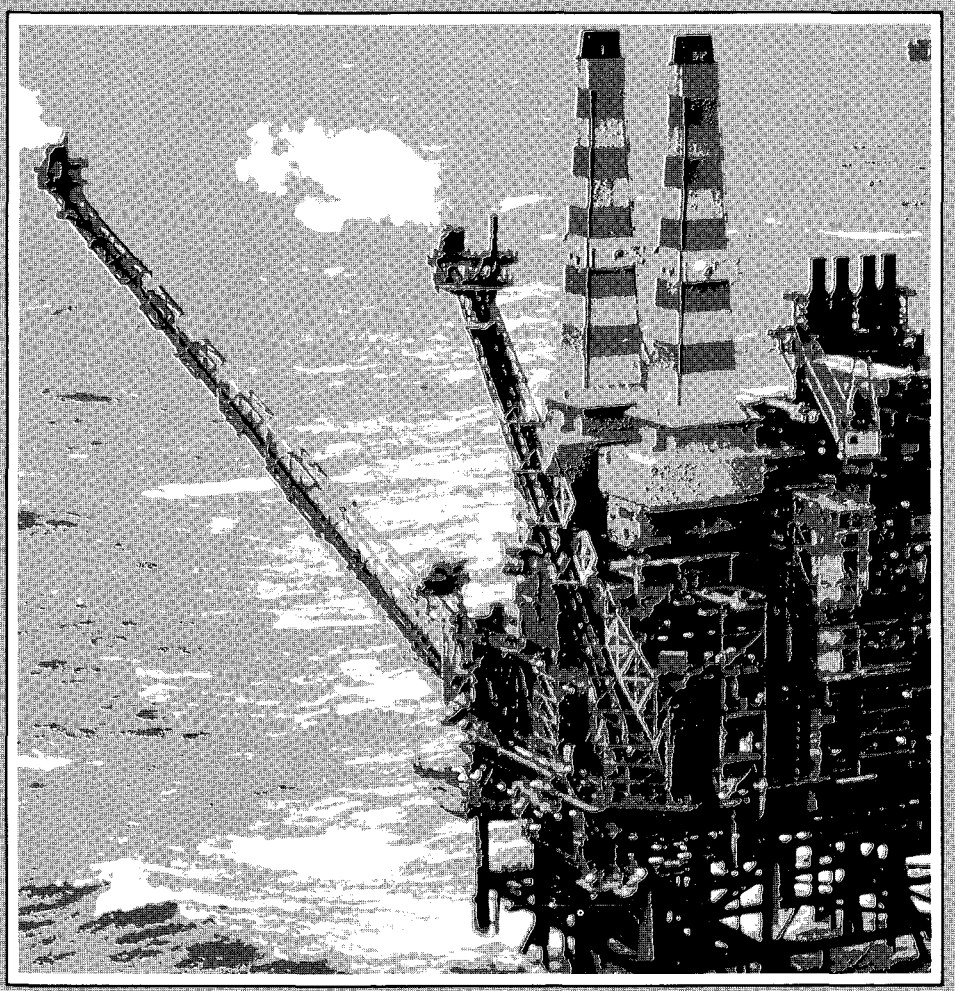
MONEY TO BURN?
The High Costs of Energy Subsidies

by Mark Kosmo



WORLD RESOURCES INSTITUTE

MONEY TO BURN? The High Costs of Energy Subsidies

Mark Kosmo

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M.K.

Foreword

To tomorrow's energy historians, the early 1980s will almost certainly seem anomalous—a blip on a trend line of half a century or more of stable or increasing oil prices. Although the declining prices of the early 1980s brought welcome relief to oil-importing countries, the reprieve now appears to be ending.

While oil is only one (albeit large) component of the energy picture, it amply illustrates the need for national governments to shelve policies that impede efforts to adjust to changes in energy prices and availability. In *Money to Burn? The High Costs of Energy Subsidies,* economist Mark Kosmo promotes this long-overdue exorcism by demonstrating how public subsidies of energy production and consumption drain government coffers, encourage resource depletion, and dampen prospects for economic growth.

Taking as his touchstone the economist's definition of efficient energy pricing, Kosmo examines the many ways energy prices are kept artificially low by government actions. He also examines the effects of these policies on government revenues, energy price stability, industrial development, environmental protection, income redistribution, balance of trade, inflation and supply. On all scores, the news is sobering.

Although many countries have reduced petroleum subsidies substantially since 1981 or so, such subsidies still persist, especially in the oil-exporting countries. Moreover, subsidies to electricity, natural gas, and coal are even more pervasive. As for both microeconomic and macroeconomic effects, Kosmo shows that the putative benefits of subsidies—economic stimulation, enhanced trade performance, and inflation control—aren't the true effects. Indeed, subsidies tend to increase unemployment (as energy is substituted for labor) and encourage over-investment in energy-intensive industries at the expense of other sectors. At the same time, they have little impact on overall trade balances, inflation, or the lot of the poor. Energy subsidies also translate into foregone revenues and the inefficient use of energy.

Of course, the ill effects of energy subsidies cannot be rooted out overnight without traumatizing a nation's economy, even if politics permitted. But *Money to Burn?* does point the way to a politically and economically acceptable transition to the next energy era, one based on sharp increases in energy efficiency in rich and poor countries alike.

Money to Burn? fits squarely into two of World Resources Institute's programs. First, it is the third in a series of studies examining economic policies and practices that discourage

sound resource use and sustainable growth. (Earlier works in this series cover water resources and pesticide use.) Second, this study complements two recent WRI releases on the global energy picture—*Energy for a Sustainable World* and *Energy for Development.*

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James Gustave Speth
President
World Resources Institute

I. Introduction

For the past 15 years, world attention has been riveted on the importance of energy in the global economy. Oil price shocks in 1973 and 1979 and subsequent price fluctuations have painfully demonstrated the economic implications of unstable energy prices—high inflation rates, world recession, and mounting debt burdens.

Now, with world oil prices again on the rise and the world economy experiencing sluggish growth, many fear continued stagnation and possibly future oil price shocks unless action is taken. Indeed, it is an opportune time for governments to reassess their domestic energy policies, cushion themselves against any future price shocks and their destabilizing effects, and promote a more stable energy future. Specifically needed are effective demand-management policies, especially pricing policies that encourage energy conservation.

This paper examines commercial[1] energy subsidies and energy pricing policies in over 30 countries. Many countries have recently raised domestic energy prices to reflect true costs more fully, but energy subsidies are still widespread. Electricity, natural gas, and coal are subsidized in all of the countries covered in this study, while petroleum consumption is still subsidized in the oil-exporting developing nations.

