gasohol is distributed through the existing marketing network. Care must be taken, however, to prevent water from getting into the fuel as this may cause "phase separation" of ethanol and gasoline and affect engine performance. The economic attractiveness of gasohol thus depends entirely on the economic cost of ethanol production relative to the

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/1 For further details on the technical aspects, see "World Bank (September 1980) and Institute of Energy Economics (1981).

price of gasoline. This production cost can vary significantly depending on the economic cost of plant construction in a given site, the costs of the plant's inputs (including fuel for heat generation), and the number of plant operating days per year. Thus, the economic viability of ethanol production can only be assessed based on detailed information about a specific project. However, it is useful to consider calculations based on approximate values. Table 3.4 presents illustrative calculations of the biomass input price associated with a 10% economic rate of return given certain assumptions about plant size and costs, operating days, and gasoline prices.

Table 3.4: ILLUSTRATIVE CALCULATIONS OF ECONOMICS OF ETHANOL PRODUCTION /a

	Unit	Molasses	Sugarcane	Cassava
Installed cost of 120,000 liters/day plant /b	US$ million	7.6	9.5	11.4
Operating days per year		180	180	275
Ex-plant Raw Material Cost for 10% ERR /c				
At $31/bbl	US$/ton	62	14	13
At $35/bbl	US$/ton	70	16	17
At $43/bbl	US$/ton	85	20	23

/a Derived from World Bank (September 1980), Table 15.
/b For "medium capital cost country." All costs in late-1979 dollars.
/c Assuming ethanol value equal to that of gasoline in volume terms. Gasoline price assumed as 1.3 times that of ex-refinery light Arabian crude price, by volume; this relationship assumed to go down with increased petroleum prices. Crude price assumed to increase at 3% per year in real terms, gasoline price at 2.5% per year, and raw material price at 1% per year.

3.18 As shown in this table, an ethanol plant based on molasses would likely yield an economic rate of return of at least 10% only if (a) the economic price of gasoline were about $0.30/liter (Rp. 187/liter, which is derived from $35/ton crude and increased in real terms at 2.5% per year, and (b) the cost of molasses at the plant was no more than $70/ton. Given current expectations for world market prices in coming years and given the fact that upon completion of the new refineries, Indonesia will become self-sufficient in gasoline, it is unlikely that gasoline and hence ethanol will be worth as much as assumed in these calculations. The price of molasses at Java plants was well below this level throughout the late 1970s, increased to over $100/ton in 1980 and 1981, but has now fallen again below $70/ton. In fact, in 1982 the export price fell sharply to under $20/ton. Thus, ethanol production from molasses might be economically viable only if long-term, average molasses prices can be expected to remain at or below present levels or gasoline prices were higher than presently expected. With respect to sugar cane, its average economic value on Java is estimated to be over $25/ton (in 1981 dollars) based on a long-run world price of $0.17/lb (fob Caribbean), estimated processing costs of about $180/ton of sugar, and an input of 10 tons of cane per ton of sugar. Thus, if world sugar prices recover to the projected level, it appears that ethanol production from sugar in Indonesia will not be attractive. In the case of cassava, the farm gate price varies greatly depending primarily on transport costs to major markets, including export points. In areas of South Sumatra reasonably well served by transport facilities, but rather far from the processing plants and export terminals in South Lampung, the farm gate price is now about Rp 10/kg, or $16/ton./1 Based on Table 3.4, ethanol production from cassava would be marginally viable in such areas at this input price given crude oil prices at $35/ton.

3.19 Based on these data, it is possible to generalize that ethanol production might be economically attractive only in the most favorable circumstances with respect to plant size and cost, the economic cost of inputs, the operational efficiency of the plant, and the future economic price of gasoline in Indonesia./2 Two circumstances appear to deserve close study. First, ethanol production may be viable in relatively isolated areas, especially transmigration areas, where the opportunity cost of cassava and/or sweet potato is very low due to transport costs to market outlets. In such situations, the cost of fuelwood for the plant is also likely to be low. Second, it may be viable on Java if the world molasses price remains at or below present levels and the number of operating days of the plant can be maximized. However, in both circumstances, economical production of ethanol would require a very well-organized and efficient effort to develop a reliable supply of inputs throughout the year. In this sense, such projects would be management intensive. Furthermore, it should be noted that the total output from plants which could possibly produce ethanol for fuel economically would be small relative to total Indonesian gasoline consumption.

/1 This is based on prices at Baturaja transmigration project in South Sumatra in late 1981.

/2 In 1980, prices from factories on Java producing ethanol for use in spirits ranged from about Rp. 500-850 per liter, which is two and a half to four times the economic price of gasoline. See Workshop on Ethanol as an Alternative Source of Fuel (1981).

3.20 It might be argued that ethanol plants in transmigration areas are justified by their contributions to employment and income even if they operate at a financial loss. The question is whether or not the construction and operation of an ethanol plant in a given transmigration area is a more cost-effective means to generate employment and income than alternatives. For example, rather than invest in the ethanol plant and cover its financial losses for many years, it may be preferable for GOI to invest in tree crop establishment or to subsidize fertilizer and agricultural chemicals more heavily and for a longer period than otherwise. Justification of an ethanol plant on the basis of employment and income effects therefore should not be accepted without careful study of such alternatives.

3.21 Current GOI Program. GOI has embarked on a program of research and development of ethanol as an automotive fuel. Since mid-1981 BPPT in cooperation with the Faculty of Technology at the University of Brawidjaja in Malang has conducted tests of vehicles fueled by gasohol. Quite significantly, tests of a 20% blend of hydrous ethanol have shown that "phase separation" does not appear to be a problem given the high ambient air temperatures in Indonesia. This could lower the cost of gasohol, since hydrous ethanol can be produced more cheaply than anhydrous ethanol. Construction has begun on an ethanol pilot plant (15,000 liters/day capacity) at Tulang Bawang in South Sumatra to be completed in 1987. A biomass energy and development center in Sulusban Lampung, utilizing a Japanese government grant of about $7 million, has been virtually completed; it includes a plant to produce 8,000 liters/day of ethanol. The plant will produce ethanol from cassava and sweet potato. Bilateral contacts have been established with other countries.

