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Environment and Development in Indonesia: An Input-Output Analysis of Natural Resource Issues

Working Paper #1
Case Study: Households and Industry

by

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Preface

The Natural Resources Management Project (NRMP) of USAID, with support from NRMP and the Environmental Programming Support Services Project (EPSS) of the Canadian International Development Agency (CIDA), in association with the Institute for Economic Analysis (IEA) of New York University, are carrying out an analysis of the economic, employment and environmental consequences of alternative development paths for the Indonesian economy. The purpose is to provide advice to the Indonesian National Planning Agency (BAPPENAS) to assist in the development of the newest five-year plan (Repelita VI) and the next Long-Term Development Plan. The first stage of this work has already been completed by IEA with the support of EPSS.

The objective of this work is to evaluate the possible trade-offs between the growth of income and employment on the one hand, and the levels of natural resource depletion and degradation of the natural environment on the other, that are likely to be associated with alternative patterns of structural change. For instance, it is important for policy makers to know how the development of the pulp or cement industry over the next 20 years is likely to affect air and water pollution and how costly, or cost saving, it might be to adopt cleaner technologies than are being used now.

The analytic framework includes a dynamic input-output model covering all economic activities and the associated input-output database. The model is dynamic in two senses. First, it incorporates a representation in which levels of sectoral investment depend on expected growth of output, the technology in use, and levels of capacity utilization. Secondly, the model is dynamic in that it explicitly incorporates projections of changes in technology for agricultural sectors, forestry, energy sectors and key manufacturing and service sectors.

Technological scenarios are developed for each sector using detailed information about likely technological and institutional changes obtained from technical experts. This includes expected changes in intermediate inputs, notably energy and raw materials, capital stocks, and human resources of different skill types as well as changes in natural resource usage and environmental degradation associated with current and alternative future technologies.

This is one of a series of working papers being prepared by NRMP and IEA researchers in collaboration with industry experts. The papers provide a critical part of the database for the numerical computations, as well as the methodology for building it.

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1. Introduction

A. Overview

The development scenarios which will be explored with the 30-sector dynamic model in the course of this study focus on resource use and possible environmental degradation. They are constructed on the basis of projections of two types: technological change in key sectors of the Indonesian economy over the years from 1985 to 2020 and changes in the overall level of economic activities. The data describing these changes will be reported in the IEA and NRMP Working Papers (WP), of which this is the first.

The purpose of this paper is to provide a preliminary "case study" about technological changes in manufacturing and service sectors in Indonesia between 1985 and 2020. It is intended as a starting point for the more detailed case study on this subject that will be carried out in Jakarta; eventually the two versions will be integrated. The general methodology for input-output case studies is described in IEA WP#2 which includes a summary of the mathematical model and shows the layout of the "data sheets" that were designed expressly for this study. The new classification scheme, that accommodates both the 30-sector description (for the dynamic model) and the more detailed 75-sector description, presented in IEA WP#2, is repeated in the Annex to this Working Paper.

This paper describes two alternative scenarios about technological change, S1 and S2, in terms of the variables and

parameters of the input-output model. As in the other case studies, S1 assumes moderate government action to promote growth and protect the environment and S2 assumes a more aggressive policy. The text identifies the variables and parameters for which data must be provided in the base year, 1985, and how they will change in the future under each of the two scenarios. The variables and parameters, which are quantified in the tables, are expressed in terms of the 30 sectors of the dynamic model wherever possible. The projections are made in whatever way is most convenient: e.g, percentage change from the 1985 value or from the 1990 value of the same variable or parameter.

A set of data sheets accompany this paper. They contain the tabulated data in the even more standardized form required for direct incorporation in the database. For this standardization, additional assumptions may be required to convert all assumptions to the 30-sector level. In addition, all parameter projections for 2020 need to be expressed in a uniform way as the percentage change from the corresponding 1985 parameter.

One of the principal sources for the assumptions about technological change discussed in this paper is the information gathered for ten case studies conducted during the course of a recent exploration of worldwide development strategies by Duchin and Lange et al. (1992). Because of the nature of that report, this paper focuses on technological changes surrounding the future use of energy, and the data are based on projections for the

geographic region, Newly-Industrializing Asia, which includes other nations as well as Indonesia. Estimates for Indonesia that were obtained in this fashion have been supplemented by information about Indonesia from other sources, such as the Berkeley Lawrence Laboratories (Sathaye and Goldman, 1991; Schipper and Meyers, 1991), a description of industrial energy rationalization in developing countires (Gamba et al., 1986), and studies of specific technologies, e.g., Electric Power Research Institute (1988) or Paper. All of the data reported for household use of energy and for the pulp and paper sector have been developed from Indonesian data.

Detailed scenario assumptions about manufacturing technology, household consumption, construction, energy and material use, and atmospheric pollution are described in this Working Paper. Assumptions about agriculture, forestry, changing labor requirements, and the use of water and land will be described in other Working Papers. The scenarios are summarized in part B of this section.

Section 2 contains a discussion of the new classification scheme and describes revisions to the representation of energy use in the current IO tables required for this study. Some of these revisions have already been carried out and, in any case, this section can be skipped by readers not interested in these considerations. Sections 3 through 11 contain the assumptions and data about technological changes in the industrial sectors.

B. Summary of Assumptions

Two scenarios will be constructed for subsequent analysis. The first, S1, represents the levels of economic activity and the technologies which are likely to be put in place over the next 30 years. Under the second scenario, S2, additional measures are taken to reduce use of resources, mainly energy resources, and the emissions and other forms of environmental degradation associated with them.

The technical assumptions cover the likely future changes in household consumption, especially energy use, and in construction, transportation, electricity generation, and key manufacturing sectors: cement, metal processing, construction, pulp and paper, fertilizer, petroleum refining, and food processing. The changes in the use of energy, materials, and other inputs are achieved though current-account substitutions of some inputs for others, substitution involving labor or investment in new types of capital goods, or through some combination of these. In the case of investment, we assume that the new capital goods are phased in through the expansion of production that relies on new technology, or through the normal, rather than accelerated, replacement of capacity in place except where otherwise indicated.

The composition of household demand will change with changes in income and urbanization. Future use of commercial energy, especially electricity, by the average household will increase with urbanization, the substitution of commercial fuels for biomass, and

improvements in the standard of living. These increases will be offset to some extent by increased energy efficiency. Gains in energy efficiency of appliances are greater under S2 than S1.

Transportation is an extremely important complex of assorted activities. The number of motor vehicles per capita is assumed to increase roughly 4-fold (slightly more for automobiles, less for trucks and buses) over the next three decades. Moderate improvements are anticipated in the fuel efficiency of the average motor vehicle in the fleet by 2020 under S1; this requires an increase in capital costs of producing new vehicles. Under S2, fuel efficiency is projected to improve as rapidly for Indonesia as is likely for developed countries.

Both capital-intensive and energy-intensive, the generation of electricity is a critical sector in terms of resource and investment requirements and the generation of pollution. While electricity currently contributes a relatively small share to total energy use in Indonesia, in part because its unique geography prevents the establishment of an extensive electricity grid, it is expected to grow faster than any other energy source in the coming decades. The fuel mix used to generate electricity is projected to change, with the substitution of coal, gas and nuclear fuels for oil. Thermal conversion efficiency is likely to increase and losses in transmission and distribution are projected to fall; these improvements are made possible by increases in capital requirements. Under S2 combined-cycle natural gas plants provide

a greater share of electricity, further increasing conversion efficiency.

Under both scenarios, cement and metal processing are projected to rely more heavily on coal in the future and improve their energy efficiency. In the large, material-intensive construction industry, the share of maintenance and repair activities is expected to grow over the next several decades with compensating reductions in the share of new construction. In addition, with income growth and urbanization, there will be a significant expansion in the construction of buildings, which use more cement, concrete, and wood, relative to the growth of infrastructure and engineering construction, which are metal-intensive. Overall, the construction industry will be less material-intensive, although inputs of chemicals, mainly paint, aluminum, and labor will increase.

Both the production and the consumption of pulp and paper are expected to continue the rapid increases they have experienced since the late 1980's. As the sector matures, there will be a shift in the input structure as domestic pulp and domestic waste paper substitute for imports of these inputs and as the product mix shifts more toward writing and printing papers and packaging materials. These assumptions will need to be coordinated with those made for the forestry sector.

Industrial energy conservation holds significant potential for energy savings especially in selected industries including:

petroleum refining, food processing, fertilizer, textiles, and glass and clay products. These savings will be represented under both scenarios.

Presently, about 25% of manufacturing output (accounting for 75% of the manufacturing labor force) is produced by small-scale, cottage-style enterprises with low levels of labor productivity. A UNIDO report (UNIDO, 1990) identified several industries with a potential for significant growth in the future which are in this category: wooden furniture, textiles and apparel, machine tools, woodworking machinery, fabricated metal products, and rubber. Several other important manufacturing sectors already use relatively modern production techniques and equipment; these include leather and footwear, fertilizer and petrochemicals, pulp and paper, and basic metal processing.

In the future, Indonesia can be expected to upgrade much of the existing manufacturing capacity; and new capacity installed in the coming decades will use more modern, typically more capital-intensive, technology and require more skilled labor (UNIDO, 1990). In particular, the government is placing great emphasis on modern, computer-based manufacturing systems for the future. One notable example is a bilateral agreement with Japan which will set up CAD/CAM service and training facilities for the metalworking industry.

In order to represent the modernization of manufacturing technology in the scenarios, simple assumptions will be developed

about the replacement of capital and the changing composition of labor requirements for manufacturing sectors not explicitly addressed in this Working Paper. These assumptions remain to be quantified and are not discussed further in this paper. The projections will depend in part on whether or not it is possible to obtain some occupational (or other) detail regarding past and projected future labor requirements for individual sectors.