By removing such energy subsidies, governments can encourage energy efficiency, cut the costs of producing and using energy, reduce costly energy imports (or, in the oil-exporting countries, increase oil exports), minimize environmental damages and risks, and reduce their own fiscal burdens. Such improvements, which further both environmental and resource conservation and development objectives, are critical for sustainable economic growth and development. Options include removing price controls, selectively imposing energy taxes, and more effectively targetting politically unavoidable subsidies to needy groups.

The time is right for such policies since few analysts expect world energy prices to fall. Moreover, the political and economic costs of pricing policy reform are likely to be greater during the 1990s when world oil prices should be higher. Policy-makers should seize the existing opportunity since they do not face the usual number of difficult tradeoffs, but can instead promote fiscal, economic, and environmental goals simultaneously.

II. Energy Pricing Policy: What is at Stake?

Will the energy crises that plagued the world during the 1970s return? In part, the answer depends on whether pricing policies that provide better incentives for energy conservation are adopted. Without these incentives, the 1990s might find us in a bind remarkably similar to that of the 1970s.

During the past year, oil imports have increased in several countries, including the United States, and worldwide dependence on Middle Eastern and OPEC oil has deepened. Increasing dependence on less secure oil supplies has renewed the debate on appropriate pricing policy responses: should countries impose oil-import fees, raise energy taxes, eliminate energy subsidies, or take other measures to promote energy conservation and price stability?

How governments answer this question will help to determine the world's energy future since pricing policies greatly affect energy consumption and production patterns. Indeed, in many countries today, energy taxes and subsidies are equivalent to over 50 percent of final retail prices.

Although energy production and consumption patterns will change in the years ahead, domestic energy pricing policies will be as important as ever. Through 1995, oil's importance is expected to diminish only slightly and world dependence on OPEC oil is expected to increase, soon approaching 1979 levels. *(See Table 1.)* By 2000, some predict that dependence on OPEC for oil may even exceed 1973 levels. *(See Figure 1.)* Clearly, oil conservation is needed in the short run to minimize the possibility of recurrent oil price shocks.

In the next century, natural gas, electricity, and coal will become substantially more important, as will pricing policies for these fuels. But this trend doesn't make petroleum pricing policies and oil conservation any less important since oil production in the non-OPEC countries will decline. Furthermore, since 63 percent of the world's proved oil reserves are in the Middle East, the world will become more dependent on this region's even less secure oil supplies.[2] By almost any reckoning, oil conservation will remain of paramount importance, especially in the highly vulnerable transportation sector.

In efforts to defer, and perhaps even reduce, the possibility of recurrent oil price shocks and price instability, *all* countries—not just the United States and other large energy consumers—must play a role. Since the developing countries will probably account for 95 percent of the increase in world oil consumption through 1995 and an increasing share of total commercial energy consumption, their pricing policies will become increasingly important.[3] *(See Figure 2.)*

Economic Efficiency and Energy Pricing

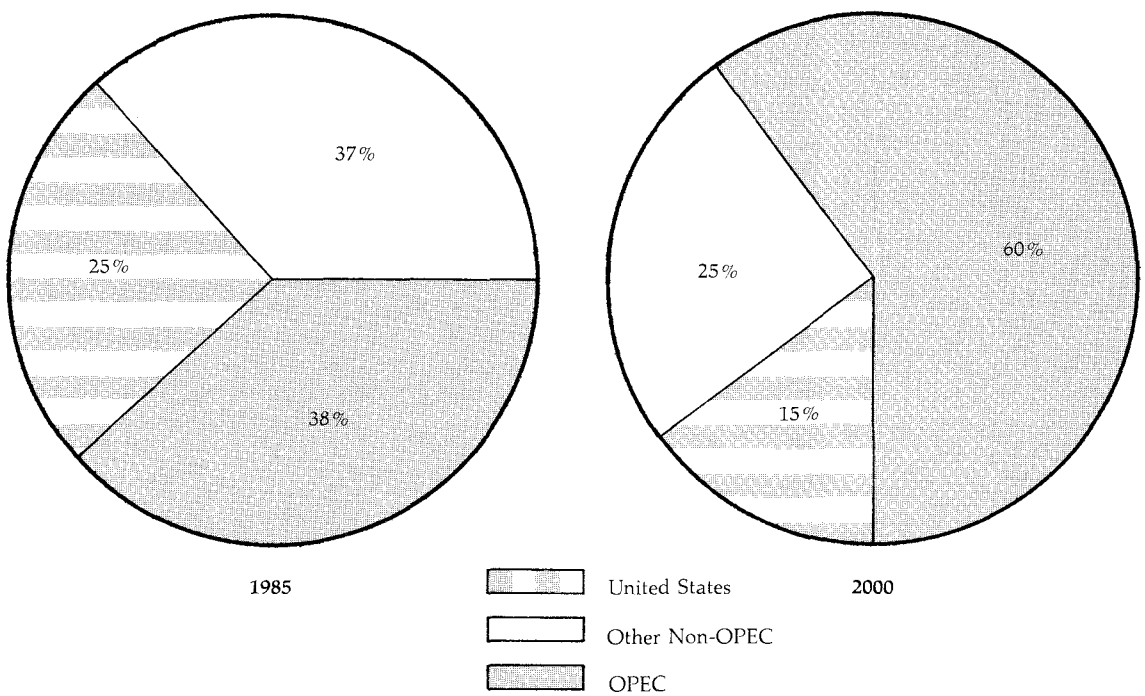
Energy prices aren't economically efficient unless they reflect the real resource costs of

Table 1. Percentage Distribution of World Energy Production, Selected Years, 1973–2010

	1973	1979	1985	1987	1990	1995	2000	2010
Non-Oil	52.7	55.0	53.7	54.1	54.5	56.6	59.3	62.3
Oil	47.3	45.0	46.3	45.9	45.5	43.4	40.7	37.1
(% of All Energy)								
Non-OPEC	44.2	50.4	65.6	64.0	56.7	53.3	50.8	44.4
OPEC	55.8	49.6	34.4	36.0	43.2	46.7	49.2	55.6
(% of Oil Production)								
Non-OPEC	20.9	22.7	30.3	29.4	25.8	23.2	20.7	16.5
OPEC	26.4	22.3	15.9	16.5	19.7	20.2	20.0	20.1
(% of All Energy)								