3.22 Institutional and Pricing Issues. In its discussion of ethanol development to date, GOI seems to have focussed primarily on production in transmigration areas in which the opportunity cost of cassava, sweet potato, and fuel wood is low. This seems entirely appropriate, especially since most transmigrants need additional sources of cash income. In implementing pilot and eventually larger-scale projects in such areas, it is critical that GOI be able to monitor carefully the full costs of the projects and their operational efficiency so as to determine correctly their economic viability. It will also be necessary to establish institutional arrangements which provide maximum incentive for efficiency, and the issues of institutional and management arrangements should be considered within GOI at an early stage in the program. In this regard, the key question is whether or not Pertamina, which necessarily will be the distributor for gasohol through its existing marketing system, should also be the producer of ethanol. There are both advantages and disadvantages of Pertamina as the major producer of ethanol. On the one hand, if Pertamina - perhaps through a subsidiary - were the owner and operator of ethanol plants, it could give full attention to technical aspects which are important for marketing, especially controlling the purity of ethanol, and to the implications of ethanol production for desired output from petroleum refineries./1 On the other hand, smaller companies may devote closer attention to the complex management tasks of ethanol production, which would necessarily be a minor element in Pertamina's overall operations, and might therefore be more efficient. If GOI does choose to encourage private companies, or a public company other than Pertamina, to enter into ethanol production,/2 it would of course be necessary for Pertamina to offer a long-term contract for the purchase of the ethanol. GOI and Pertamina would have to decide whether or not such a contract should offer a fixed long-term price, which would be approximately equal to the current or projected price of gasoline. Alternatively, the ethanol producer would bear the risk that world gasoline prices and thus the value of ethanol to Pertamina would fluctuate significantly during the life of the plant. Since this risk could be substantial and would greatly discourage private investment in ethanol production, it would seem useful for GOI to provide a "safety net" to prospective production in the form of a guaranteed minimum price for ethanol. However, this guaranteed price should be no higher than the medium-term price projected for gasoline.

Methanol /3

3.23 Technical Aspects. In addition to its traditional uses as a chemical feedstock, especially for production of formaldehyde, methanol can be used as a transport fuel in several ways. As a partial replacement for petroleum-based gasoline in spark-ignition engines, methanol can be used for: (a) low-level (up to 4-5%) methanol/gasoline blending; (b) high-level (up to 15-20%) methanol/gasoline blending; (c) straight methanol fuel (85-100%); (d) raw material for high-octane gasoline additives, especially methyl tertiary butyl ether (MBTE); and (e) raw material for gasoline production. Low-levels blends require no engine modifications or parts replacement and can be marketed through the existing distribution system. High-level blends require minor engine adjustments, replacement of corrodable engine parts, and modifications to the distribution system. Straight methanol fuel can be used only with specially designed engines and an additional commercial distribution system. The additive MBTE can be blended in amounts up to 10-11% into conventional gasoline to boost octane ratings. Methanol can also be used in low-level blends with diesel for compression-ignition engines, but this involves significant engine modifications and performance losses.

/1 If ethanol were available in large quantities, refinery configurations would be changed to decrease total gasoline output and reduce the average octane number of that output.

/2 There were 10 companies producing alcohol for non-fuel uses in Indonesia in 1980. See The Institute of Energy Economics (1981).

/3 This section is based primarily on World Bank (April 1982).

3.24 Economic Aspects. Because of its abundant natural gas resources, Indonesia can likely produce methanol at a price competitive with world market prices. GOI has already contracted to build a natural gas-based methanol plant on Bunyu Island, East Kalimantan, with a capacity of about 300,000 tons/year at an estimated cost of $340 million./1 By 1990, an estimated 93,000 tons/year of methanol could be absorbed in the domestic production of formaldehyde, which is needed to produce resins for the plywood industry, and of other chemical products./2 Thus, a substantial quantity of methanol will be available for export or for domestic fuel uses.

3.25 Because no significant modifications in vehicles or in the distribution systems would be required, use of methanol for low-level blends and for production of MBTE promises to be the most economically attractive./3 However, it is not now clear whether the value of methanol in either use in Indonesia would exceed its export value. The value of methanol in low-level blends depends on the fuel economy of such blends in Indonesian vehicles and conditions and on the savings which could be achieved in Indonesian refinery costs due to reduced demand for high-octane gasoline output. Depending on these two factors, the value of methanol for low-level blends might range from $150 to $240/ton compared to a world market price of $220-240./4 The value of methanol as a raw material for MBTE depends on the cost of the complementary input, isobutylene, and the processing cost, which varies with the size of plant and capital costs. Assuming that significant quantities of isobutylene will not be produced from the catalytic crackers of Indonesia's planned refineries and would therefore need to be produced from gas liquids, the estimated value of methanol in this use is $185-295. In other words, its value in such use might significantly exceed its export value. In summary, the economic attractiveness of both such uses in Indonesia deserves further study.

3.26 However, it must be recognized that, if prices in the world market of crude oil and hence gasoline steadily increase relative to the price of methanol produced from natural gas or coal, other countries will pursue the options for methanol use discussed above, thereby limiting the gasoline-methanol price differential. Because the ocean transport cost of methanol

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/1 BPPT (1980) reports the capacity of the proposed plant to be about 1,000 tons per stream day.

/2 See Chem Systems International, Inc. and Davy McKee (March 1982).

/3 For detailed discussion of the economics of these and other uses of methanol, see World Bank (April 1982).

/4 These are 1980 prices. See World Bank (April 1982).

is about equal to that for petroleum and its products, there is no advantage inherent in the transport cost structure for Indonesia to use its methanol domestically rather than export it. In this sense, methanol is less attractive for domestic fuel use than LPG, which involves relatively costly ocean transport, or even ethanol, which might be produced in interior locations close to fuel consumption points but not close to export terminals.