2. New Classification Scheme for the Dynamic Model

This study makes use of the 19-sector dynamic input-output model and database and the 71-sector static model and database that were developed by Duchin and Lange in an earlier study (1992). In that study, the physical, price, and income versions of the model were implemented in an integrated although preliminary fashion.

For present purposes, it is necessary to extend that framework in several ways. First, the sectoral classification scheme needs to be disaggregated to accommodate the detail of the scenarios to be analyzed. While it is desirable to measure as many variables as possible in physical units for use with the physical model, we will attempt, as our second objective, to do so at least for the energy variables. Whether or not this is possible will depend upon the availability of additional information.

The current classification of the 19-sector dynamic model will be disaggregated to 30 sectors to better reflect the sectors of importance in the scenarios. Part A of this section provides an overview of this classification scheme. Because of the importance of energy use, and the difficulty of obtaining some of the data required for the representation we propose, a separate discussion of the energy sectors is provided in part B. The 71-sector static model will also be expanded to accommodate additional detail about energy. The new classification scheme, which accommodates both the 30-sector and the 76-sector levels of detail, is given in Annex A.

A. The Expanded Dynamic Model: 30-Sector Classification Scheme

The sectors covered by the case studies are shown in the new classification in Table 1 along with the corresponding sectors at the 19-, 66-, and 169-sector levels, except for Electricity, Petroleum refining, and fossil fuels which are addressed separately in part B. The new classification scheme takes into account the needs of the scenario components and the realities of energy and water resource use. The sources of data for the disaggregation from the more detailed input-output tables are identified in Table 2. Data required for the transformation from money values to physical units have not yet been obtained.

Table 1. Sectors Identified in Scenario Components and Their Representation in the Various Classifications

	19-Sector IO Table	66-Sector IO Table	169-Sector IO Table	New Classification[a]
Households, urban and rural	Household Consumption	Household Consumption	Household Consumption	Household Consumption
Transportation Services	pt. #15 Transportation and Communication Services	#55-59 Rail, Road, Water, Air Transport, and Services	#149-155 Rail, Road, Water, Air Transport, and Related Services	#26.1-26.5 (detailed)
Motor Vehicles	pt. #9 Manufacturing	pt. #48, Machines; pt. #49, Transportation equipment and repair	#120, Motor vehicles; #126-131, Other transportation equipment and repair (detailed)	pt. #17.9 Transportation Equipment and repair
Cement	pt. #9 Manufacturing	#44 Cement and limestone	#111 Cement and limestone	#16
Construction	#12 Construction	#52 Construction	#141-145 Construction (detailed)	#23
Metal Processing	pt. #9 Manufacturing	#45 Basic iron and steel; #46 Nonferrous basic metal	#113 Basic iron and steel; #114 Nonferrous basic metal	#17.5 #17.6
Food Processing	pt. #8 Food processing and tobacco	#27-33 Food processing (detailed)	#52-72 Food processing (detailed)	#11.1-11.8 (detailed)
Fertilizer	pt. #9 Manufacturing	#39 Fertilizer and pesticides	#94 Fertilizer and pesticides	#15
Chemicals	pt. # 9 Manufacturing	#40 Chemicals	#93-103 Chemicals (detailed)	#14
Pulp and Paper	pt. #9 Manufacturing	pt. #38 Paper (including Pulp), cardboard and products, printed material	#90 Paper (including Pulp) and cardboard	#13
Textiles	pt. #9 Manufacturing	#36 Textiles, apparel, leather goods	#76-83 Textiles, apparel, leather goods (detailed)	#17.1 and 17.2

Note: "pt." means "part of."

[a]See Annex A for detailed sector names.

Table 2. New 30-Sector and Former 19-Sector Classifications for the Dynamic Model

19-Sector Classification		New Classification (source of data in parentheses)	
1	Paddy	1	Paddy
2	Other Farm Food Crops	2	Other Farm Food Crops
3	Other Agricultural Crops	3	Other Agricultural Crops
4	Livestock and Products	4	Livestock and Products
5	Forest Products	5	Forest Products
6	Fisheries	6	Fisheries
7	Mining	7	Coal (#39, 169-sector)
		8	pt. Crude oil and natural gas (#40, 169-sector)
		9	pt. Crude oil and natural gas (#40, 169-sector)
		10	Other Mining
8	Food and Tobacco Products	11	Food and Tobacco Products
9	Manufacturing	12	Wood products (#37, 66-sector)
		13	Pulp, paper and products (#38, 66-sector)
		14	Fertilizer (#39, 66-sector)
		15	Chemicals (#30, 66-sector)
		16	Cement (#44, 66-sector)
		17	Other manufacturing
10	Petroleum Refining and Products	18	Oil refineries and products (#101, 169-sector)
		19	Liquid natural gas (#102, 169-sector)
11	Electricity, Gas, and Water Utilities	20	Electricity (pt. #139, 169-sector)
		21	Gas Utilities (pt. #139, 169-sector)
		22	Water Utilities (#140, 169-sector)
12	Construction	23	Construction
13	Trade	24	Trade
14	Restaurants and Hotels	25	Restaurants and Hotels
15	Transportation and Communication	26	Transportation and Communication
16	Financial and Business Services	27	Financial and Business Services
17	Public Administration	28	Public Administration
18	Services	29	Services
19	Unspecified	30	Unspecified

B. Representation of Energy

If energy use is represented in energy-equivalent units, the physical basis for atmospheric emissions can be represented explicitly and the technological projections discussed in this paper can be readily incorporated into the database. There are a

number of obstacles to transforming the current representation of energy in the IO tables to the representation intended (if possible) for this study, including the need for supplementary data.

Ideally, the production of electricity and the extraction and processing of each fossil fuel would be represented as separate sectors, measured in energy equivalent units, e.g., megajoules, tons of coal equivalent (tce) or tons of oil equivalent (toe). Unfortunately, however, data describing energy are aggregated and represented only in money values in the classification scheme and database used for the 19-sector dynamic model and in the official IO Tables on which they are based. The classifications of energy-related sectors in the 19-sector dynamic model, the 66-sector, the 169-sector IO Tables and in this study are shown in Table 3. Some aggregation occurs even in the most detailed table available.

Coal is currently a relatively unimportant source of energy. However, it will become increasingly important in the future for electricity generation, industry, and households. In the 19-sector classification scheme it is combined with other minerals (#7). At the 169-sector level, it is a separate sector (#39). It is also separate sector in the new classification (#7). The figures in the column and row corresponding to the Coal sector in the 1985 IO Tables can be converted to tons if either a unit price or the physical output in 1985 were provided. Information about the

Table 3. Sectors Representing Energy in the Input-Output Classifications and Their Conversion to Appropriate Sectors and Units of Measurement

A. Energy Sectors in the Input-Output Tables

19-Sector Dynamic Model	66-Sector IO Table	169-Sector IO Table	New Classification
#7 Mining	#24 Coal and metal ore mining	#39 Coal mining	#7 Coal Mining
	#25 Crude oil and natural gas mining	#40 Crude oil and natural gas mining	#8 Crude oil #9 Natural gas mining
#10 Petroleum refining	#41 Petroleum refining	#101 Oil refineries and their products	#18 Oil refineries
		#102 Liquid natural gas	#19 Liquid natural gas
#11 Electricity, gas, and water supply	#51 Electricity, gas, and water supply	#139 Electricity and gas supply	#20 Electric Utilities #21 Gas Utilities

B. Data Requirements for the Disaggregation of Energy-Related Sectors and Conversion to Energy Equivalent Units

(All information required for 1985; prices required in 1985 Rp.)

All sectors	If conversion is not based on IO Tables: Independent information about deliveries of energy to each sector of the economy including final deliveries in energy equivalent units
OR	If conversion is to be made by transforming rows and columns of IO Tables:
Coal	1. Tons of output of coal OR 2. Average price per ton of coal in 1985 and 3. Energy content of average ton of coal
Crude Petroleum and Natural Gas	1. Output of crude petroleum, in energy units or barrels, tons, etc. 2. Output of raw natural gas, in energy units or cubic meters, etc. 3. If data are provided in volume or mass units, energy content of volume/mass must be provided for a. crude petroleum, and b. natural gas 4. Final Deliveries of each product
Petroleum Refining	1. Average prices of major petroleum products 2. Average energy content of major petroleum products 3. Distribution among sectors of major petroleum products 4. Output, deliveries and price of liquid natural gas OR 5. Output of petroleum products and of LNG in value terms, use of each by other sectors, a single price for LNG and the average price and energy content of all refined petroleum products (for a crude measure of petroleum products in energy equivalent units).
Electricity	1. Total output of electricity 2. Deliveries to sectors in both value units and kWh
Gas Utilities	1. Output of gas utilities 2. Deliveries to sectors in both value units and energy equivalents (or cubic meters and energy content of a cubic meter).

energy content of the average ton of Indonesian coal would also be required to complete the conversion of this sector to energy equivalent units.

The extraction of crude oil and gas are combined with all other mining in sector #7 of the 19-sector table, and the two products are not separately distinguished in the detailed tables either; we will disaggregate them in the new classification (#8, #9). These products, in most instances, must be processed before they are used; hence they are delivered primarily to Petroleum refining, Electricity, gas, and water utilities, or exported, with a small amount delivered to Fertilizer to be used as a feedstock. It is reasonable to assume that crude petroleum is delivered to Petroleum refineries and natural gas to Gas utilities and, probably, to Fertilizer and on this basis alone a rough disaggregation could be achieved. Both products are exported, but even the 169-sector table does not specify in what proportions.

Information about the output of crude petroleum and natural gas, measured in equivalent units of energy content, and the deliveries of each to final users, would be sufficient to disaggregate and convert this row and column to the appropriate unit. If the information is not available, a crude disaggregation can be performed since the two products are used only by a few, and largely by different, sectors.