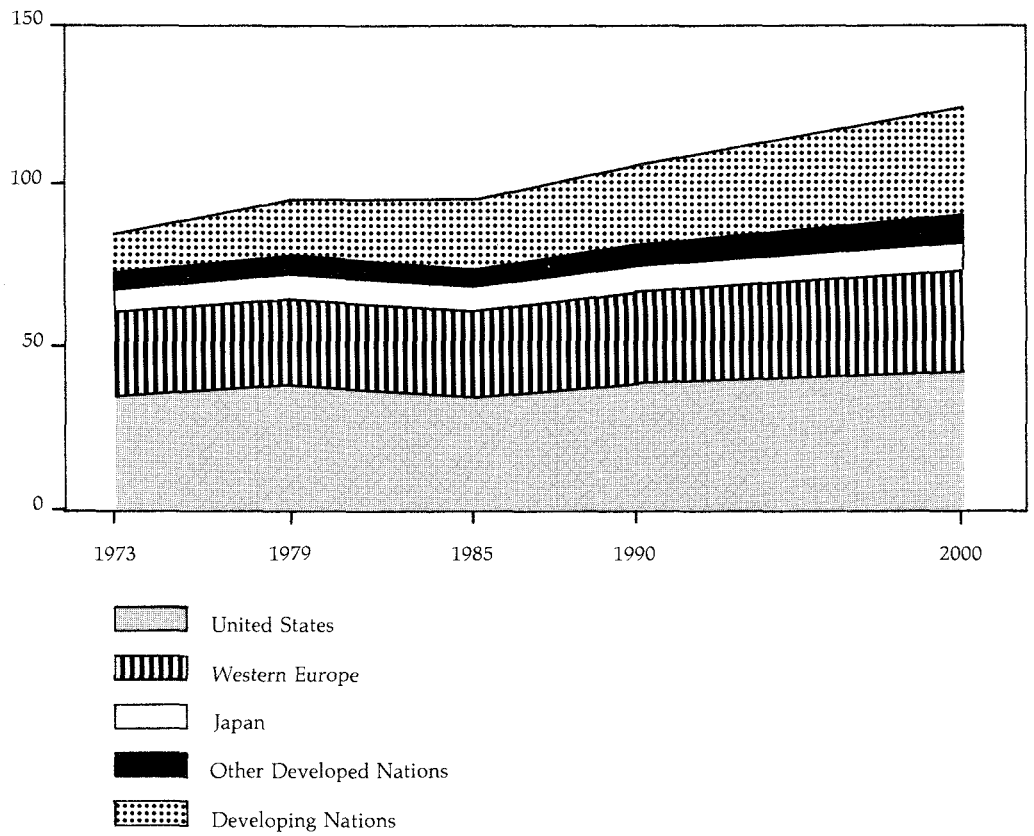
Source: World Energy Outlook to 2000, Petroleum Economics Ltd. and World Resources Institute calculations.

Figure 1. Sources of World Oil Supply



Source: World Energy Outlook Through 2000, Conoco, Inc., (September, 1986) p.4

Figure 2. World Energy Demand (Million Barrels Per Day Oil Equivalent)



Source: World Energy Outlook Through 2000, Conoco, Inc., (September, 1986) p. 6

additional energy use. These so-called opportunity costs include the costs of exploring for, developing, producing, refining, transporting, and distributing petroleum products, natural gas, and coal, and the costs of generating, transmitting, and distributing electricity. They also include the costs of pollution from energy production and consumption and the national security risks that dependence on unstable foreign energy supplies entails.

Since petroleum products are easily traded, the world oil market effectively determines prices. In the absence of externalities, these prices would equal opportunity costs. However, since the market does not reflect the social costs of such externalities as pollution or high dependence on unstable foreign oil supplies, world oil prices do not reflect full opportunity costs. Economically efficient pricing requires taxes on petroleum products—especially in heavily dependent oil-importing countries.

For such rarely traded energy sources as electricity or natural gas, world prices do not exist.

Instead, efficient prices are based on the long-run marginal costs of providing service.[4] For a nontradeable natural resource, such as natural gas, the right price always lies somewhere above the marginal cost of providing service and below the replacement cost of the fuel(s) it displaces. For example, if the marginal cost of providing natural gas is $2 per thousand cubic feet (mcf) and the equivalent price of heavy fuel oil is $3/mcf, then an efficient price for natural gas is between $2 to $3/mcf.[5] If the price of competing fuels is below the marginal cost of providing service (as is frequently the case with electricity in developing countries), then prices should equal marginal costs.

Any adjustments in domestic oil prices must begin from world oil prices. Oil-importers can raise domestic prices with oil-import fees, import quotas, or excise taxes, while oil-exporters must generally rely on taxation. On the other hand, countries can lower petroleum prices through direct subsidies, price controls, or exchange rate subsidies. Since oil is traded in dollars, oil-importing countries that overvalue their exchange rates are lowering the costs of oil imports.[6] Subsidies for consumers of natural gas, electricity, and coal, on the other hand, usually take the form of price controls since these fuels' prices are administered.

Like consumers, energy producers also receive subsidies in many countries. Depletion allowances for extraction of oil, natural gas, and coal and tax deductions for drilling costs help finance the production of energy resources. Also, interest deductions favor capital-intensive industries, which have heavier borrowing needs. These industries include the extractive industries and electricity generation. Finally, direct cash subsidies and loan guarantees are sometimes made to fledgling energy industries, such as ethanol in Brazil or synfuels in the United States.

Objectives of Energy Pricing Policy

Getting the prices right is more than a game economists play. Properly set energy prices that reflect their true costs minimize behavioral distortions and uneconomic fuel substitutions. If energy producers and consumers receive incorrect price signals, resources are misallocated and economic growth and development are stunted.

In practice, however, economic efficiency is but one objective of energy pricing policy. Other objectives include raising government revenues, stabilizing energy prices, protecting the environment, promoting particular industries, redistributing income, and reducing dependence on unstable foreign energy supplies. To address these concerns, policy-makers often devise energy subsidies or energy taxes that sacrifice economic efficiency. Still, taxes or subsidies may improve economic efficiency when they offset such externalities as pollution or correct other existing distortions in the energy market.

Even though energy pricing policies vary widely by country, extensive intervention is the norm. In virtually all countries, governments influence energy prices via taxes, tariffs, subsidies, and price controls. In many nations, energy subsidies and price controls lead to pervasive distortions and economic losses totalling billions of dollars; in others, governments depend heavily on energy taxes for revenues.

Energy taxes are especially important in countries where high levels of nonmarket transactions, widespread illiteracy, and bureaucratic inefficiency make income tax collection problematic.

Energy taxes are especially important in countries where high levels of nonmarket transactions, widespread illiteracy, and bureaucratic inefficiency make income tax collection problematic. In the Philippines 25 percent of all

government revenues come from energy taxes.[7] Many other oil-importing countries also assess large taxes on oil products. *(See Table 2.)*

Besides raising revenues, energy taxes serve several other purposes. First, for oil-importers they are the most effective tool for reducing oil-import bills and trade deficits—a major selling point since in many countries oil accounts for 20 to 30 percent of all imports. Taxes on domestic oil consumption help conserve foreign exchange and reduce the outflow of income in the event of oil price shocks. Furthermore, by reducing trade and fiscal deficits and encouraging energy conservation, these taxes also help energy-poor countries service their debts.