Natural Gas Liquids (NGLs)

3.27 BPPT (1980) notes that, as a by-product of its LNG trains, Indonesia will produce increasing amounts of natural gas liquids (NGLs), which are also known as natural gasoline or condensates./1 That report suggests that these NGLs can supply essentially all of the gasoline in the transport sector as early as 1983 and, in addition, satisfy all of the diesel and fuel oil demand after 1988. However, despite its name, "natural gasoline" cannot be used directly as a transport fuel without further refining. For that reason, its economic value is about the same as that of light naphtha,/2 and its most economic use should be determined accordingly. For the future, Pertamina plans to utilize NGL as the feedstock for the planned aromatics plants in north Sumatra. Without further study, it cannot be assumed that this is not the most economic use.

CHAPTER 4. SUMMARY AND CONCLUSIONS

4.01 The objectives of Indonesia's energy policy are conservation of petroleum products and diversification of energy sources. This paper has considered ways in addition to pricing policies by which these objectives should be pursued in the transport sector. This chapter presents a summary of the paper and its major conclusions.

/1 Current production is about 33 million barrels per year from the Arun field in North Sumatra, which is exported directly to Japan, and 10 million barrels per year from the Bontang field in East Kalimantan, which is mixed with crude oil for export. BPPT (1980) forecasts that by 1988 NGL production to reach over 100 million barrels per year, to which the Natuna field could eventually add about 66 million barrels.

/2 For example, in June 1982, the f.o.b. price at the Persian Gulf for natural gasoline was 79.8¢ per gallon and for light naphtha, 80.8¢ per gallon.

Nonprice Conservation Measures

4.02 Although pricing policy is probably the most powerful tool for encouraging efficient use of fuel, there are important nonprice measures to promote conservation. GOI has already taken important steps to identify and begin implementation of such measures. In many cases difficult implementation problems must be overcome, and in all cases such measures must be evaluated and justified by overall economic rate of return, not only fuel savings.

4.03 Urban Traffic Management. Because urban driving accounts for an estimated one-third of fuel consumption in the transport sector, and because fuel efficiency can be improved by increasing average speeds on urban roads, better urban traffic management would contribute to fuel conservation. Specific measures might include better use of traffic lights, building overpasses at level crossings between major roads and the railway, improving parking systems, etc. To help identify and implement the many small investments required in the major cities of Indonesia, it is recommended that GOI (a) train a small cadre of traffic management specialists to be assigned to each major city; (b) complete regulations to the 1980 National Road Law to fully clarify the respective responsibilities of city governments vis a vis the central government agencies, especially Bina Marga; and (c) consider reorganization of national agencies or improved coordination mechanisms so that responsibility for road infrastructure development and traffic engineering rests with the same authority; and (d) develop standard guidelines for evaluation of alternative means to reduce vehicle waiting times at road-rail crossings.

4.04 Urban Public Transport. Improved public transport in the major cities would contribute to energy conservation by increasing average vehicle load factors, reducing demand for private vehicles, and reducing congestion and hence inefficiency in urban traffic. Among the diverse types of urban transport services in Indonesia, GOI directly provides large bus services through two public companies - PPD in Jakarta and Damri in other cities. In seeking to improve urban public transport, GOI must determine what should be the role of these companies relative to providers of other types of transport services (e.g., minibuses, and bemos), how to improve the operational efficiency of these two large companies, how much to subsidize their operations, and how much to invest in the commuter rail system in Jakarta. With regard to these issues, it is recommended that GOI consider the following: (a) subsidies provided to PPD and Damri should be large enough to allow sound management, including maintenance and planned replacement and expansion of the bus fleet; (b) Damri's management should be decentralized to ensure greater attention to the circumstances in individual cities; (c) technical assistance should be provided to strengthen the financial and technical management of the two companies; (d) fares for large buses should gradually be increased to limit the differential with fares charged by private operators of other types of services; (e) regulations or guidelines should be developed to define the types of services to be provided by the large bus companies and the types to be left to other operators; and (f) the economic and financial performance of the first phase of improved Jabotabek rail services should be thoroughly evaluated before commitment is made in the subsequent phases.

4.05 Regulation of Road Vehicle Production and Sales. GOI has sought to develop the domestic industry for vehicles with the objective that all component manufacture and vehicle assembly will eventually be done domestically. At present vehicles are imported in Completely Knocked Down condition, and their fuel efficiency is as good as or better than the newest vehicles produced in developed countries. In implementing its policy of requiring domestic manufacture of all major components, including engines, GOI must exercise great care not to allow a technological gap to develop with respect to fuel efficiency, as this would have a very negative impact on fuel conservation. It is also recommended that GOI review the structure of taxes and duties on vehicles with a view toward penalties on larger engines and air conditioners.

4.06 Road Infrastructure Improvements. Improvements in road and bridge infrastructure can improve the fuel efficiency of existing vehicles by increasing average speeds and can make possible the use of larger, heavier vehicles which carry more cargo per unit of fuel consumed. Thus, substantial investments in road and bridge improvements should be viewed as an important part of GOI's fuel conservation efforts. Also, GOI should review its vehicle weight and dimension regulations with a view toward permitting larger, more fuel-efficient vehicles and should allocate the resources necessary to develop and maintain an arterial road network to accommodate such vehicles. This could make a very important contribution to fuel efficiency in the road subsector.

4.07 Development of the Railway Sector. In terms of fuel consumed per ton-kilometer of cargo, railways are more efficient than road. But the relative economic attractiveness of rail and road depends on many factors in addition to fuel efficiency. Thus, in developing the railway network in Indonesia, it is recommended that GOI should (a) give priority to improving the management and operations of PJKA; (b) evaluate railway investments, including electrification, in terms of overall economic rates of return, not only fuel savings; (c) in evaluating railway development along the north coasts of Java and north Sumatra, consider the competition from sea transport and utilize consistent traffic projections for rail and port projects; and (d) investigate and implement, where feasible, use of unit trains, which are relatively more fuel efficient.