The uses of petroleum products and liquid natural gas (LNG) are represented by inputs from Petroleum refining (row #10) to

other sectors of the economy. Even at the 169-sector level, these two commodities are combined. Information about the output and deliveries of each to other sectors of the economy will be required to disaggregate this sector to #18 and #19. For conversion to energy equivalent units, a price for each product will be required. A single, economy-wide average price will be sufficient for LNG, but the prices of petroleum products differ substantially so that use of a single price for the conversion of petroleum products is not desirable. Prices for specific petroleum products and information about the distribution of specific products are required to convert this row to physical units. If these data are not available, a crude conversion can be made on the basis of an average price per ton and energy content per ton of refined petroleum products.

Natural gas utilities and electricity are more problematic: the two products are combined even in the 169-sector IO Table and we have no basis for distinguishing the deliveries of electricity to other sectors from deliveries of natural gas. Also, the inputs of processed gas as a fuel for electricity generation cannot be distinguished from the use of electricity by the electricity sector. These sectors need to be split to distinguish electric, gas, and water utilities (#20, #21, and #22); but additional data not available in the input-output tables are required to do so.

3. Households: Energy Use and Consumption of Other Goods and Services

The scenarios describe future household consumption of the full range of goods and services but most of our attention focused on the changing use of energy in households. Projections about the future consumption of other goods and services are part of the macroeconomic projections (Hamilton and Hulu, 1992) which include projections about the levels of consumption of individual goods and services. We have nonetheless made independent estimates of the energy-related sectors to assure consistency between these projections and the assumptions about energy in other aspects of the scenarios.

Future household use of energy depends upon both increases in energy services and changes in the energy efficiency that can be achieved in delivering these services. End-use studies, such as those conducted by the Lawrence Berkeley Laboratories about Indonesia, typically treat residential energy use and transportation energy use separately. In the IO Tables, household energy use is represented as purchases of energy by households for all purposes combined, both residential and for transportation. To make use of the technical data gathered by end-use studies, the shares of household energy used for residential vs. transportation purposes (the latter involves the purchase of oil only) need to be known, and projections must be made separately for each of the two categories of household energy use. Estimates of the shares of oil used by households for different purposes in the 16 major regions

of the world economy have been made by Duchin and Lange et al. (1992).

In the dynamic input-output model, household consumption is treated as part of final deliveries. It is represented by a vector of levels of consumption. By contrast, other sectors addressed in this paper are represented by vectors of input coefficients (inputs per unit of output). Projected levels of consumption of energy commodities in 2020 will be based on rates of change applied to the 1985 levels of consumption of energy products.

A. Residential Energy Use

Energy is used in residences for lighting, cooking, refrigeration, and ironing as well as powering fans, air conditioners, and other appliances. In Indonesia, there is a vast difference between rural and urban households in terms of both the type of energy used (biomass vs. commercial fuels) and the level of energy use per household: an urban household typically uses as much as an order of magnitude more energy than a rural household. This is partly because of the greater availability of commercial energy in urban areas and partly because higher household income in urban areas makes possible the greater use of appliances.

The use of energy by households in 1985 and projections of rates of change of energy use between 1985 and 2025 made by Sathaye and Goldman (1991) are shown in Table 4 for two scenarios, assuming 3% average annual growth of GDP. Sathaye and Goldman consider their High Energy Scenario a "most likely" projection; the Low

Energy Scenario assumes measures are taken to encourage the use of more energy-efficient appliances and greater use of natural gas. Their scenarios correspond in intent to the scenarios S1 and S2, respectively, that will be used in this study. The rates of change in energy use projected by Sathaye and Goldman are used to project energy use by households for 2020 for use with the dynamic model. These projections are shown in Table 4 for the scenarios S1 and S2, and the assumptions behind them are discussed below. For completeness, use of biomass by households is included in Table 4, though fuels of biological origin are not explicitly identified in the classification scheme. Biomass is a major source of energy for households and some industries and may be added as a sector in future work.

These projections rely heavily on assumptions about urban and rural households in 1985 and about future changes regarding each set of households made by Schipper and Meyers (1991). Schipper and Meyers provide a detailed analysis of urban household energy use in Indonesia, based on the Household Energy Strategy Study conducted by the World Bank. Projections for the year 2011 were made on the basis of presumed appliance saturation and improvements in energy efficiency. The current design of domestically produced and assembled household appliances is roughly equivalent to Japanese design of ten years ago. Assuming that design advances will continue to parallel Japanese design (Japanese are the main partners for manufacture of household appliances in Indonesia),

Schipper and Meyers' projection of a 50% improvement in energy efficiency between 1985 and 2011 provides a plausible basis for the 50% improvement assumed between 1985 and 2025 by Sathaye and Goldman.

Table 4. Residential Energy Use in 1985 and 2020 under Scenarios S1 and S2

(petajoules, except electricity in billions of Kwh)

		Average Annual Percentage Growth		2020	
	1985	High Energy Scenario	Low Energy Scenario	Scenario S1	Scenario S2
Oil	308	0.8%	-1.1%	402	207
Gas	8	8.5	10.9	139	302
Coal	0	na	na	107	45
Total fossil fuel	316	2.1	1.6	648	554
Biomass*	421	0.7	0	537	421
Electricity					
Total	5.4	4.4	4.1	24.5	21.5
Urban	5.3	4.3	3.9	23.2	20.2
Rural	0.1	7.5	7.5	1.3	1.3

*not included in the classification scheme.

na: not applicable.

Note: "High Energy" and "Low Energy" scenarios, defined by Sathaye and Goldman for the period through 2025, are discussed in the text.

Source: Institute for Economic Analysis, based on Sathaye and Goldman, 1991.

In the World Bank survey of urban household energy use, households were classified into five income groups. The average household's energy use in 2025 is assumed to equal that of the highest income group in 1985 (Sathaye and Goldman, 1991), an assumption that also appears plausible.

The assumptions in the last two paragraphs, about the level of energy services used and the energy required to deliver these services (1985 levels adjusted for projected efficiency

improvements), are the basis for the projections of future household energy use.

Use of commercial fuel under the scenario S1 is projected to double between 1985 and 2020. In 1985 households used petroleum products almost exclusively (98% oil and 2% natural gas). By 2020, they are projected to use much more natural gas (22% of all fuel) and coal (17%) and much less oil (62%). Under the scenario S2, fuel use rises less rapidly and gas will account for an even greater share (55%), with less use of coal and oil: 8% and 37%, respectively.

The use of biomass is projected to rise slowly under the scenario S1 and to remain constant under the scenario S2 with the introduction of more efficient stoves and greater use of electricity for cooking.

The doubling of electricity use by the average rural household, combined with a more than five-fold increase in the share of households which are wired for electricity and the projected increase in the number of rural households, results in electricity use in rural areas in 2020 roughly 13 times the 1985 level. Similarly, the increase in the use of electricity in the average urban household, combined with the increase in the number of urban households and the share which receive electricity, result in a 4-fold increase in urban electricity use under the scenario S2 and a slightly greater increase under the scenario S1. Total electricity

use grows by more than 4% annually under both scenarios between 1985 and 2020.

B. Energy for Motor Vehicle Transportation

Detailed projections about transportation, assumed to affect both households and the Road Transportation Services sector (#26.2), are discussed in Section 4 below. No information was available about the share of the motor vehicle fleet operated by households or about the share of oil purchased by households which was used for transportation. In Duchin and Lange et al. (1992) the share of transportation in household oil use was estimated at 40% in 1990 for the entire region of Newly-Industrializing Asia. This figure is assumed for Indonesia in 1985. We assume that all the changes projected for transportation -- rate of growth of fleet, gains in energy efficiency, changes in average vehicle miles drive --apply equally to all sectors using motor vehicles. Assumptions about the size and use of the motor vehicle fleet discussed in Section 4 apply to household transportation as well.

Motor vehicle density is projected to grow roughly 4-fold between 1990 and 2020 and fuel efficiency increases 25% under the scenario S1 (based on Duchin and Lange, et al., 1992). The more rapid growth of oil for transportation purposes than for residential purposes (see Table 5) means that the transportation share of oil in household energy use increases from 40% in 1985 to 63% in 2020 under the scenario S1.

Table 5. Household Use of Oil for Transportation and Residential Purposes in 1985 and 2020 under the Scenarios S1 and S2

(in petajoules)

		2020	
	1985	Scenario S1	Scenario S2
Transportation	308	678	516
Residential	205	402	207
Total	513	1080	723
Average Annual Rate of Growth between 1985 and 2020		2.1%	1.0%

Sources: Table 4 and Institute for Economic Analysis projections.

Under the scenario S2 we assume gains in fuel efficiency equivalent to those projected for developed countries, a 50% improvement between 1985 and 2020, and also assume greater growth in the use of motorcycles rather than cars. Consequently, the share of oil used by households for transportation increases to about 70% by 2020.

4. Road Transportation Energy Use

Transportation activities are undertaken primarily by the Transportation Services sector and households. For the purposes of constructing scenarios about the future, we will consider transportation activities in these two sectors only. In the 30-sector classification scheme, commercial road transportation activities are included under Transportation and Communications Services (sector #26 at the 30-sector level). However, at the more detailed level, the two are disaggregated (#26.2 and #26.5). Changes discussed in this section will be incorporated in the 76-sector matrix which will then be aggregated for the 30-sector representation.

Duchin and Lange et al. (1992) assumed that the average fuel efficiency of the motor vehicle fleet of Newly-Industrializing Asia will increase by 25% by 2020 and that the number of motor vehicles per capita would increase roughly 4-fold (more for automobiles, and less for trucks and buses, while motorcycles were not explicitly addressed). In this study, we assume a fuel efficiency gain of 25% in Indonesia under the scenario S1 and 50%, the same as that projected for developed countries, under the scenario S2. The fuel efficiency gains are made possible by a 20% and 30% increase in the capital costs of producing an average new vehicle under the scenarios S1 and S2, respectively. With the rapid increase in the number of motor vehicles, the number of miles driven by the average vehicle is projected to decrease by 15% under the scenario S1 and

10% under the scenario S2. The size of the stock of motor vehicles required per unit of Transportation Services will increase by a corresponding amount.