Second, energy taxes' role in reducing dependence on unstable foreign energy supplies is critical given the blows that supply disruptions and price instability dealt to economic growth during the 1970s.[8] Certainly, such policies that reduce a nation's susceptibility to oil price shocks are warranted. Indeed, many economists advocate optimal taxation of energy as risk insurance against excessive dependence on unstable foreign supplies.[9] In short, since most oil-importing countries set retail prices above world prices, many governments apparently believe in an "optimal" tax.

Third, energy taxes can be levied to reflect some of the usually hidden costs of energy consumption, including air pollution control or clean-up. For example, pollution taxes on gasoline and coal use would reflect the external costs of the air pollution released when these fuels are burned. Such taxes could also help to finance pollution control. Finally, taxes on transport fuels are the least costly way to collect road-user charges.

Subsidies for consumers encourage excessive demand while producer subsidies speed the depletion of nonrenewable energy supplies.

Although most economists are quick to argue against any price distortions (be they subsidies or taxes), national security considerations, pollution control, and revenue requirements

Economic and Financial Subsidies

As used here, the term "subsidies" refers to economic subsidies—not financial or budgetary subsidies. Economic subsidies for such traded energy products as gasoline or fuel oil equal the difference between world oil market prices and domestic ones. For example, if gasoline is traded for 70¢/gallon on the world market but a country's domestic price is only 50¢/gallon, then the economic subsidy is 20¢/gallon. If the *average* costs of producing, refining, and marketing the gasoline are 60¢/gallon, then the financial subsidy is 10¢/gallon. Financial or budgetary subsidies are what a government pays out to cover these operating costs; they do not include the opportunity costs of foregoing transactions at higher market prices. For rarely traded energy forms, such as natural gas or electricity, per unit economic subsidies equal the long-run marginal costs of providing service minus the domestic price, where marginal costs represent the costs of providing one additional unit of energy. Accordingly, if the long-run marginal costs of providing electricity are 10¢/kWh while the price is only 7¢/kWh, then the economic subsidy is 3¢/kWh, even though the utility might not need any financial subsidies to cover average costs: the utility receives no financial subsidy so long as average costs are less than 7¢/kWh.

Table 2. Ratio of Retail to Border Prices for Selected Petroleum Products, 1981 and 1985

Country		Regular Unleaded Gasoline	Household Kerosene	Diesel Oil	Heavy Fuel Oil	Total[a]
Oil-Importers						
Argentina	('81)	1.23	0.90	0.60	0.43	0.78
	('85)[b]	1.91	0.97	0.81	0.74	1.18
Brazil		2.77	1.21	1.62	0.76	1.70
		1.60	1.09	1.24	0.78	1.25
Chile		1.83	1.22	1.70	1.33	1.62
		1.63	1.51	1.51	1.26	1.49
Colombia		0.78	0.81	0.86	—	—
		0.71	0.63	0.79	0.58	0.71
Ethiopia		1.96	1.02	0.89	0.91	1.13
	('83)	2.26	1.23	1.54	1.29	1.70
Ghana		3.47	1.58	2.73	1.37	2.70
	('83)	3.80	1.69	2.99	1.57	3.05
India		2.21	0.63	1.07	1.12	1.07
		1.94	0.64	1.19	0.84	0.90
Kenya		2.28	1.01	1.58	0.89	1.49
	('83)	2.13	1.07	1.70	0.89	1.57
Korea		3.48	1.27	1.28	1.34	1.40
		3.43	1.56	1.59	1.27	1.61
Morocco		2.51	1.39	1.47	0.90	1.33
	('83)	3.05	1.53	1.60	1.19	1.59
Pakistan		1.74	0.91	1.07	0.63	1.09
	('83)	1.69	0.84	1.10	0.54	1.05
Philippines		2.16	1.29	1.34	1.19	1.33
		2.11	1.77	1.93	—	—
Sri Lanka		—	0.66	1.03	0.88	—
	('83)	—	0.73	1.17	0.95	—
Thailand		1.86	0.95	1.21	0.96	1.23
		1.80	1.10	1.30	0.91	1.29
Uganda		2.97	1.63	1.83	1.16	2.06
	('83)	3.83	2.36	2.71	—	—

provide compelling political and economic reasons for petroleum taxes that are not mirrored for subsidies. Unlike energy taxes, commercial energy subsidies exacerbate import dependence. Subsidies for consumers promote excessive demand while subsidies for producers speed the depletion of nonrenewable energy supplies. In addition, all subsidies entail either

Table 2. Continued

Country	Regular Unleaded Gasoline	Household Kerosene	Diesel Oil	Heavy Fuel Oil	Total[a]
Oil Exporters					
Ecuador	0.54	0.22	0.32	0.43	0.43
	0.90	0.27	0.81	0.41	0.70
Egypt	0.55	0.15	0.13	0.05	0.15
	0.74	0.13	0.72	—	—
Indonesia	0.84	0.20	0.30	0.50	0.50
	1.67	0.72	1.03	1.25	1.12
Mexico	0.43	0.24	0.18	0.11	0.26
	0.75	0.29	0.49	0.16	0.48
Peru	0.88	0.16	0.62	0.62	0.61
	0.94	0.79	0.74	0.72	0.79
Tunisia	1.95	0.37	0.79	—	—
('83)	2.00	0.60	0.93	0.64	0.90
Venezuela	0.13	0.09	0.10	0.12	0.12
	0.77	0.41	0.30	0.25	0.55
OECD Countries					
Canada	1.10	0.80	1.27	—	—
	1.74	1.24	1.73	1.15	1.59
France	2.72	—	2.17	1.05	2.03
	2.85	—	2.55	1.23	—
Japan	2.26	1.19	1.54	1.05	1.43
	2.63	1.49	2.06	—	—
United Kingdom	2.53	1.33	2.72	1.40	2.20
	2.56	—	2.77	1.31	—
United States	1.18	1.09	1.09	0.91	1.13
	1.39	—	1.73	0.95	—
West Germany	2.25	—	2.28	—	—
	2.12	—	2.28	0.98	—

Source: World Resources Institute calculations based on World Bank data.
a. Based on weighted average of the four petroleum products.
b. Figures are averages for the last quarter of 1985 or 1983 annual averages where 1985 data were unavailable.

direct revenue expenditures or foregone revenues due to price controls. In almost all countries, parastatal companies run the energy industry so these losses increase fiscal deficits and make debt-servicing more difficult. Then too, because subsidies for fossil fuels increase energy consumption and production, they increase pressures on the environment.

III. Current Fuel-Pricing Trends

This section presents findings on fuel-pricing in over thirty countries. The data reveal that electricity, natural gas, and coal consumption are subsidized in all of the countries studied, while, as a rule, petroleum consumption is subsidized only in the oil-exporting countries.