4.08 Public Information and Technical Assistance. The fuel efficiency of road vehicles depends significantly on driver behavior and the quality of vehicle maintenance, and there is therefore considerable potential for fuel conservation through better operation of vehicles. To ensure that this potential is realized, it is recommended that GOI develop a program of information and technical assistance specifically targeted at the owners and operators of trucks and buses. For this purpose, a team should be formed to undertake a survey of awareness of fuel saving measures, prepare detailed brochures, and provide technical assistance to individual companies. This may be the most cost-effective means to improve fuel conservation in the sector.

Alternative Fuels for the Transport Sector

4.09 Because the transport sector requires liquid fuels suitable for internal combustion engines, there are fewer technically feasible substitutes for petroleum products in this sector than in the industrial, power, or household sectors. Alternative fuels which might be feasible for the transport sector are liquefied petroleum gas (LPG), ethanol, methanol, and natural gasoline from natural gas liquids (NGL). At present none of these alternative fuels appear to be an economical substitute for significant quantities of gasoline or diesel in the transport sector, but the possibilities for LPG, ethanol, and methanol deserve continued study. As domestic production grows, LPG can probably be economically utilized by replacement vehicles in some commercial fleets in urban areas, especially taxis and buses. This use of LPG should be pursued, although it holds less promise and lower priority than development of LPG as a substitute for kerosene in the household market. In order to encourage LPG use in both the household and transport sector, GOI will need to substantially reduce its domestic price. The problems and prospects of increasing domestic use of LPG will be addressed in the LPG feasibility study to be financed by the Bank, and this study should be initiated as soon as possible. Regarding ethanol, GOI's current program promises to provide technical and economic data on the production and use of gasohol and should therefore be continued on an experimental, pilot basis. However, available evidence indicates that even under the most favorable circumstances ethanol production is only marginally economic. Unless new data suggests otherwise, GOI should not make substantial investments in ethanol production. Finally, when the new methanol plant in East Kalimantan is completed, Indonesia will have available substantial quantities of methanol for low-level blends with gasoline and for production of the gasoline-additive MBTE. Both of these uses might be profitable alternatives to export of methanol and should be carefully studied.

Estimates of Consumption of Diesel and Fuel Oil in the Transport Sector

1. There are substantial differences in available estimates of consumption of automotive diesel, industrial diesel, and fuel oil in the transport sector. These various estimates are summarized in Table A.1.1, and the detailed data are provided in Tables A.1.2-A.1.4. This annex considers the plausibility of the various estimates and concludes that those of Technical Working Team (TKT) on Energy are most realistic.

2. Each of the estimates except that of the Ministry of Communications (MOC) report is based on domestic supply and marketing data. The MOC estimates are derived from an analysis of demand taking into account the estimated number of road vehicles, locomotives, and ships, and the estimated fuel consumption of each.

3. For automotive diesel, the TKT Energy estimate is approximately equal to the following summation of estimated consumption by mode in 1980. For road transport, the MOF/Halcrow Fox estimate of 12.1 m BBL is accepted because it is based on the plausible assumption that virtually all dealer retail sales (11.5 m BBL) plus a small part of wholesale/depot sales (0.6 m BBL) are for road transport (Table A.1.3) and because it is not too far below the MOC demand estimate of 14.4 m BBL based on the number of operating vehicles (Table A.1.5). For sea transport, automotive diesel consumption is likely to be 3 to 5 m BBL: the T.P. O'Sullivan report cites the Integrated Sea Transport Study estimate of 2.95 m BBL, and the MOC report estimates 4.8 m BBL (including marine diesel fuel). For rail transport, the MOC estimate of .5 m BBL is based on detailed data from the National Railway Corporation (PJKA). The sum of the etimates for these three modes (assuming 4 m BBL for sea transport) is then 16.6 m BBL. Allowing at least .5 m BBL for river and ferry transport (compared to the MOC estimate of 5.7 m BBL, which is acknowledged by the Directorate of River and Ferry Transportation as a gross overestimate), the TKT Energy estimate of 17.16 m BBL appears realistic.

4. For fuel oil, the TKT Energy estimates (Table A.1.2) of consumption by the National Power Company (PLN) and the industrial sector appear realistic. PLN consumption is estimated at 6.5 m BBL, which is consistent with the trend to shift from diesel to fuel oil for PLN power generation and the consumption figures from PLN Annual Reports of 2.14, 2.70 and 5.57 m BBLs in 1977/78, 1978/79, and 1979/80 respectively. The TKT estimate of fuel oil consumption in the industrial sector (8.0 m BBL) is consistent with

results of the survey of energy use among large and medium scale manufacturers,/1 which indicates consumption of 3.69, 4.22, and 5.02 m BBLs in 1976, 1977, and 1978 respectively and by extrapolation 6.8 m BBL in 1980. Adding fuel oil consumption by small-scale and cottage industry, which accounts for about 20% of value added in the sector /2 and presumably a similar, though smaller share, of fuel oil consumption, brings the total close to 8.0 m BBL. Thus, regarding transport consumption as the residual, the TKT estimate of 1.51 m BBL is realistic. Furthermore, unlike the MOF/Halcrow Fox estimate for combined industrial diesel and fuel oil, the TKT estimate is consistent with estimated fuel oil consumption for sea transport of 1.88 m BBL by ISTS /3 and 1.7 m BBL in the MOC report (excluding consumption by special service ships which may be counted as international bunker sales elsewhere). The World Bank's report (November 1981a) notes the conflicting data on consumption of diesel and fuel oil in the transport sector and cites not only the BPPT data noted here but also an estimate of 8.71 m BBL of fuel oil consumed in transport in 1978/79 obtained from the Ministry of Mining and Energy. Using this figure, the report calculates that transport accounts for about 41% of total petroleum product consumption compared to about 34% from Table A.1.2. There may, in fact, have been a significant decline in fuel oil consumed by transport between 1978 and 1980 as the volume of log exports, which according to the MOC report consume substantially quantities of fuel oil for shipment, declined from 16 to 13 million tons, and this decrease may have been offset by the increasing fuel oil consumption in transport cited in the World Bank report seems to be an extreme over estimate.

5. Only TKT Energy reports consumption of industrial diesel separately and this estimate of 0.9 m BBL, is not inconsistent with the totals for industrial diesel and fuel oil reported by others, and represents an appropriately small share (11%) of total industrial diesel consumption.