Our projections are similar to those made by others, e.g., Sathaye and Goldman (1991); the latter are, however, more optimistic about the gains in fuel efficiency achieved in the future, but they do not discuss how these improvements are to be achieved. Since individual modes of transportation are not distinguished in the 30-sector classification scheme, the changes in fuel efficiency, represented by reductions in the oil input coefficient, will be applied to the entire Transportation Services sector under the assumption that similar gains in fuel efficiency are achieved by the other modes. No assumptions have been made about the use of natural gas or biomass for transportation.

Table 6. Change in Coefficients Related to Transportation in 2020 Relative to 1985 under the Scenarios S1 and S2

	S1	S2
Petroleum Inputs to Transportation Services (#26)	-25%	-50%
Motor Vehicle Inputs to Capital Requirements of Transportation Services (#26)	+15	+10
Capital Inputs to Motor Vehicles (part #17; #17.9 in 76-sector database)	+20	+30

Note: Household transportation activities are discussed in Section 3.

5. Electricity Generation

The generation of electricity (sector #20) is an important sector in terms of resource use, pollution, and investment requirements. While electricity currently contributes a relatively small share of total energy, it is expected to grow faster than ther energy sources in the coming decades to satisfy both industrial and household requirements. Most electricity production is concentrated on Java (60% in 1986, as much as 70% by 2011) where an extensive electric grid exists.

Thermal conversion efficiency in Indonesia, which fell from 30% to 26% between 1981 and 1986 (UN, 1988), is projected to rise, reaching the current rate of developed economies (35%) by 2020. (See Table panels A and B). Improved efficiency, as well as reduced losses from transmission and distribution, will result from the large cogeneration plants that will be installed in individual sectors, notably in Pulp and Paper mills. Conversion efficiency could improve even more if advanced, combined-cycle, natural gas plants are used extensively. Such plants could constitute as much as 23% of capacity in Java by 2011, but this share may decline thereafter unless additional natural gas reserves are found (Agency for the Assessment and Application of Technology and Nuclear Research Centre, 1988).

Losses in transmission and distribution have been falling since the early 1980's and will continue to fall, reaching 15% by 2020 (see panel A of Table 7). Losses will not fall to the rate in

developed economies (10%), however, because of natural obstacles (i.e., many islands spread over a vast distance) to establishing a more efficient, national electrical grid. The parameters that will be used for the scenarios S1 and S2 are given in panel B of Table 7. According to Duchin and Lange et al. (1992), projected improvements in conversion efficiency and losses in Newly-Industrializing Asia were assumed to require a 20% increase in capital inputs per unit increase in capacity. The same assumption is made for Indonesia.

Table 7. Parameters Governing Thermal Conversion Efficiency and Losses in Transmission and Distribution, and Production of Electricity by Source in the 1980's and 2020 Under the scenarios S1 and S2

A. Current and Projected Thermal Conversion Efficiency and Losses in Transmission and Distribution

	Thermal Conversion Efficiency	Losses in Transmission and Distribution
1981	30%	21%*
1985	28	19
1986	26	16
2020, projected		
Scenario S1	36	15
Scenario S2	39	15

B. Change in Input Requirements Due to Changes in Projected Thermal Conversion Efficiency and Losses in Transmission and Distribution

	Fossil Fuels	Own Use of Electricity	Capital Coefficients
Scenario S1	-28%	-21%	+20%
Scenario S2	-39	-21	+20

Table 7 (cont'd)

C. Electricity Production by Source in 1985 and 2020 Under the Scenario S1 and S2

	1985	2020 Scenario S1	2020 Scenario S2
Thermal	77.9%	60%	60%
oil	60.1	20	15
gas	14.3	20	30
coal	3.5	20	15
Hydro-electric	21.4	35	35
Geothermal	0.7	1	1
Nuclear	0	4	5
Total	100.0 (28.8 GWh)	100	100
Change in capital requirements per unit of output relative to 1985 capital requirements		+17%	+15%

D. Total Change in Input Coefficients to Electricity Production Relative to 1985

	2020 Scenario S1	2020 Scenario S2
Oil	-76%	-85%
Gas	+29	+67
Coal	+339	+200
Electricity	-21	-21
Capital Requirements	+37	+35

*1983

Sources: panels A and B: 1981-1986: United Nations, 1988; 2020: Institute for Economic Analysis projections.
panel C: 1985: UN, 1988; 2020: Institute for Economic Analysis projections.
panel D: Derived from panels B and C.

The mix of fuels used to generate electricity is projected to change: the share of electricity produced with oil will fall while the use of gas, coal, hydroelectric and nuclear technologies increases. In addition to changes in current-account inputs, this change will require increases in capital requirements. The distribution of sources of electricity in 1985, according to UN

(1988), is shown with our projections for 2020 under the scenarios S1 and S2 in panel C of Table 7.

Typically, coal and nuclear plants, and some installations for hydroelectric power production, require more capital per unit of output than technologies that use other fuels (Electric Power Research Institute, 1988). By 2020, capital requirements per unit of output resulting from the changing mix of energy sources used to generate electricity will increase 17% and 15% under the scenarios S1 and S2, respectively.

The combined effect of changes in conversion efficiency, losses, and changing fuel mix on input parameters to electricity production are given in panel D of Table 7. No significant changes in labor requirements are anticipated. There are no plans to install equipment to reduce the emission of sulfur or nitrogen on existing or new electric power capacity (BPPT and KFA, 1988).

6. Pulp and Paper

The first Repelita (1969 - 1973) envisaged a large-scale, domestic pulp and paper industry (#13) for Indonesia but it was not until 1987, the year in which Indonesia became a net exporter, that its implementation began to be realized. Considering the country's extensive forestlands, short growing period, inexpensive raw materials and labor, and the policy of promoting exports other than oil and gas, this sector is likely to remain one of the fastest-growing in the economy in the next decade. The government has been spinning off this industry to the private sector. The portion of Pulp and Paper capacity that is privately owned has risen from 20% in 1980 to 80% in 1990, and bidders are now being sought for 6 state-owned mills. All new capacity is likely to be privately owned.

There are, however, several potential bottlenecks. One is obtaining financing for expansion in this extremely capital-intensive sector: a single pulp mill with a capacity of 2,000 tons per day costs about a billion US dollars (Paper, p. 18). The government has blocked foreign borrowing because of the concern about foreign debt, and domestic interest rates are extremely high. Other problems are the shortage of skilled manpower, reliance on imported machinery and waste paper, and interruptions in the supply of power. Nonetheless, major new projects are being realized.

In a single project currently underway at Indah Kiat, 570,000 tons per year of chemical pulp capacity and 360,000 tons per year

of printing and writing paper capacity are planned for the end of 1993. Two even larger projects are in the stage of advanced planning; if actually implemented, each could produce a million tons per year of pulp and as much as 600,000 tons per year of paper. The capacity of each of these two projects amounts to practically the entire country's pulp capacity in 1990 and more than one-third of its paper capacity.

This section contains preliminary projected values for some of the parameters and variables that will be used to represent the Pulp and Paper sector over the period from 1990 to 2020. The assumptions that have been made about the growth in pulp and paper production will have to be reviewed and integrated, subsequently, with those that will be made about forestry and water (in companion Working Papers). At that time, the remaining parameters will be quantified.

A. Capacity

Indonesian pulp and paper capacity in 1980 and 1990 are shown in Table 8 along with projections for 1995 and 2000 from the published literature. The implicit average annual rates of growth for individual sub-periods are also show. We have made projections for the likely future rates of growth of capacity between 2000 and 2020 based on this information.

Pulp is disaggregated in the table according to the three principal technologies for its production: chemical, which will be used for most of the new capacity in the 1990's, semi-chemical and

mechanical. The major categories of paper are newspaper, printing and writing (also known as "cultural") paper, which is expected to grow the fastest in the first half of the 1990's, and all others. The last category includes papers for packaging.

Capacity for producing paper grew at almost 20% in the 1980's and is likely to continue to grow almost as fast in the first half of the 1990's. This growth should taper off to 6% in the second half of the 1990's reaching a total capacity of over 5 million tons a year in 2000. We project a slightly lower rate of growth over the following 20 years.

Table 8. Capacity for Pulp and Paper in 1980 and 1990 and Projections for 1995 and 2000

	(thousands of tons) capacity					Average Annual Rates of Growth			
	1980	1990	1995	2000	2020	1980-1990	1990-1995	1995-2000	2000-2020
Pulp									
Chemical		803	1675	3000	9621		15.8	12.4	6.0
Semi-Chemical		175	515	515	1652		24.0	0	6.0
Mechanical		60	60	240	770		0	32.0	6.0
Total	103	1038	2250	3755	12043	26.0	16.7	10.8	6.0
Paper									
Newsprint		180	300	500	1995		10.8	10.8	7.0
Cultural		600	1536	2000	5307		20.7	5.4	5.0
Other		941	1969	2600	8308		15.9	5.7	6.0
Total	292	1721	3805	5100	15570	19.4	17.2	6.0	5.7
Ratio of Pulp to Paper (%)	35	60	59	74	77				

Source: 1980 - 2000: Pulp and Paper International, November 1991, p.83, and other sources. Projections for 2020 were made by IEA.

The capacity to produce pulp was only about 35% (in tons) of that for producing paper in 1980. Pulping capacity grew at a dramatic rate of 26% a year throughout the decade; it reached 60%

of the paper capacity in 1990 and is likely to rise to 74% by 2000 assuming that growth rates well over 10% can be maintained during the 1990's. We project that this capacity will grow at 6% a year, slightly faster than paper, between 2000 and 2020. (This is the variable c^*.) While this still leaves a shortfall of pulp for the paper industry (discussed below), we will depend upon the discussion in the Working Paper about forestry to determine if even this rate of growth is feasible.