Petroleum Product Pricing

Petroleum products account for approximately 44 percent of the world's commercial energy consumption and 67 percent of the developing world's (excluding China).[10] Consequently, the backbone of any energy pricing policy is the pricing of the most important petroleum products—gasoline, kerosene, diesel oil, and heavy fuel oil.[11]

Table 2 provides a "snapshot" of petroleum product pricing in 1981 and 1985. International trade or "border" prices are treated as the opportunity costs of petroleum products. Effectively, they are the world price of these products for net oil exporters[12] and the world price plus transport, handling, and insurance costs for oil importers.[13] Here, ratios above one indicate net taxation of petroleum products[14] while ratios below one depict net consumer subsidies.

Table 2 reveals several interesting relationships. First, the largest petroleum subsidies during the 1980s have been in the oil-exporting developing countries—Ecuador, Egypt, Indonesia, Mexico, Peru, Tunisia, and Venezuela. Through price controls, all of these countries substantially subsidized consumption of petroleum products. Second, since 1981, all of the oil-exporting developing countries have reduced petroleum product subsidies. In Indonesia, where only kerosene subsidies persist, they have been cut by 90 percent since 1981. However, subsidies of all petroleum products still contribute to large fiscal losses in most of the oil-exporting countries and these subsidies speed the depletion of exportable reserves.

Among the OECD countries, the United States and Canada impose the lowest taxes on petroleum products.

Third, while almost all of the oil-importing developing countries tax petroleum products on average, in many, high gasoline taxes cross-subsidize the other three petroleum products, which encourages the use of lightly taxed or subsidized products. *(See Table 3.)* Fourth, among the OECD countries, the United States and Canada impose by far the lowest taxes on petroleum products—in most cases less than half of those levied in other OECD countries. Finally, since 1981 petroleum subsidies have been reduced substantially around the world. Many countries now recognize that these subsidies impair economic performance and have taken remedial actions.

Table 3. Countries that Subsidize Petroleum Products, 1985*

All Products	Kerosene	Diesel	Heavy Fuel Oil
Colombia	India	Argentina	Argentina
Ecuador	Indonesia		Brazil
Egypt	Pakistan		India
Mexico	Sri Lanka		Kenya
Peru	Tunisia		Pakistan
Venezuela			Tunisia

Source: Table 2
* Includes all countries for which the ratio of retail to border prices is below .90.

Electricity Pricing

Throughout the world, electricity prices generally fail to reflect the long-run marginal costs of electricity production. In the United States and many other countries, prices are designed to recover average costs plus a guaranteed rate of return. Unfortunately, this approach usually spawns consumer subsidies since prices seldom reflect the full costs of providing additional generating capacity. In all of the countries studied here, prices are below long-run marginal costs. *(See Table 4.)*

Table 4. Comparisons of Average Revenues and Long-Run Marginal Costs of Electricity in Selected Countries

Country (Year)		Avg. Revenues (¢/kWh)	LRMC (¢/kWh)	Price/LRMC
Bangladesh	(1984)	5.94	9.09	.65
Bolivia	(1982)	3.70	5.85	.63
China	(1984)	3.29	5.65	.58
Ethiopia	(1983)	6.01	18.78	.32
India	(1981)	3.70	7.00	.52
Morocco	(1983)	8.00	12.70	.63
Paraguay	(1982)	4.00	5.00	.80
Peru	(1983)	5.36	8.40	.45
Senegal	(1981)	11.70	12.72	.82
Tanzania	(1983)	7.79	8.20	.95
Uganda	(1982)	1.20	8.00	.15
United States	(1984)	6.52	8.93	.73

Sources: Reports of the UNDP/World Bank Energy Sector Assessment Program. Reports prepared for World Resources Institute (deLucia and Associates, Kosmo, Li *et al.*).

Over the years, some electricity pricing policies have been flagrantly uneconomic. Historically, in Brazil and India, prices have not covered even average costs. In China, real prices declined inside the Great Wall by 25 percent from 1936 to 1979, and in Mexico real electric rates fell by 80 percent between 1962 and 1981.[15] Both countries now align prices more closely to long-run marginal costs, but decades of subsidies cannot be eliminated overnight without massive "rate shock."

Decades of subsidies cannot be eliminated overnight without massive "rate shock."

Although electricity prices are inching up in other developing countries, electricity subsidies are still pervasive. Data from countries in which the World Bank has made recent power loans corroborate this conclusion. In only three of fourteen countries surveyed did average revenues exceed long-run marginal costs. *(See Table 5.)* If all countries are combined, average prices equal 6.47¢/kWh and are only 77 percent of the long-run marginal costs of 8.36¢/kWh.

Table 5. Average Electricity Tariffs as a Percent of LRMC in Selected Developing Countries

Tariffs/LRMC Range	Number of Projects
0— 24%	0
25— 49%	2
50— 74%	4
75— 99%	5
100—125%	2
125—149%	1
TOTAL	14

Projects not reporting LRMC = 7

Average Price = 6.47 ¢/kWh
Average LRMC = 8.36 ¢/kWh

Marginal Cost Recovery (Average) = 77%

Source: Unpublished data drawn from appraisal reports of power projects approved by the World Bank in 1984-85.

Natural Gas Pricing

Natural gas is the most underutilized fossil fuel, largely because low producer prices discourage its production in many countries. Often, gas is flared or bypassed in the search for oil, which has a higher market value and can more easily be exported. In many developing countries, export potential is limited and pipeline capacity for transporting gas to large numbers of domestic end-users is inadequate—severe constraints on natural gas production.

Natural gas is under-utilized and over-regulated.

Until recently, natural gas pricing was not an important issue in most developing countries. As a World Bank study put it:

> *"In general, the development of natural gas resources for domestic use in LDCs is so limited that systematic pricing procedures have not yet evolved in most countries. Because most of the gas produced has been associated gas, countries have not felt the need to establish economically rational pricing rules.... Therefore, gas prices do not bear any relationship to their marginal physical cost or their opportunity cost...."*[16]

In 1984, Nigeria flared 2 billion cubic feet of gas per day (84 percent of total production) and less than 1 percent of associated natural

gas was recovered.[17] The much higher degree of flaring in Nigeria and other developing countries reflects both inadequate gas-distribution networks and low producer prices for associated gas. *(See Table 6.)* Although allocating joint production costs and establishing prices for associated gas and oil is difficult, low producer prices for natural gas certainly don't provide adequate production incentives.

Table 6. Percentage of Natural Gas Flared and Production Levels by Region, 1980

Location	Percentage Flared	Production (Billions of m^3)
OECD	4	850
Europe	5	200
North America	0	635
Eastern Europe	3	510
Developing Countries	47	340
Africa	72	70
Asia	20	60
Latin America	24	85
Pacific	5	15

Source: International Energy Agency, 1982.