6. On the basis of the above, the estimates for consumption of automotive diesel, industrial diesel, and fuel oil made by TKT Energy are accepted as realistic and are used throughout this report.

/1 Central Statistics Bureau, Annual Survey of Large and Medium Sacale Manufacturing Industry, 1977.

/2 See World Bank, Indonesia: Cottage and Small Industry in the National Economy, November 9, 1979, Volume II, Table 0.3.

/3 As reported in T.P. O'Sullivan (1982), Table 13.

ALTERNATIVE ESTIMATES OF CONSUMPTION OF DIESEL
AND FUEL OIL IN TRANPORT SECTOR
(in million BBLs)

Source	Automotive Diesel 1978	Automotive Diesel 1980	Industrial Diesel and Fuel Oil 1978	Industrial Diesel and Fuel Oil 1980
TKT Energy /a	-	17.16	-	1.45
MOF/Halcrow Fox /b	10.35	14.24	0.91	0.96
T.P. O'Sullivan /c	11.4	14.97	2.02	2.68
MOC /d	19.8 /f	25.4 /f	4.40 /g	5.05 /g
BPPT /e	12.5 /f	-	1.6 /h	-

/a Team Kerja Teknik Energi dan BBM (Technical Working Team on Energy and Petroleum Products), July 22, 1981, based on data from the Marketing and Processing Section of Pertamina.

/b Ministry of Finance (Directorate of Oil Revenue) as reported by Halcrow Fox and Associates, 1982.

/c T.P. O'Sullivan and Partners Consulting Engineers, "The Oil Fuel Subsidy and Transport Policy" (Task A.1 of the Transport Research and Planning Project), Ministry of Transport, Communications, and Tourism, June 1982, Table 7A; based on data from Ministry of Fiannce, PJKA, and the Integrated Sea Transport Study.

/d Derived from Ministry of Communications, "Perkiraan Kebutuhan Bahan Bakar Minyak Sektor Angkutan (Tahan 1980-1990), 1979.

/e Badan Pengkajian dan Penerapan Teknologi (Agency for Development and Application of Technology) in association with Bechtel National, Inc., Alternative Strategies for Energy Supply in Indonesia 1979-2003, December 1980, Table 4-8.

/f Includes industrial diesel fuel.

/g Includes only fuel oil, including that consumed by special, ocean-going log carriers.

/h Includes only fuel oil.

INDONESIA

ENERGY USE IN THE TRANSPORT SECTOR

TKT Energy Estimates of

Fuel Consumption by Sector in 1980
(barrels)

Type of fuel	Transport	Household	Industry	Power (PLN)	Total
Aviation fuel	4,478,927	-	-	-	4,478,927
Gasoline	23,919,795	-	-	-	23,919,795
Kerosene	-	48,997,548	-	-	48,997,548
Automotive diesel	17,156,338	-	18,247,172	5,146,642	40,550,152
Industrial diesel	938,118	-	7,034,240	219,395	8,191,753
Fuel oil	1,513,289	-	8,001,607	6,498,407	16,013,303
Subtotal	48,006,467	48,997,548	33,283,019	11,864,444	142,151,478
Refinery own use	115,301	56,467	7,101,821	-	7,273,589
Total	48,121,768	49,054,015	40,384,840	11,864,444	149,425,067
Percentage	32.20	32.83	27.03	7.94	100

Source: TKT Energi and BBM.

T.P O'SULLIVAN ESTIMATES OF
FUEL CONSUMPTION: TRANSPORT BY FUEL TYPE 1978/79 - 1980/81

ADJUSTED TOTALS

(Millions of Litres)

	Total	Trans-port	Avgas	Avtur	Super	Premium	Auto-Diesel	Industrial Diesel + Fuel Oil
1978/79	17781.0	5563.2	21	420	112.5	2883.8	1813.1	321.8
1979/80	19573.3	6212.4	20	640	96.5	3096.5	1995.6	363.8
1980/81	21841.6	6814.6	20	491	72.4	3426.0	2379.4	425.8

Adjustments: Alternative Ministry of Finance totals for Super and Premium Authodiesel and Industrial Diesel + Fuel Oil adjusted by PJKA and ISTS data for 1980/81, 1978/79; 1979/80 adjusted pro rata.

Source: Ministry of Finance, PJKA, ISTS. as reported by T.P.O'Sullivan (1982)

INDONESIA

ENERGY USE IN THE TRANSPORT SECTOR

MOF/Halcrow Fox Estimates of
Fuel Consumption by Marketing Channel and Sector, 1978-80
(Millions of liters)