B. Production and Consumption of Paper and Pulp

As the growth in demand for paper slows down in the developed countries, Southeast Asia is expected to be the locus for the greatest growth in both production and demand over the next decade or two.

Production, consumption and trade of paper and pulp in Indonesia are shown in Table 9 for 1980, 1990, and 2000. These figures have been assembled from various places and are not available for all the years. These can serve as guidelines for evaluating consumption, exports, and imports as reported in the columns of final deliveries in the 1985 input-output table and in the projections that were made for 2020. At the present time the latter are in value units while the figures in Table 9 are measured in tons.

Per capita consumption of paper in Indonesia, shown in Table 9, is among the lowest in the world. While some have estimated that it will grow from 7 kg in 1990 to 12 kg a year by 2000, this

Table 9. Production and Consumption of Paper and Pulp (#13) in 1980 and 1990 and Projections for 2000

(thousands of tons)

	1980	1990	2000	Average Annual Rate of Growth 1980-1990	1990-2000
Paper					
Consumption	512	1371	2496[a]	10.4	6.2
Consumption per capita (kg)	3.5	7.0	12.0		
Production	232	1438		20.0	
Exports			1000		
Direct Employment	8400	33200			
Pulp					
Consumption	83	701			
Exports	0	180	900		
Imports		140	400		
Waste Paper Imports			800		
Domestic Waste Paper Use	66	187			

[a]estimated

Source: Pulp and Paper International, various issues.

is probably an overestimate. The industry cannot count on the expansion of the domestic market and is very much oriented toward export. By contrast with Indonesia, per capita use of paper is expected to exceed 100 kg by a wide margin in South Korea and will reach nearly 400 kg in the US by 2000.

Until now, the shortfall in domestic pulp production relative to requirements of the paper industry has been met by the use of domestic waste paper and imports of pulp and, especially, waste paper from the US. In 1990, 50% of the fibre used was recycled (Paper, p. 29). In the future, the use of domestic waste paper will become relatively more important because of greater availability and collection efforts. In addition, imported wastes

may become scarcer as other countries also increase their use of recycled materials.

C. Technology

Most of the capacity in place, and most of the new pulp capacity that will be installed in Indonesia in the 1990's, will make use of chemical pulping (see Table 8). This is the most expensive pulping technology as it requires not only more chemicals but also more energy and greater amounts of capital per ton of pulp capacity. The advantage is that it is less destructive of the fibre than mechanical pulping; for this reason, it is used where paper strength is important, like in the production of packaging materials. Future input requirements to the Indonesian Pulp and Paper sector, especially of chemicals, will depend upon technological advances as well as on the mix of products produced in Indonesia. We have assumed that the rapid growth of newsprint, which can use mostly non-chemical pulp, will be moderated after 2000 (see projections in Table 8) and that the other pulping technologies will grow at the same rate as chemical pulping (also shown in Table 8).

Despite the rapid growth of the pulp industry, it is anticipated that softwood pulp will continue to be imported. While observers expect that there will be increased recovery of domestic waste paper, there will probably also continue to be imports at least through 2000. To the extent tha stepaper displaces pulp,

the input of pulp to the paper sector (i.e., the diagonal element at this level of aggregation) will fall.

Despite a shortfall of softwood pulp, the literature suggests that a surplus of nearly one million tons per year of hardwood pulp is expected to be available for export by 2000. Softwood pulp is used for packaging and high-quality, glossy cultural paper while hardwood pulp is used to make xerographic paper, newsprint, and publication paper such as that used in telephone directories or catalogues.

The need of the Pulp and Paper sector for electricity cannot be satisfied by the existing Indonesian infrastructure. Under-utilized paper capacity is in part explained by disruptions in the provision of power. For this reason, pulp and paper mills will increasingly supply their own electricity and steam. They will also provide housing for employees and will take the initiative in training their own personnel.

The question arises as to how to represent these activities in the input-output database. Since these services are not the principal outputs of the sector in question, the inputs necessary to produce them are conceptually "redefined" to the sectors for which they are the primary outputs. This means that the electricity produced by Pulp and Paper for its own use will be represented as a purchase by the Pulp and Paper sector from the electricity utility. The electricity sector defined to include power generation in other sectors will, as a consequence, be more

productive for a number of reasons: the pulp and paper mills will tend to use the efficient technique of cogeneration because of their need for steam as well as electricity; they will use less purchased fossil fuel per kWh because of the availability of wood and agricultural wastes, rice straw, and bagasse; and finally, the losses due to distribution will be held to a minimum because the cogeneration equipment will be on-site.

The future of this sector is highly dependent on government policies regarding forests and plantations (as well as the availability of financing). Other upstream sectors will, in turn, depend upon it. Virtually all the equipment needed by the Pulp and Paper sector are now imported. Yet many fabricated metal requirements, like tanks, digesters, and piping, could be satisfied more quickly and cheaply by domestic producers. The percentage of these items that is imported can be expected to fall in the future. These major linkages need to be represented in the scenarios that are being constructed.

Environmental concerns regarding land, water, and air surround the Pulp and Paper sector. While tropical hardwood forests are still being cut, most new pulp mills will depend upon plantations, and mills with a capacity over 1,000 tons per day now need to be located outside of Java (Paper, p. 27).

As is already the case with electricity, availability of water may become a problem: the government has indicated that it might have to cut the supply to the Pulp and Paper sector by 30% if there

is a general shortage. Effluents from these mills discharged into bodies of water affect BOD and COD, contain high concentrations of suspended solids, and have a high Ph. Waste-water treatment facilities are required on new plants, and old ones in principle have a three-year period to come into compliance. Nonetheless, the daily newspapers still carry stories of toxic discharges from Pulp and Paper plants.

The coefficient changes associated with an increase in recycling to provide as much as 60% of the fibre inputs are shown in Table 10. The other parameter changes have not yet been tabulated.

Table 10. Coefficients Changes in the Pulp and Paper Sector Associated with the Recycling of Paper

	Change between 1990 and 2020 (%)
All energy inputs	-7.5%
Virgin wood (Forest products, #5)	-20
Chemicals (#15)	+7.5

Source: This is half the rate assumed for Newly-Industrializing Asia in Duchin and Lange et al. (1992).

7. Cement

Total fuel input requirements per ton of cement production (#16) are expected to decline roughly 40% (about 1.4% annually) between 1985 and 2020, with a switch from wet to dry cement processing and an expansion of the scale of operations made possible by a rapidly growing economy and improved transportation infrastructure.

Coal is projected to substitute increasingly for oil in cement production in future years. Estimates made by Duchin and Lange et al. (1992) for Newly-Industrializing Asia, given in Table 11 for 1980, 1985, 1990 and 2020, have been revised to reflect information about Indonesia's cement industry obtained from (Gamba, Caplin, and Mulckhuyse, 1986). No estimates of changes in capital or labor requirements have been made.

Table 11. Fuel Inputs per Ton of Cement in 1980, 1985, 1990 and Projections for 2020 under the Scenario S1 and S2

(tce per ton of cement)

	1980	1985[a]	1990	2020
Oil	0.118	0.107	0.086	0
Gas	0	0	0	0
Coal	0.024	0.022	0.029	0.079
Total fossil fuel	0.142	0.129	0.115	0.079

[a]fuel inputs for 1985 are assumed to be the average of 1980 and 1990 input requirements.

Source: Figures are for the region, Newly-Industrializing Asia, in Duchin and Lange et al. (1992); revised with information from Gamba, Caplin, and Mulckhuyse (1986).

8. Construction

As the entire industry expands between 1985 and 2020, maintenance and repair construction is expected to become an increasingly important component of the Construction sector (#23). This assumption is significant because replacement and maintenance construction activities are considerably less material-intensive than new construction although they require increased inputs of chemicals, mainly paints, and labor.

Within new construction, there will be a significant expansion in the construction of buildings due to income growth and urbanization, and relatively slower growth of infrastructure and engineering construction. The former uses more cement, concrete, and wood, while the latter is more metal-intensive. Aluminum, produced in Indonesia in growing quantities, will substitute for many other materials in construction.

The combined effect of these assumptions about construction is a reduction in the physical quantity of raw materials required per average structure. Estimates of the average annual percent change of input coefficients to construction for Indonesia, based on the assumptions of Duchin and Lange et al. (1992) for Newly-Industrializing Asia, are shown in Table 12. These changes contribute toward a substantial direct savings of energy per unit of output of the construction sector. No changes have been projected for the input of Wood products (#5), an assumption we may revise given the importance of this input to the construction

industry in Indonesia. While labor requirements may increase slightly, we have not made estimates of changes in labor coefficients in this paper.

With the new sectoral classification, the projections about inputs of chemicals (#15) and cement (#16) can be directly incorporated in the 30-sector database. Projections about other inputs will have to be incorporated at the 76-sector level and aggregated to 30 sectors. The same projections are used in both scenarios.

Table 12. Changes in Construction Input Coefficients in 1985 through 2020 under the Baseline and Scenarios S1 and S2

(average annual percentage change)

Iron and Steel	-2.0
Other Minerals	nc
Copper	-1.5
Aluminum	+1.0
Wood Products	nc
Chemicals (#9.3)	+1.0
Stone, glass and clay products	nc
Cement (#9.5)	-0.5

Notes: 1. nc no change
2. Chemicals include mainly plastics, paints, and glues.

Source: Figures are for the region, Newly-Industrializing Asia, in Duchin and Lange et al. (1992).