Fortunately, many countries have recently reduced flaring. Indonesia, for instance, is increasing the use of natural gas as a feedstock in fertilizer plants. But flaring will continue until higher producer prices spur gas development and provide the revenues for constructing the infrastructure for transporting and distributing natural gas to large numbers of customers.[18]

Like electricity use, natural gas consumption is subsidized in virtually all developing countries. A World Bank survey of eight countries found that retail gas prices ranged from 38 to 70 percent of the equivalent border prices of competing fuels (primarily heavy fuel oil and coal). *(See Table 7.)* The average retail price across countries studied was $1.43/MCF, only 53 percent of the average border price of $2.70/MCF. Besides substantial subsidies to natural gas consumers, these figures also imply significant shortages due to excess demand for gas at such low prices.

Other data corroborate the conclusion that subsidies are deep and lead to shortages. Chinese natural gas prices amount to only 25 percent of marginal costs.[19] In Bolivia, the ratio is between 36 and 51 percent. In Bangladesh, the power and fertilizer industries (which consume 70 percent of the nation's natural gas) bear only 63 percent of marginal costs while the commercial and industrial sectors bear 100 percent and 75 percent, respectively.[20] Clearly, natural gas subsidies encourage greater use of electricity and chemical fertilizers in Bangladesh: the low price of a key input lowers production costs and, in turn, prices.

Table 7. Domestic Price of Natural Gas as a Percentage of Border Price in Selected Developing Countries

Domestic Price/Border Price % Range	Number of Projects
0 - 24%	0
25 - 49%	2
50 - 74%	6
75 —100%	0
100 or more	0
TOTAL	8

Projects not reporting 2

Average Price of Natural Gas = $1.43/mcf
Average Border Price (Fuel Oil Equivalent) = $2.70/mcf

Average Border Price Recovery = 53%

Source: Unpublished data drawn from appraisal reports of energy projects approved by the World Bank in 1984–85.

Eliminating these subsidies, however, may not reduce natural gas consumption. Indeed, consumption should increase as gas supplies are substituted for even more costly alternative fuels. Since the production and distribution costs of natural gas are considerably below the border prices of competing fuels in all of the countries studied, higher producer prices will increase supplies without reducing consumption. For all ten developing countries listed in Table 8, the marginal costs of providing natural gas service (city-gate delivery costs) in 1984 are significantly below the border price equivalents of heavy fuel oil and coal, which average $2.70/mcf.

Higher producer prices for natural gas will increase supplies without reducing consumption.

Table 8. Marginal Cost of Natural Gas (in 1982 US$)

Country	Production Cost ($/mcf)	City Gate Delivery Cost ($/mcf)
Bangladesh	0.24	0.61
Cameroon	1.29	1.79
Egypt	0.65	0.71
India	0.95	1.51
Morocco	1.16	1.71
Nigeria	0.65	1.10
Pakistan	0.36	0.46
Thailand	0.80	1.50
Tanzania	0.61	1.05
Tunisia	0.67	1.60

Source: Mashayekhi, 1985

Coal Pricing in India and China

China and India today account for 70 percent of all coal consumption in the developing world.[21] In 1984, coal accounted for 72 percent of China's commercial energy consumption and 60 percent of India's.[22] Obviously, rational coal pricing is vital to the economic development of these countries. For perspective, only three other developing countries (Jamaica, Zimbabwe, and Yugoslavia) had coal shares exceeding 21 percent of commercial energy consumption.

China is the world's third largest consumer of coal; by 2000, it may be the world's largest.[23] Unfortunately, its coal pricing policies contribute to the inefficient use of its most abundant resource. From 1974 to 1984, coal consumption increased by 60 percent in China.[24] In 1984, coal prices averaged 39 percent of long-run marginal costs and were roughly one-quarter of the average world price.[25] These low prices led to a negative rate of return (−1 percent) for the coal industry in 1984, compared to an average manufacturing return of 14 percent. Over 65 percent of all coal enterprises lost money since prices were 1.5 percent below average costs.[26]

In 1984, two-thirds of all Chinese coal enterprises lost money.

Low coal prices also spurred excessive demand and frequent supply shortages in China. In turn, shortages meant that 20 to 30 percent of China's industrial capacity was not fully utilized in 1984.[27] Clearly, industrial output losses of this size can't be sustained. Yet, subsidies to coal consumers in 1983 amounted to $10.4 billion, the equivalent of 3.7 percent of GNP.[28]

For China, as for no other developing country, rational coal pricing is the key step toward improving energy efficiency, encouraging better natural resource management, and promoting

economic development. Recognizing as much, the Chinese government has begun to raise coal prices and promote end-use efficiency. From 1970 to 1980, average coal prices increased by 0.85 percent per year. But, from 1980 to 1983, average prices increased by 3.7 percent per year and energy efficiency (real GNP per unit of energy consumption) increased by nearly 20 percent.[29]

Although some of this improvement undoubtedly stemmed from higher oil prices and the declining share of heavy industry in China, surely the gradual increase in coal prices and other conservation policies also played a part. Still, in large measure, China's notoriously inefficient use of commercial energy reflects low coal prices that discourage the investments needed to make coal use more efficient. *(See Table 9.)*

Table 9. Commercial Energy Consumption/GNP Ratios, Selected Countries, 1983

Country	Energy Consumption/Real GNP (Megajoules/1975 Dollars)
Argentina	40
Brazil	17
China	72
India	42
Indonesia	23
Japan	17
Korea	46
Qatar	133
Romania	88
United Kingdom	29
United States	33
Venezuela	50
Median for World	19

Source: World Resources Report, 1986

Historically, coal prices have been virtually uniform throughout China. Recently, however, the central government has adjusted prices to reflect differences in the quality of coal, increasing prices 5 to 9 percent on various grades of coal. Also, under a new two-tier pricing system, prices for mine production that exceed annual quotas increased by 100 percent in 1985.[30] Shortages will diminish since the higher prices will increase production and discourage demand. Although a two-tier pricing system is inherently inefficient, it is a step in the right direction.[31] Combined with other policies, these changes increased coal prices from 10 to 15 percent in 1985.[32]

Like China, India depends heavily on subsidized coal for commercial energy. Although India has increased coal prices sharply since 1980 to reflect long-run marginal costs, subsidies continue and, for some mines, revenues don't cover production costs.[33] For 1979, the World Bank estimated that losses for Coal India, Limited (India's largest coal company) were $300 million on sales of only $700 million.[34] The coal industry earned an estimated 0.6 percent rate of return, compared to 8.6 percent for industry as a whole.[35]

Subsidizing consumption of indigenous fuels is, at best, an expensive way to reduce oil imports.

Historically, coal subsidies have reflected the Indian Government's intention to displace expensive oil imports, which accounted for 65 percent of India's foreign exchange earnings in 1983.[36] Indeed, a World Bank study of coal pricing in sixteen countries found that India had the third lowest average annual increase in real coal prices from 1973 to 1982—3.5 percent.[37] In 1982, average prices were $18.5/ton, or roughly 50 percent of international prices.[38] Clearly, domestic consumers were receiving substantial subsidies, but subsidizing consump-

tion of indigenous fuels is, at best, an expensive way to reduce oil imports.