Type of fuel	Wholesale/depot sales: Agriculture	Wholesale/depot sales: Transportation: Land	Wholesale/depot sales: Transportation: Water	Wholesale/depot sales: Transportation: Subtotal	Wholesale/depot sales: Utilities	Wholesale/depot sales: Industry & others /a	Wholesale/depot sales: Subtotal wholesale	Dealer retail sales	Total sales	Percentage distribution of sales by sector: Agriculture	Percentage distribution of sales by sector: Transportation /b	Percentage distribution of sales by sector: Utilities	Percentage distribution of sales by sector: Industry & other	Percentage distribution of sales by sector: Households
Volume														
Super Petrol														
1978	-	-	-	-	-	4.8	4.8	112.4	117.2	0.0	95.9	0.0	4.1	0.0
1979	-	-	-	-	-	4.5	4.5	96.0	100.5	0.0	95.5	0.0	4.5	0.0
1980	-	-	-	-	-	2.8	2.8	72.4	75.2	0.0	96.3	0.0	3.7	0.0
Premium Petrol														
1978	21.4	1.3	0.1	1.4	1.1	288.5	312.4	2,856.6	3,169.0	0.7	90.2	/c	9.1	0.0
1979	28.3	0.6	-	0.6	0.6	260.6	290.1	3,122.6	3,402.7	0.8	91.5	/c	7.7	0.0
1980	29.3	0.1	0.3	0.4	0.4	268.9	299.0	3,425.6	3,724.6	0.8	92.0	/c	7.2	0.0
Kerosene														
1978	-	-	-	-	-	71.1	71.1	6,491.5	6,562.6	0.0	0.0	0.0	1.1	78.9
1979	-	-	-	-	-	71.0	71.0	7,164.1	7,235.1	0.0	0.0	0.0	1.0	99.0
1980	-	-	-	-	-	70.7	70.7	7,719.1	7,789.8	0.0	0.0	0.0	0.9	99.1
Automotive Diesel (Solar)														
1978	525.7	101.0	266.1	367.1	829.7	2,114.2	3,836.7	1,277.7	5,064.4	10.4	32.5	16.4	41.7	0.0
1979	627.2	108.6	299.4	408.0	718.0	2,303.9	4,057.1	1,500.3	5,557.4	11.3	34.3	12.9	41.5	0.0
1980	639.8	99.8	341.3	441.1	786.9	2,755.5	4,623.3	1,822.9	6,446.2	9.9	35.1	12.2	42.7	0.0
Industrial Diesel and Fuel Oil														
1978	41.8	52.3	90.0	142.3	499.9	2,130.8	2,814.8	3.0	2,817.8	1.5	5.2	17.7	75.6	0.0
1979	46.7	39.8	92.1	131.9	809.4	2,289.4	3,277.4	0.2	3,277.6	1.4	4.0	24.7	69.8	0.0
1980	47.4	35.4	117.9	153.3	1,067.7	2,537.4	3,805.8	-	3,805.8	1.2	4.0	28.1	66.7	0.0
Total														
1978	588.9	154.6	356.2	510.8	1,330.7	4,609.4	7,039.8	10,741.2	17,781.0	3.3	26.8	7.5	25.9	36.5
1979	702.2	149.0	391.5	540.5	1,528.0	4,929.4	7,700.1	11,873.2	19,573.3	3.6	26.8	7.8	25.2	36.6
1980	716.5	135.3	459.2	594.5	1,855.0	5,635.3	8,801.6	13,040.0	21,841.6	3.3	27.1	8.5	25.8	35.3
Average Annual Percentage Change 1978-80														
Super petrol	-	-	-	-	-	(23.6)	(23.6)	(19.7)	(19.9)	-	-	-	-	-
Premium petrol	17.0	(72.3)	73.2	(46.6)	(39.7)	(3.5)	(2.2)	9.5	8.4	-	-	-	-	-
Kerosene	-	-	-	-	-	(0.3)	(0.3)	9.1	9.0	-	-	-	-	-
Automotive diesel (solar)	10.3	(0.6)	13.3	9.6	(2.6)	14.2	9.8	19.4	12.8	-	-	-	-	-
Industrial diesel and fuel oil	6.5	(17.7)	14.3	3.8	46.1	9.1	16.3	-	16.2	-	-	-	-	-
Total	10.3	(6.5)	13.3	7.9	18.1	10.6	11.8	10.2	10.8	-	-	-	-	-

/a Includes military, sales of bunker fuel to international vessels and Pertamina consumption.
/b Includes wholesale sales to the transportation sector plus dealer/rental sales less dealer/retail sales of kerosene.
/c Includes dealer/retail sales of kerosene.

Note: Excludes avgas and avtur.

Source: Direktorat Penerimaan Minyak, Ditjen. Moneta Luar Negri, Departemen Keuangan Republik Indonesia.

MOC ESTIMATED CONSUMPTION OF DIESEL AND FUEL OIL BY
TRANSPORT SUBSECTORS IN 1978 and 1980 /a
(in million of barrels)

	1978		1980	
	Diesel	Fuel oil	Diesel	Fuel oil
Sea transport /b				
Regular liner service	.99		1.20	-
Local services	.41		.50	-
Pioneer services	.07		.08	-
Special services (domestic)	.15		.18	-
Ocean-going (Indonesian flag)	.21	1.4	.26	1.67
Special services (international)	.20	2.8	.24	3.36
Off-shore industry and noncommercial ships	1.90	.02	2.30	.02
	3.9	4.2	4.76	5.05
Road transport /c				
Commercial vehicles	9.7		11.7	-
Buses	1.2		2.2	-
Passenger cars	.4		.5	-
Motorcycles	0		0	-
Subtotal	11.3	0	14.4	0
River and ferry transport /d	4.3	0	5.7	0
Rail transport				
Java	.28	.17	.41	0
Sumatra	.04	.01	.09	0
Subtotal	.3	.2	.50	0
Total	19.8	4.4	25.4	5.05

/a Derived from "Perkiraan Kebutuhan Bahan Bakar Minyak Sektor Angkutan (Tahun 1980-1990)" prepared by Research and Development Board of the Ministry of Communications, 1979.

/b 1978 estimates based on 1980 estimates assuming 10% growth rate in 1978 and 1979. Includes both high speed diesel and marine diesel fuel.

/c Based on estimates for operation vehicle populations in 1978 (including public, private, and government vehicles), percentage of those vehicles which use diesel fuel, fuel consumption per kilometer, and average kilometers per year for each category of vehicle.

/d Based on 1976 estimates and 15% annual growth rate between 1976 and 1980.

ANNEX 2: Background Data

INDONESIA

ENERGY USE IN THE TRANSPORT SECTOR

Domestic Sales of Petroleum Products, 1971-80 /a
(In ´000 bbl)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Aviation gas	144	118	123	139	139	143	128	134	134	130
Aviation turbo	961	1,200	1,658	2,150	2,579	2,758	2,913	3,494	3,656	4,355
Premium gasoline	100	201	359	496	661	706	710	728	618	466
Regular gasoline	10,409	10,779	1,757	12,787	14,284	15,606	17,356	19,608	21,295	23,321
Kerosene	18,927	20,697	23,146	26,769	30,623	33,259	36,880	41,717	45,458	48,975
Motor diesel	6,895	9,027	11,838	14,524	18,023	22,749	27,041	31,709	34,595	40,115
Industrial diesel	2,364	2,676	3,488	4,022	4,673	5,429	6,239	6,744	7,580	7,828
Fuel oil	4,095	5,379	7,924	8,755	7,844	8,222	10,296	11,061	13,626	15,739
Total	43,895	50,077	60,293	69,642	78,826	88,872	101,563	115,195	126,962	140,930

/a Excluding lubricating oil and other products.