9. Metal Processing and Metal Use

Currently, Indonesia uses natural gas for all its steel-making (OTA, 1992), which accounts for most of its metal processing (part of #17 in 30-sector model; #17.5 and #17.6 in 76-sector model). In the future, coal is expected to substitute increasingly for natural gas in the processing of iron. Energy inputs for the entire Newly-Industrializing Asian region, in which Korea and Taiwan dominate metal processing, are shown in Table 13 (based on Duchin and Lange et al. (1992)). Total fossil fuel input requirements decline by about 1% annually between 1987 and 2020 with coal completely replacing other fossil fuels by 2020. Electricity inputs increase 0.5%, in part due to the increasing share of aluminum in metal processing.

Projections about energy inputs are based in part on assumptions about the mix of metals processed and the degree of recycling of metals. In 1987, steel accounted for 94% of metal processing, and aluminum and copper for 3% each, in terms of volume of metal processed in Newly-Industrializing Asia. By 2020, steel is projected to account for only 88%, aluminum 9% and copper 3%. While these figures overestimate the copper that will be processed in Indonesia and ignore the processing of tin and nickel, the effect on current and future energy input requirements is negligible since these metals constitute such a small share of processed metals. We will use the projections developed for Newly-

Industrializing Asia and adjust them to reflect the different mix of fossil fuels used in Indonesia.

The share of virgin metals out of total metal consumption will remain relatively high in the foreseeable future. A large share of metals is used for building construction and infrastructure, and much of this is difficult to recover due, in part, to a very long life-cycle. These reductions in the shares of virgin metals are represented by declines in minerals delivered to the metal fabricating sector (part of #17 at the 30-sector level; #17.7 at the 76-sector level) and are given in Table 14: inputs of all metals decline, except for aluminum.

Table 13. Changes in Energy Input Coefficients to Metal Processing in 1985 through 2020 under the Baseline and Scenarios S1 and S2

Oil	+5%
Natural Gas	-32
Coal	-34
Total Fossil Fuel	-30
Electricity	+19

Source: Figures are for the region, Newly-Industrializing Asia, in Duchin and Lange et al. (1992).

Table 14. Changes in Gross Metal Input Coefficients to Metal Fabricating in 1985 through 2020 under the Baseline and Scenarios S1 and S2

(average annual rate of change)

		% Change between 1985 and 2020
Iron	-2.0	-51%
Aluminum	+1.0	+42
Copper	-1.5	-41
Nickel	-0.5	-16
Zinc	-1.0	-30
Lead	-1.0	-30
Other mining (#10.1)	-1.0	-30

Source: Figures are for the region, Newly-Industrializing Asia, in Duchin and Lange et al (1992).

10. Other Sectors

A. Industrial Energy Conservation

Industrial energy conservation holds significant potential for energy savings in virtually all industrial sectors. Some of these sectors have been explicitly addressed above; projections about other sectors are given in Table 15. The same assumptions are made for both scenarios.

Table 15. Projections of Energy Savings Due to Industrial Energy Conservation between 1990 and 2020 under the Scenarios S1 and S2

(reduction of energy coefficients relative to 1990)

Food Processing	25%
Petroleum Refining	37
Textiles	32
Fertilizer	30
Glass and Clay Products	32
All other sectors[a]	20

[a]sectors not explicitly mentioned in the text.

Source: Figures are for the region, Newly-Industrializing Asia, in Duchin, Lange, and others (1992).

Energy conservation includes measures such as housekeeping (e.g., regular tune-ups and calibration of instruments), waste heat recovery, improvements to combustion and steam systems and electric systems, process modification, and cogeneration. Specific measures for each sector and the energy savings associated with these measures are discussed in detail in Duchin and Lange et al. (1992) based on Gamba, Caplin, and Mulckhuyse (1986). While some of these are virtually costless, others can require significant expenditures, though all the measures identified are estimated to have a

payback period of no more than a few years. The costs are approximated by an increase in capital requirements per unit of output of 0.50% between 1985 and 2020 in the sectors affected.

B. Service Sectors and Government

Trade, finance, government administration, and other services (#24-29) comprise a large share of Indonesia's economic activity, but they account for a very small share of total energy use (about 1% of energy use in 1985, mainly electricity (Sathaye and Goldman, 1991)). Duchin and Lange et al. (1992) projected that these sectors would decrease their energy use per unit of output by 20% between 1990 and 2020 (or 23% between 1985 and 2020). A similar reduction in energy inputs will be assumed for this study under both scenarios.

11. Emissions of Carbon Dioxide and Oxides of Sulfur and Nitrogen

Depletion of resources, pollution, and environmental degradation are increasingly recognized as problems that need to be addressed in many countries, including Indonesia. In this study we will be able to track the use of resources to the extent that they are distinguished in the 30-sector classification scheme. The use of energy raw materials is represented in the most detail, and for this reason the associated atmospheric pollution can be tracked. Some aspects of the use and discharge of water and of the consequences of different types of land use will be represented and analyzed at a later stage of this work.

In previous sections, the energy coefficients projected under the scenarios S1 and S2 have been described. A significant body of work has been done by Duchin and Lange et al. (1992) associating emissions of carbon dioxide and oxides of sulfur and nitrogen with the combustion of different fuels under alternative conditions and the technical considerations will not be repeated here. The physical determinants of emissions are independent of the economy in which combustion takes place. Other aspects, like the sulfur content of the fuel burned, are not. The parameters governing the emissions in Indonesia under the two scenarios are summarized in Table 16. Unless otherwise noted, the same parameters are used in both scenarios.

Table 16. Parameters Governing the Emission of Carbon, Sulfur and Nitrogen in all Years under the Scenarios S1 and S2

A. Carbon

(tons of carbon per ton of coal equivalent of fuel)

Oil	0.576
Natural Gas	0.399
Coal	0.697

B. Sulfur

(the product of the factors in the 3 columns yields a single parameter, tons of SO_2 equivalent per ton of coal equivalent of fuel)

Fuel	Sulfur content of fuel	Tons of fuel per tce	Conversion of fuel sulfur to SO_2
Coal (all sectors)	0.6	1.8	1.95
Natural Gas	na	na	na
Oil			
Agriculture	0.50	0.737	1.90
Mining	1.13	0.724	1.90
Industry	1.13	0.724	1.90
Transportation	0.27	0.737	1.90
Electric Power	1.08	0.725	1.90
Commercial Sectors	0.27	0.737	1.90
Households	0.04	0.737	1.90

Table 16 (cont'd)

C. Nitrogen

(tons of NO_2 equivalent per ton of coal equivalent of fuel)

	Oil	Natural Gas	Coal
Agriculture	33.71	2.74	4.41
Mining	2.07	3.84	5.26
Industry	2.07	3.84	5.26
Transportation	36.64	na	6.01
Electric Power	6.71	7.52	9.99
Commercial Sectors	2.07	2.74	4.41
Households, 1985	11.80	2.74	1.67
Households, 2020			
Scenario S1	17.40	2.74	1.67
Scenario S2	19.10	2.74	1.67

na: not applicable. In the processing of natural gas (panel B), virtually all the sulfur is removed.

Notes to panel B:
1. Residual fuel oil has a sulfur content of 1.75%, diesel oil, 0.50%, and gasoline and other products, 0.035%.
2. Residual fuel oil has an energy content of 0.710 tons per tce, other petroleum products 0.737 tons per tce.
3. Electricity generation uses 54% diesel and 46% residual fuel oil. Mining and industry use half diesel and half fuel oil. Agriculture uses all diesel oil. Transportation and commercial sectors use half diesel and half gasoline, kerosene and other low-sulfur products. Households use all gasoline, kerosene and low-sulfur products.

Notes to panel C:
1. Households are assumed to use 40% of oil for transportation with an emission parameter of 26.40 and the remainder for residential purposes with a parameter of 2.07 in 1985. By 2020, use of oil by households for transportation will account for 63% and 70% of their total oil use under the scenarios S1 and S2, respectively.
2. 54% of oil use for electric power is diesel with an emission parameter of 5.39 and 46% is residual fuel oil with a parameter of 8.25.

Sources: Duchin and Lange et al. (1992a). Panel B: Energy content of coal from Foell and Green, 1992; Distribution of fuel use based on UN, 1988; all other factors based on Duchin and Lange et al. (1992a).

References

Agency for the Assessment and Application of Technology (BPPT) and Nuclear Research Centre Juelich Ltd., Germany (KFA). 1988. "Energy Strategies for Indonesia, Summary of Final Report." (No publication information given).

Duchin, F. and G. Lange. 1992a. Input-Output Modeling: Development and the Environment: Final Report. March. Prepared for BAPPENAS with support from the Environmental Programming Support Services Project of CIDA.

_____. 1992b. "Environment and Development in Indonesia: An Input-Output Analysis of Natural Resource Issues." An IEA Working Paper Series - WP#1: Case Study for Households and Industry*; WP#2: Case Study Methodology; WP#3: Case Study for Water.

Duchin, F. and G. Lange with K. Thonstad and A. Idenberg. 1992. "Strategies for Environmentally Sound Economic Development," Final Report to the United Nations (In press, Oxford University Press, 1993.)

Electric Power Research Institute. 1988. Technical Assessment Guide. vols. 1-4, EPRI: Palo Alto, CA.

Gamba, J., D. Caplin, and J. Mulckhuyse. 1986. Industrial Energy Rationalization in Developing Countries. Baltimore: Johns Hopkins University Press.

Hamilton, C., S. Foley, E. Hulu, et al. 1992. National Resources Management Project Working Paper Series - WP#1: Macroeconomic Projections; WP#2: Case Study for Forestry; WP#3: Case Study for Industry.*

Paper. February 1992. (Special Section, "Focus on Indonesia," pages 18-31.)

Paper and Pulp International (PPI). November 1991, July 1992, and other issues.

Sathaye, J. and N. Goldman. 1991. "CO_2 Emissions from Developing Countries: Better Understanding the Role of Energy in the Long Term," Lawrence Berkeley Laboratories Paper LBL-30060.

Schipper, L. and S. Meyers. 1991. "Improving Appliance Efficiency in Indonesia," Energy Policy, July/August, pp. 578-588.

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*These will eventually be merged.