Fortunately, India has substantially increased coal prices each year since 1980. Although estimates vary, depending on the type of coal, annual prices rose by at least 10 percent per year from 1980 to 1985.[39] Yet, further large price increases are required to eliminate subsidies. Since most coal prices are still based on average costs, prices seldom recover long-run marginal costs.[40]

Clearly, rational coal pricing is critical for promoting economic development and efficient energy use in China and India. Both countries, especially China, number among the world's least efficient users of energy, and coal subsidies are partly to blame.

IV. Macroeconomic Effects of Energy Subsidies

Do energy subsidies promote economic growth and development? No, on the contrary they lead to excessive energy consumption, accelerated resource depletion, and large government revenue losses. They also favor wealthier urban families over needier urban and rural households, seriously distort energy decisions, lead to large efficiency and economic losses, and favor energy-intensive activities that displace labor and misallocate capital resources toward energy-intensive industries. Energy subsidies may benefit particular industries and consumers, but, on balance, they are more likely to make a country worse off.

Conceptual Framework

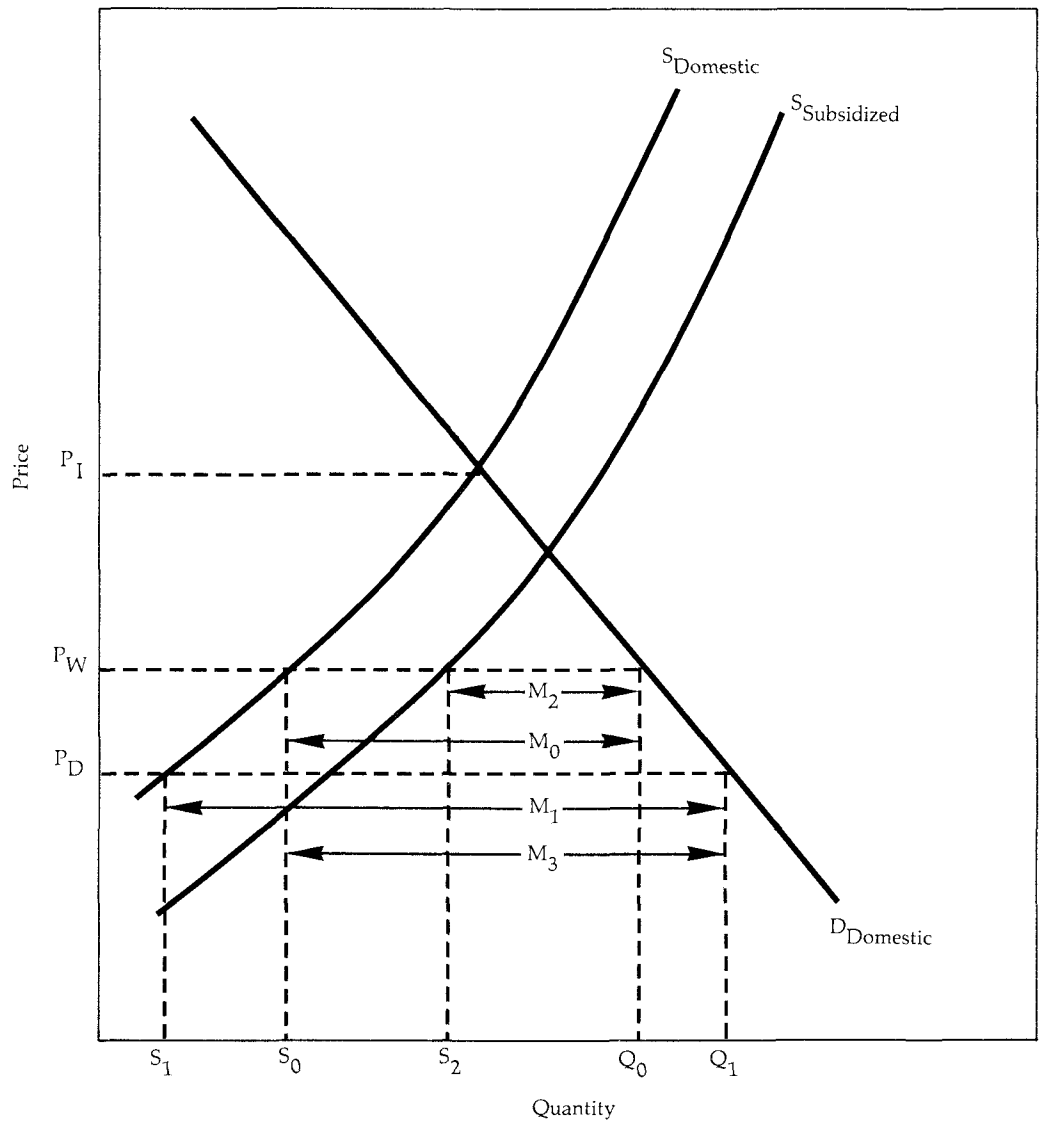
Energy subsidies take many forms, including price controls, subsidies for domestic consumers and producers, and specific import and export subsidies. Each affects domestic energy consumption and production and the level of energy imports or exports quite differently. Moreover, these effects register differently in oil-importing countries than they do in oil-exporting countries.[41]

Figures 3 and 4 illustrate the effects of alternative subsidies in oil-importing and oil-exporting countries.[42] In each case, the implicit assumption is that the world oil price (P_W) determines domestic consumption and production levels and, in turn, imports and exports. At price P_W, domestic supply is only S_0 in the importing country, while domestic demand is Q_0. Hence, the country must import the residual $M_0(Q_0 - S_0)$ units of oil to satisfy domestic demand. Imports will not fall to zero unless the world price rises to P_I since, at this price, domestic production and consumption are equal. Similarly, for an oil-exporting country, exports at the going world price are given by $X_3(S_3 - Q_3)$ and will fall to zero only if the world price decreases to P_E.