Source: Department of Mines and Energy.

INDONESIA

ENERGY USE IN THE TRANSPORT SECTOR

Number of Motor Vehicles by Type
and Number of Motor Vehicles per Thousand Persons; Selected Years 1970-80
(Excludes military and special purpose vehicles)

Vehicles by type, population, GDP and vehicles per capita	1970	1972	1974	1976	1977	1978	1979	1980	Average annual present change 1970-74	1974-77	1977-80
Number of vehicles ('000)											
Motorcycles	441.2	615.0	948.8	1,421.8	1,704.8	1,973.0	2,290.4	2,682.5	21.1	21.6	16.3
Sedans /a	238.0	275.0	339.9	421.8	479.1	534.2	581.5	737.1	9.3	12.1	15.4
Petrol	233.0	269.5	332.5	409.3	463.5	513.9	559.9	708.4	9.3	11.7	15.2
Diesel	5.0	6.0	7.4	12.5	15.6	20.3	21.6	28.7	10.3	28.2	22.5
Buses	23.3	26.0	31.3	39.6	47.9	57.9	69.5	88.1	7.7	15.2	22.5
Petrol	18.1	18.8	21.4	23.1	25.4	27.7	28.5	31.6	4.3	5.9	7.6
Diesel	5.2	7.2	9.9	16.5	22.5	30.4	41.0	55.5	17.5	31.5	35.1
Light and mini	4.8	5.1	6.8	10.6	13.7	17.2	21.3	28.7	9.1	26.3	28.0
Petrol	4.6	4.8	6.3	9.6	11.9	14.7	17.7	23.9	8.2	23.6	26.2
Diesel	0.2	0.3	0.5	1.0	1.8	2.5	3.6	4.8	25.7	53.3	38.7
Medium and heavy	18.5	20.9	24.5	29.0	34.2	40.7	48.2	59.4	7.3	11.8	20.2
Petrol	13.5	14.0	15.1	13.5	13.4	12.8	10.8	8.7	2.8	(3.9)	(13.4)
Diesel	5.0	6.9	9.4	15.5	20.7	27.9	37.4	50.7	17.1	30.1	34.8
Trucks and trailers /b	99.9	126.2	166.8	222.3	279.0	335.7	389.4	475.3	13.7	18.7	19.4
Petrol	78.7	97.3	124.5	152.3	177.6	197.1	215.9	250.0	21.1	12.6	12.1
Diesel	21.2	28.9	42.3	70.0	101.4	138.6	173.5	225.3	18.9	33.8	30.5
Pick ups /c	39.5	52.5	73.5	109.3	137.2	165.8	201.3	247.6	16.8	23.1	21.7
Petrol	38.9	51.3	71.3	105.5	131.0	156.1	187.2	226.8	16.4	22.5	20.1
Diesel	0.6	1.2	2.2	3.8	6.2	9.7	14.1	20.8	38.4	41.3	49.7
1.2 lights	27.8	29.9	31.5	33.7	36.8	46.6	57.6	69.4	3.2	5.3	23.5
Petrol	20.2	21.0	20.9	18.0	15.6	15.1	11.3	10.3	0.9	(9.3)	(12.9)
Diesel	7.6	8.9	10.6	15.7	21.2	31.5	46.3	59.1	8.7	26.0	40.7
1.2 medium and heavy	31.6	42.3	59.7	76.5	100.4	116.9	123.1	148.2	17.2	18.9	13.9
Petrol	18.8	23.9	31.0	27.4	29.1	23.6	15.6	11.2	13.3	(2.1)	(27.3)
Diesel	12.8	18.4	28.7	49.1	71.3	93.3	107.5	137.0	22.4	35.4	24.3
3 axled /d	1.0	1.5	2.1	2.8	4.6	6.4	7.4	10.1	20.3	29.9	30.0
Petrol	0.8	1.1	1.3	1.4	1.9	2.3	1.8	1.7	12.9	13.5	(3.6)
Diesel	0.2	0.4	0.8	1.4	2.7	4.1	5.6	8.4	41.4	50.5	45.0
Trailers and semitrailers/e	3.9	4.3	4.8	5.8	6.4	6.9	7.2	7.4	5.3	10.1	5.0
Total Motor Vehicles	802.4	1,042.7	1,486.8	2,105.5	2,510.8	2,900.8	3,330.8	3,983.0	16.7	19.1	16.6
Population (millions)	116.4	122.0	127.7	134.1	137.4	140.6	143.9	147.5	2.3	2.3	2.3
Motor vehicles per thousand persons											
Motorcycles	3.8	5.0	7.4	10.6	12.4	14.0	15.9	18.2	18.1	18.8	13.6
Sedans /a	2.0	2.3	2.7	3.1	3.5	3.8	4.0	5.0	7.8	9.0	12.6
Buses	0.2	0.2	0.2	0.3	0.3	0.4	0.5	0.6	0.0	14.5	26.0
Trucks	0.9	1.0	1.3	1.7	2.0	2.4	2.7	3.2	9.6	15.4	17.0

/a Includes jeeps, opelets and all other passenger type vehicles seating less than eigh passengers.
/b Total for trucks and trailer category includes trucks only.
/c Includes delivery vans.
/d Estimated based on survey results of the 1978 VWDS.
/e Includes both full trailers and semitrailers estimated based on DLLAJR inspection data.

Source: Total numbers of motorcycles, sedans, buses and trucks for 1970-80 from data supplied by the Republic of Indonesia, Headquarters of State Police. Distribution of vehicles by size and by fuel type based on inspection data supplied by DLLAJR. Population and GDP from Appendix Tables.

Reported in Halcrow Fox and Associates (1982).