United Nations. 1988. Energy Balances and Electricity Profiles 1986, UN: New York.

United Nations Industrial Development Organization (UNIDO). 1990. "Indonesia's Industrial Development," Report prepared by UNIDO mission to Indonesia, PPD/R.33.

United States Congress, Office of Technology Assessment. 1992. Fueling Development: Energy Technologies for Developing Countries. GPO: Washington, D.C.

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Annex A. The Input-Output Classification Scheme for the Dynamic and Static Models

The table in this Annex describes the correspondence between the new classification scheme and the scheme used in the official 169-sector IO table. The new scheme is similar to that used in (Duchin and Lange, 1992), but additional categories have been added to represent the energy sectors in greater detail and to distinguish the water utility. The new scheme has the important feature that it accommodates both the 30-sector classification for the dynamic model and the 76-sector classification for the static model <u>in a single enumeration</u> through the use of decimals, where necessary, after the 2-digit code.

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Table A.1 Correspondences Among the Indonesian 66-Sector and 169-Sector Input-Output Classifications and the IEA 30- and 76-Sector Classifications

IEA 76-sector (and IO 30-sector)		IO 169-sector	
[01-23]	Agriculture, Animal Husbandry, Forestry and Fisheries		
1	Paddy	1	Paddy
2	Other Farm Food Crops		
2.1	Handpounded rice	4	Handpounded rice
2.2	Maize	2	Maize
2.3	Root crops & flour	5	Cassava
		6	Other root crops
		7	Dried cassava
2.4	Vegetables & fruits	11	Fresh vegetables
		12	Fresh fruit
2.5	Other farm food crops	3	Other cereals
		8	Peanuts
		9	Soybeans
		10	Other beans
3	Other Agricultural Crops		
3.1	Rubber	13	Latex
3.2	Sugar cane & brown sugar	14	Sugar cane
		15	Brown sugar
3.3	Coconut	16	Coconut
3.4	Crude coconut & palm oil	17	Coconut oil
		18	Oil palm
3.5	Tobacco	20	Tobacco
3.6	Coffee	21	Coffee
3.7	Tea	22	Tea
3.8	Cloves	23	Cloves
3.9	Pepper & nutmeg	24	Pepper
		25	Nutmeg
3.10	Other estate crops	26	Other estate crops
3.11	Other crops	19	Fibre crops
		27	Other crops
4	Livestock & Products		
4.1	Livestock products	28	Livestock products
		30	Milk (from livestock)
4.2	Slaughtering	29	Slaughtering
		32	Other livestock and products
4.3	Poultry and products	31	Poultry and products
5	Forest Products		
5.1	Wood	33	Wood
5.2	Other forest products	34	Other forest products
		35	Hunting products

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Table A.1 (cont'd)

6	Fishery products	36	Sea fish, etc.
		37	Fresh water fish
		38	Dried fish
[7-10]	Mining and Quarrying		
7	Coal mining	39	Coal
8	Crude oil mining	pt. 40	Crude oil & natural gas mining
9	Natural gas mining	pt. 40	Crude oil & natural gas mining
10.1	Metal ore mining	41	Iron sand
		42	Tin ore
		43	Nickel ore
		44	Bauxite ore
		45	Copper ore
		46	Gold and silver ore
		47	Other nonferrous metal ore
10.2	Other mining and Quarrying	48	Chemical & fertilizer mineral
		49	Crude salt
		50	Asphalt
		51	Quarrying
[11-19]	Manufacturing		
11	Food and Tobacco Products		
11.1	Food processing & preserving	52	Canned and preserved meat
		53	Dairy products
		54	Processed and preserved vegetables
		55	Processed and preserved fish
11.2	Oil & fat	56	Vegetable & animal oil
11.3	Cereal mill products	57	Milled & polished rice
		58	Other milled cereals
11.4	Flour	59	Wheat flour
		60	Other flour
		61	Bread and bakery products
		62	Noodles,macaroni, etc.
11.5	Sugar	63	Sugar
11.6	Other food products	64	Chocolate & sugar confec. industry
		66	Ground coffee
		67	Processed tea
		68	Processed soybean
		69	Other foods
		70	Animal feed
11.7	Beverages	65	Syrup, all kinds
		71	Alcoholic beverages
		72	Nonalcoholic beverages
11.8	Cigarettes	73	Cigarettes
		74	Other processed tobacco

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Table A.1 (cont'd)

12	Wood Products		
12.1	Sawn and processed wood	84	Sawn and processed wood
12.2	Plywood & other products	85	Plywood & other products
12.3	Wooden construction material	86	Wooden construction material
12.4	Wooden furniture and fixtures	87	Wooden furniture and fixtures
12.5	Wood and cork products	88	Wood and cork products
12.6	Woven goods other than yarn and plastic	89	Woven goods other than yarn and plastic
13	Paper, Cardboard & products	90	Paper and Cardboard
		91	Goods made of Paper and Cardboard products
		92	Printed & published material
14	Fertilizer & pesticides	94	Fertilizer & pesticide
15	Chemicals	93	Nonfertilizer basic chemical
		95	Synthetic resin and plastic material
		96	Paint, varnish and lacquer
		97	Medicine
		98	Cleaning material & cosmetics
		99	Other chemicals
		100	Traditional medicine
		103	Other chemical prod. from coal
16	Cement and limestone	111	Cement and limestone
17	Other Manufacturing		
17.1	Yarn spinning	75	Spinning
17.2	Textile, leather & wearing apparel	76	Weaving
		77	Made-up textiles goods, except wearing apparel
		78	Knitting
		79	Wearing apparel
		80	Carpet,rugs, rope, etc.
		81	Other textiles
		82	Tanned and finished leather
		83	Footwear & leather products
17.3	Rubber & plastic wares	104	Smoked & crumped rubber
		105	Tires and tubes
		106	Other rubber
		107	Plastic ware
17.4	Non-metallic mineral products	108	Ceramic and earthenware products
		109	Glass & glassware
		110	Structural clay and ceramic products
		112	Other nonmetallic mineral structural products
17.5	Basic iron and steel	113	Basic iron and steel
17.6	Nonferrous basic metal	114	Nonferrous basic metal
17.7	Fabricated metal products	115	Kitchen industry
		116	Cutlery and agricultural tools
		117	Metallic furniture and fixtures
		118	Structural metal products
		119	Other metal products nec.
17.8	Machines, electrical mach. & apparatus	120	Motor vehicles & motorcycles
		121	Electrical machinery
		122	Communication equip. & apparatus

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Table A.1 (cont'd)

		123	Household electrical appliances
		124	Other electrical appliances
		125	Accumulator and dry batteries
17.9	Transportation equipment & repair	126	Ships and spare parts
		127	Trains and repair/ maintenance
		128	Car bodies
		129	Motorcycles
		130	Nonmotorized vehicles
		131	Aircraft and spare parts
17.10	Other products n.e.c.	132	Professional, scientific/measuring equip.
		133	Photographic goods
		134	Watches, clocks, etc.
		135	Jewelry
		136	Musical instruments
		137	Sporting goods
		138	Other manufacturing industries nec.
18	Oil refineries	101	Oil refineries
19	Liquid natural gas	102	Liquid natural gas
20	Electric Utilities	pt. 139	Electricity and gas
21	Gas Utilities	pt. 139	Electricity and gas
22	Water supply	140	Water supply
23	Construction	141	Residential and non-residential building
		142	Public works in agriculture
		143	Public works on roads, railroads, bridges, harbors, airports
		144	Construction and installation
		145	Other construction
24	Retail & wholesale trade	146	Retail & wholesale trade
25	Restaurant & hotels	147	Restaurants
		148	Hotels
26	Transportation and Communication		
26.1	Railway transport	149	Railway transport
26.2	Road transport	150	Road transport
26.3	Water transport	151	Sea transport
		152	Inland water transport
26.4	Air transport	153	Air transport
26.5	Services allied to transport	154	Services allied to transport
		155	Storage and warehousing
26.6	Communications	156	Communications
27	Financial and Business Services		
27.1	Financial intermediaries	157	Banking & other financial institutions
		158	Insurance
27.2	Real estate & business services	159	Real estate
		160	Business services

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Table A.1 (cont'd)

[28-30]	Services		
28	Public adm.and defense	161	Public admin. and defense
29	Services		
29.1	Social & community services	162	Educational services
		163	Health services
		164	Other social and community services
29.2	Other services	165	Film production & distribution
		166	Amusement, recreation & art
		167	Repair shops nec.
		168	Personal and household services
30	nspecified sector	169	Unspecified sector

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Data Sheets for Case Study on Households and Industry

Attached are the 12 Data Sheets, DS1 through DS12, that accompany IEA WP#1, Case Study: Households and Industry.

In addition to the assumptions in these data sheets, we have also assumed that sectors #6 to #30 are subject to the following changes:

1. Labor coefficients for these sectors fall in both scenarios following the average annual rates assumed for the period through 2000 by BAPPENAS, except in agriculture and forestry where changes projected in NRMP case studies were introduced.

2. Sectoral capital coefficients increase at the same rate by which labor coefficients decrease, except where indicated otherwise.

DS1

Sector: Households column

Source: Table 4 (Table 5 for #18) of IEA WP#1

Scenarios: LG, HG, S1, S2 are specified.

Data: % increase (+) or decrease (-) in coefficient in 2020 relative to 1985

LG

A matrix		S1	S2	
#7	coal	a	b	
#18	oil	+110.5%	+40.9%	(Table 5)
#20	electricity	+353.7%	+298.1	
#21	gas	1637.5%	+3675.0	
	biomass	+27.6%	0	

HG

A matrix		S1	S2	
#7	coal	same as LG		
#18	oil	+168.0%	+62.2%	(Table 5)
#20	electricity	+537.6%	+453.1	
#21	gas	2489.0%	5586.0	

Notes

a. Use is 0 in 1985. In 2020, use is .7698 times that of gas (measured in common energy units) in the corresponding scenario.

b. Use is 0 in 1985. In 2020, use is .149 times that of gas (measured in common energy units) in the corresponding scenario.