Estimated Annual Fuel Consumption
Per vehicle by Type of vehicle
(in barrels)

	Commercial	Private	Government
Gasoline			
Truck	107.8	89.8	71.9
Bus	150.9	110.1	94.3
Car	25.2	15.7	15.7
Motorcycle	-	3.1	3.1
Diesel			
Truck	88.8	74.0	59.2
Bus	120.7	88.0	75.5
Car	20.1	12.6	12.6

Source: MOC (1979)

ANNEX 2
Page 4
Table A.2.4

INDONESIA

ENERGY USE IN THE TRANSPORT SECTOR

Singapore (Pulau Bulcom) Prices for Refined Products
as of December 31, 1973-79
(¢/gal or $/bbl)

	1971/e	1972/e	1973	1974	1975	1976	1977	1978	1979/a	1980/b	1981/c
Aviation gasoline (Grade 100/130)	-	-	25.6	53.0	-	64.0	66.0	66.5	-	107.0/d	111.5/d
Motor gasoline (Regular 85 Oct)	13.7	13.6	18.4	36.0	-	39.5	42.3	42.3	73.3	99.3	101.0
Kerosene	12.9	12.8	20.5	35.5	-	38.0	41.0	41.5	78.7	106.2	110.5
Diesel (50 cet) or gasoil (1.0% sulfur)	-	-	18.4	33.1	-	36.6	39.7	39.3	75.9	101.1	105.8
Medium fuel (in $)	-	-	-	10.6	-	11.0	12.4	11.6	22.2	32.0	31.0
LPG	-	-	-	-	-	33.1	34.5	34.5	64.5	87.5	83.5

/a December 21, 1979.
/b January 7, 1981.
/c November 20, 1981.
/d Jet A-1.
/e Annual average at New York Harbor terminal.

Note: Conversion factors:
1 barrel = 42 US gallons
1 liter = 0.264172 US gallons
1971-78: Rp 415 = US$1
1979-81: Rp 625 = US$1

Source: Platt's Oilgram, annual edition.

Price Elasticities of Gasoline Demand
in Selected Countries /a

	Length of adjustment period			
	Year			
	1	5	15	25
Belgium	0.124	0.581	1.24	1.51
Canada	0.110	0.481	1.01	1.23
France	0.126	0.596	1.30	1.60
Italy	0.051	0.328	0.838	1.13
Netherlands	0.121	0.565	1.22	1.51
Norway	0.137	0.683	1.54	1.94
Sweden	0.119	0.551	1.19	1.47
Switzerland	0.120	0.560	1.20	1.48
U.K.	0.131	0.642	1.24	1.77
U.S.	0.111	0.490	1.03	1.26
West Germany	0.117	0.530	1.13	1.38
Total:	0.111	0.501	1.06	1.31

/a All of these elasticities are negative, but the minus signs have been left off.

Source: World Bank (Sept. 1981).

PROJECTED DEMAND/SUPPLY OF REFINED PRODUCTS IN INDONESIA
(in thousand barrels per calendar day, MBCD)

	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1989/90
Gasoline								
Demand	73.2	80.5	86.9	93.9	101.4	109.5	118.3	127.8
Supply w/o Expansions	56.9	56.9	56.9	56.9	56.9	56.9	56.9	56.9
Supply w/Expansions	n.a	n.a	n.a	113.8	132.7	132.7	132.7	132.7
Surplus (Deficit w/o Exp.)	(16.3)	(23.6)	(31.7)	(37.0)	(44.5)	(52.6)	(61.6)	(70.9)
Surplus (Deficit w/Exp.)	n.a	n.a	n.a	19.9	31.3	23.2	14.4	4.9
Kerosene and Aviation Fuel								
Demand	165.0	183.2	196.0	209.7	224.4	240.1	256.9	274.9
Supply w/o Expansions	92.3	92.3	92.3	92.3	92.3	92.3	92.3	92.3
Supply w/Expansions	n.a	n.a	n.a	223.8	267.6	267.6	267.6	267.6
Surplus (Deficit w/o Exp.)	(72.7)	(90.9)	(105.5)	(121.3)	(138.4)	(156.9)	(176.8)	(198.3)
Surplus (Deficit w/Exp.)	n.a	n.a	n.a	10.2	36.9	18.4	(1.5)	(23.0)
Diesel								
Demand	147.2	169.3	187.9	208.6	231.5	257.0	285.3	316.7
Supply w/o Expansions	56.8	56.8	56.8	56.8	56.8	56.8	56.8	56.8
Supply w/Expansions	n.a	n.a	n.a	134.6	180.5	180.5	180.5	180.5
Surplus (Deficit) w/o Exp.	(90.4)	(112.5)	(131.1)	(151.8)	(174.7)	(200.2)	(228.5)	(259.9)
Surplus (Deficit w/Exp.)	n.a	n.a	n.a	(74.0)	(51.0)	(76.5)	(104.8)	(136.2)
Fuel Oil								
Demand	57.3	61.3	66.2	72.2	79.4	88.1	98.7	111.5
Supply w/o Expansions	43.5	43.5	43.5	43.5	43.5	43.5	43.5	43.5
Supply w/Expansions	n.a	n.a	n.a	80.2	92.4	92.4	92.4	92.4
Surplus (Deficit) w/o Exp.	(13.8)	(17.8)	(22.7)	(28.7)	(35.9)	(44.6)	(55.2)	(68.0)
Surplus (Deficit) w/Exp.	n.a	n.a	n.a	8.0	13.0	4.3	(6.3)	(19.1)
Total								
Demand	442.7	494.3	537.0	584.4	636.7	694.7	759.2	830.9
Supply w/o Expansions	249.5	249.5	249.5	249.5	249.5	249.5	249.5	249.5
Supply w/Expansions	n.a	n.a	n.a	552.4	673.2	673.2	673.2	673.2
Surplus (Deficit) w/o Exp.	(193.2)	(244.8)	(287.5)	(334.9)	(387.2)	(445.2)	(509.7)	(581.4)
Surplus (Deficit) w/Exp.	n.a	n.a	n.a	(32.0)	36.5	(21.5)	(86.0)	(157.7)

Source: Unpublished World Bank memorandum, March 1981.

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