DS2

Sector: Road Transport (#26.2) column closest equivalent at 2-digit level: Transport and Communications #26

Source: Table 6 of IEA WP #1

Scenarios: S1 and S2 are specified.

Data: % increase (+) or decrease (-) in coefficient in 2020 relative to 1985

A matrix	S1	S2
#18 Refined Petroleum to Road Transportation	-25%	-50%
B matrix		
part of #17.9 Motor Vehicles	+15%	+10%

Coefficient Changes at the 2-digit level, sector #26

A matrix	S1	S2
#18 Refined Petroleum	-16%	-32%
B matrix		
#17 Other Manufacturing	+3%	+2%

DS3

Sector: Motor Vehicles (part of #17.9) column closest equivalent at 2-digit level: Other Manufacturing, #17

Source: Table 6 of IEA WP#1

Scenarios: S1 and S2 are specified.

Data: % increase (+) or decrease (-) in coefficient in 2020 relative to 1985

B matrix	S1	S2
entire column	+20%	+30%

Note: See data sheet DS12 for coefficient changes to sector #17.

DS4

Sector: Electricity (#20) column

Source: Table 7D of IEA WP#1

Scenarios: S1 and S2 are specified.

Data: % increase (+) or decrease (-) in coefficient in 2020 relative to 1985

		S1	S2
A matrix			
#18	oil	-76%	-85%
#21	gas	+29	+67
#7	coal	+339	+200
#20	electricity	-21	-21
B matrix			
	entire column	+37	+35

DS5

Sector: Pulp & Paper (#13) column

Source: Table 10 of IEA WP#1

Scenario: Same coefficients for S1 and S2

Data: % increase (+) or decrease (-) in coefficient in 2020 relative to 1985

A matrix

#7	coal	-8.7%
#18	oil	-8.7
#20	electricity	-8.7
#21	gas	-8.7
#5	forest products	-22.9
#15	chemicals	+8.8

Other information that may be relevant:

Source: Table 8 of IEA WP#1

capacity (c^*) of #13 is over 20 times larger in 2020 than in 1985:

pulp	X	36.9
paper	X	22.0

Source: Table 9 of IEA WP#1

employment coefficient fell -36% between 1980 and 1990

DS6

Sector: Cement (#16) column

Source: Table 11 of IEA WP#1

Scenario: Same coefficients for S1 and S2

Data: % increase (+) or decrease (-) in coefficient in 2020 relative to 1985

#18	oil	0
#21	gas	0
#7	coal	+159%

DS7

Sector: Construction (#23) column

Source: Table 12 of IEA WP#1

Scenario: S[illegible] coefficients for S1 and S2

Data: % increase (+) or decrease (-) in coefficient in 2020 relative to 1985

#17.5	iron & steel	-51%
#17.6	other minerals	nc
	copper	-41
	aluminum	+42
#12	wood products	nc
#15	chemicals	+42
#17.4	stone, glass, day products	nc
#16	Cement	-16

Coefficient Changes at the 2-digit level

#15	+42%
#16	-16
#17	-12

Note: The change of an input at the 2-digit level is the sum of the change for each input subsector (3-digit level) weighted by the proportion of a given subsector in 1985.

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DS8

Sector: Metal Processing (#17.5, 17.6) column
closest equivalent at 2-digit level: Other Manufacturing, #17

Source: Table 13 of IEA WP#1

Scenario: Same coefficients for S1 and S2

Data: % increase (+) or decrease (-) in coefficient in 2020 relative to 1985

A matrix

#18	oil	+ 5%
#21	gas	-32
#7	coal	-34
#20	electricity	+19

DS9

Sector: Metal Fabricating (#17.7) column
closest equivalent at the 2-digit level: Other Manufacturing, #17

Source: Table 14 of IEA WP#1

Scenario: Same coefficients for S1 and S2

Data: % increase (+) or decrease (-) in coefficient in 2020 relative to 1985

#17.5	basic iron and steel	-51%
#17.6	nonferrous basic metal	+20

Note: See data sheet DS12 for total changes to sector #17.

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DS10

Sector: Rows for:

#7 coal
#18 oil
#20 electricity
#21 gas

Scenario: Same coefficients for S1 and S2

Data: % increase (+) or decrease (-) in coefficient in 2020 relative to 1985

#11	food processing	-28.5%
#14	fertilizer	-34.0
#17.1-17.2	textiles	-36.2
#17.4	glass & clay products	-36.2
#18	petroleum refining	-41.6
#12, 15, 19, 21-23		-22.9

Note: See data sheet DS12 for changes to sector #17.

DS11

Sector: Services (#24 - #29) columns

Source: page 44 of IEA WP#1

Scenario: Same coefficients for S1 and S2

Data: % increase (+) or decrease (-) in coefficient in 2020 relative to 1985

#7	coal	-23%
#18	oil	-23
#20	electricity	-23
#21	gas	-23

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DS12

Sector: Other Manufacturing (#17) column

Source: Data Sheets DS3, DS8, DS9 and DS10

Scenarios: S1 and S2 are specified

Data: % increase (+) or decrease (-) in coefficient in 2020 relative to 1985

A matrix		Same coefficients for S1 and S2
#18	oil	-19%
#21	gas	-30
#17	coal	-32
#20	electricity	- 9
#17	Other manufacturing	- 2

B matrix	S1	S2
entire column	+3%	+5%

Note: The change of input to a sector at the 2-digit level is the sum of the change of the input to each subsector (3-digit level) weighted by the proportion of a given subsector in its sector in 1985.

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SCENARIO SUMMARY

SECTOR = 2 OTHER FARM FOOD CROPS S1 ONLY

	1985	%Δ 2020
A		
2. Other farm food crops		+14%
14. Fertiliser		+7%
L Person years / Tm		
Total labour	0.0806	−14%
N		
N1. Water input (1000m³ / Tm)	765	−14%
N7 Land area (ha / Tm)	0.127	−10%
N8 Soil erosion (tons / Tm)	3.492	+5%

Unit price (Rp / Tm) =

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SCENARIO SUMMARY

SECTOR # 3 OTHER AG. CROPS S1 ONLY

	1985	% Δ 2020
A		
3. Other ag crops		+ 100%
14. Fertilizer		+ 25%
17. Other manufact.		+ 20%
23. Construction		+ 10%
24. Retail & wholesale		− 10%
26. Transport & comm.		− 15%
27. Fin & bus. services		+ 10%
L Person years / Tm		
Total labour	0.05	− 50%
N		
N1. Water input (1000 m³/Tm)	250.	−25%
N7. Land area (ha/Tm)	1.1710	−75%
N8. Soil erosion (tons/ha)	1.5	+10%

Unit price (Rp/Tm) =

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SCENARIO SUMMARY

SECTOR #4 LIVESTOCK & PRODUCTS S1 ONLY

		1985	%Δ 2020
A			
4	Livestock & prod.		-10%
1.	Food & tobacco		-5%
18.	Oil refining		+5%
24.	Retail & whole.		-5%
L	Person yrs / Tm		
	Total labour	0.05	-5%
N			
N1.	Water input (000 m³/Tm)	11	0
N7.	Land area (ha/Tm)	3	-10%

Unit price (Rp/Tm) =

SCENARIO SUMMARY

SECTOR # 5 FOREST PRODUCTS S1 & S2

	1985	2020 S1	2020 S2	%Δ
A				
14. Fertiliser per unit / Rp. million	0	.00064	.00109 *	
17 Other manufacturing	.0275	+3.2%	+5.4%	
L person years / Rp million				
Total labour		+211%	+289%	
B				
17. Other manufacturing	.2948 (mean lag)	+45% 5yrs	+68% 8yrs	
N				
N10. Land area (ha / 1000 m³)	26.5	17.2	10.7	**
N11. Soil erosion (tons / ha)	79	16	6.2	**
N12. Deforestation (ha / ha logged)	.26	.09	.05	**

Unit price (Rp / m³ logs) = 61,548

* Fertilier figures are coefficient levels, not % changes

** Absolute figures, not %Δ.

Input for sector _____, #_____.

Scenario S1_____ S2_____ (check one)

Environmental Matrix (N)

	Column Number and Name:		Percentage Change of Environemtal Coefficient From 1985		
		1985	Other Year If Relevant	Other Year If Relevant	2020
	Water				
N1	Water Input (000's of m^3/unit of output)				
N2	Water Output (000's of m^3/unit of output)				
N3	BOD (kg/000's of m^3)				
N4	COD (kg/000's of m^3)				
N5	Dissolved Solids (kg/000's of m^3)				
N6	Suspended Solids (kg/000's of m^3)				
N7	Heavy Metals (kg/000's of m^3)				
N8					
N9					
	Land				
N10	Land Area (ha/unit of output)				
N11	Soil Erosion (tons/ha)				
N12	Deforestation (ha deforested/ha logged)				
N13					
N14					
	Air				
N15	Carbon (tons/TCE) oil gas coal				
N16	Sulfur Dioxide (tons/TCE) oil gas coal				
N17	Nitrogen Oxides (tons/TCE) oil gas coal				
N18	Particulates (tons/TCE)				
N19					
N20					

SCENARIO SUMMARY

SECTOR # 1 PADDY S1 ONLY

A	1985	% Δ 2020
1. Paddy		-26%
14. Fertilizer		37%

L	Person years / Tm (ton metric)	
Total labour	0.0885	-26%

N		
N1 Water input (000 m³ / Tm)	2,367	-28%
N7 Land area (ha / Tm)	0.2367	-35%
N14 methane (kg / Tm)	42	-36%

Unit price (Rp / Tm) = 182,941

ha / 10⁶ Rps. = 1.29386

water / 10⁶ Rps = 12.939

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