Within this framework, the effects of alternative subsidies can be assessed. In oil-importing countries *(See Figure 3)*, government price controls on domestic production and consumption that hold the domestic price of oil (P_D) below the world price (P_W) increase domestic consumption from Q_0 to Q_1, decrease domestic production from S_0 to S_1, and increase imports from $M_0(Q_0 - S_0)$ to $M_1(Q_1 - S_1)$. Alternatively, if the price controls were imposed only on domestic oil consumption, then the return to producers would be unaffected and domestic production would not change. Consumption and imports would still increase, but imports would increase only from M_0 to M_3—an amount equal to the increase in domestic demand $(Q_1 - Q_0)$ since domestic production remains constant. In this case, the government, rather than producers, pays for consumer subsidies.[43]

Producer subsidies in the importing countries, on the other hand, shift the entire domestic supply curve to the right. They

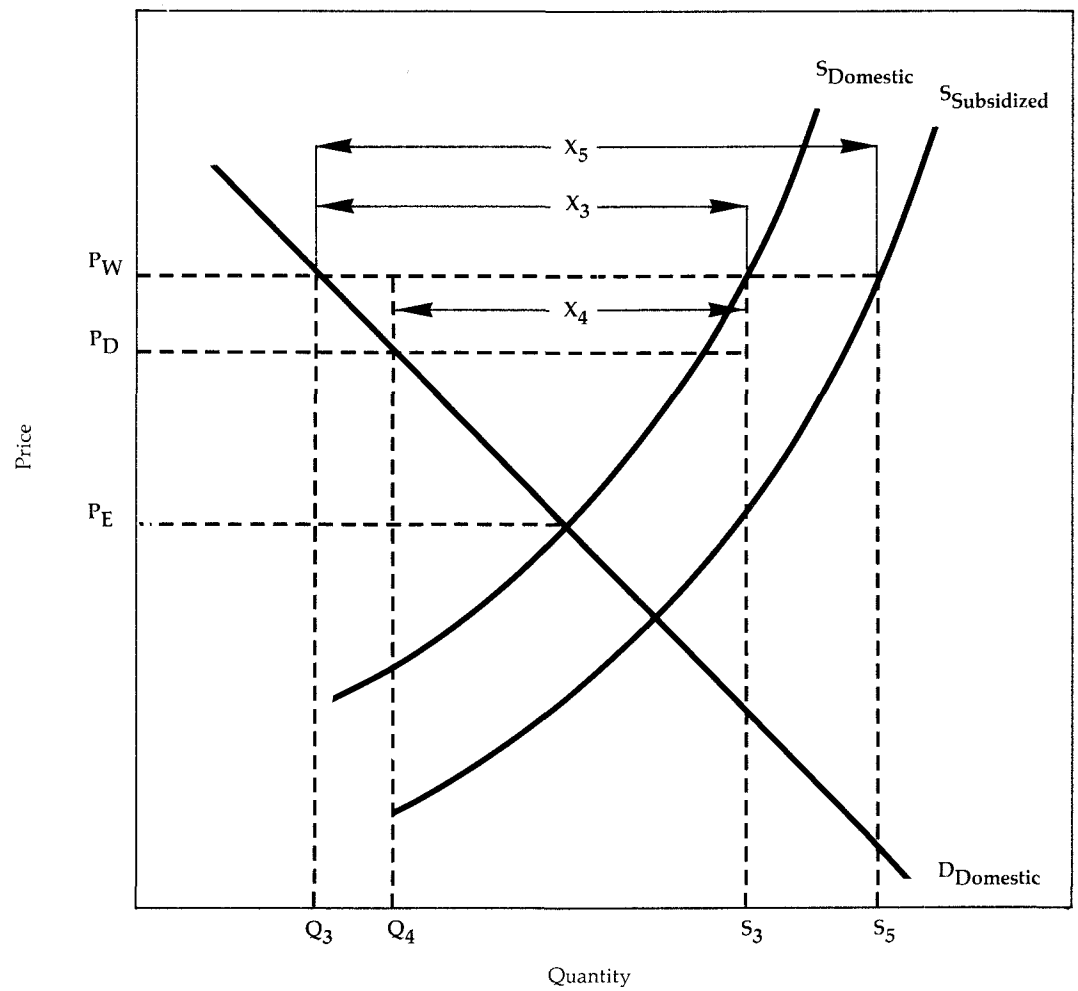
Figure 3. Example of An Oil-Importing Country; Supply and Demand for Oil



increase domestic oil production from S_0 to S_2 and reduce imports (at least until depletable reserves are exhausted) from $M_0(Q_0 - S_0)$ to $M_2(Q_0 - S_2)$. As long as these subsidies do not lower world oil prices, they have no effect on domestic consumption since world oil prices effectively determine domestic demand.[44]

Finally, if energy imports are subsidized (because, say, exchange rates are overvalued), imports and consumption will increase. In addition, import subsidies must displace domestic production since they effectively lower the price that consumers will pay for oil. Graphically, the result is similar to the example of

Figure 4. Example of An Oil-Exporting Country; Supply and Demand for Oil



price controls on domestic consumption *and* production since overvaluation has roughly the same effect as reducing the world oil price. If import subsidies effectively lower the domestic price to P_D, then imports will increase from M_0 to M_1.

For oil-exporting countries, energy subsidies have quite similar effects. *(See Figure 4.)* If price controls bring domestic prices below world oil prices, then domestic consumption will increase from Q_3 to Q_4, domestic production will remain unchanged, and exports will fall from $X_3(S_3-Q_3)$ to $X_4(S_3-Q_4)$. Domestic production does not fall because producers (in most oil-exporting countries, the national oil company) are serving two markets. In the domestic market they sell Q_4 units and earn a return

below the world oil price, but the country will still export all it can at the going world oil price(P_W) once domestic demand is satisfied. This residual is now X_4 units of oil. In short, since world oil prices remain unchanged, only exports decline.

Finally, for oil-exporters, producer subsidies will shift the entire domestic supply curve to the right, thereby increasing domestic production from S_3 to S_5 and increasing exports from $X_3(S_3-Q_3)$ to $X_5(S_5-Q_3)$ since domestic demand is unaffected. An export subsidy will have the same effect since it is equivalent to a producer subsidy for an oil-exporting country. If domestic prices don't change, neither will domestic demand. Again, the only caveat is that in the long run oil exports will decline since domestic reserves are exhausted more rapidly.

Economic Growth

Many governments justify various energy subsidies on the grounds that keeping fuel costs low promotes economic growth and development. Yet, energy subsidies lead to inefficiencies and are more likely to constrain development. Subsidies for energy consumers increase unemployment by encouraging firms to substitute energy for labor.[45] Moreover, artificially low energy prices encourage overinvestment in energy-intensive industries, in turn diverting capital from other sectors of the economy where it could be employed more productively. Similarly, producer subsidies inhibit development by diverting resources and capital from the production of non-energy goods and services.

Finally, all subsidies must be financed by either taxes or government borrowing, which also drains and distorts other sectors of the economy. Larger fiscal deficits lead to higher interest rates that displace private investment, while taxes necessarily reduce spending and growth in the private sector.

Historically, increased energy consumption has accompanied economic growth and development. But the experience of the past 13 years shattered this relationship: most OECD countries maintained positive economic growth rates during this period while reducing energy consumption. Even though higher world oil prices lowered economic growth, continued economic growth in the industrialized countries did not require additional energy consumption.[46] *(See Figure 5.)* Indeed, if energy is expensive, as it was during the 1970s, excessive energy consumption is more likely to impede growth because the misallocation of resources has high costs.

In their study of Asian energy-pricing policies during the 1970s, Sankar and Schramm found no relationship between energy pricing policies and economic growth:

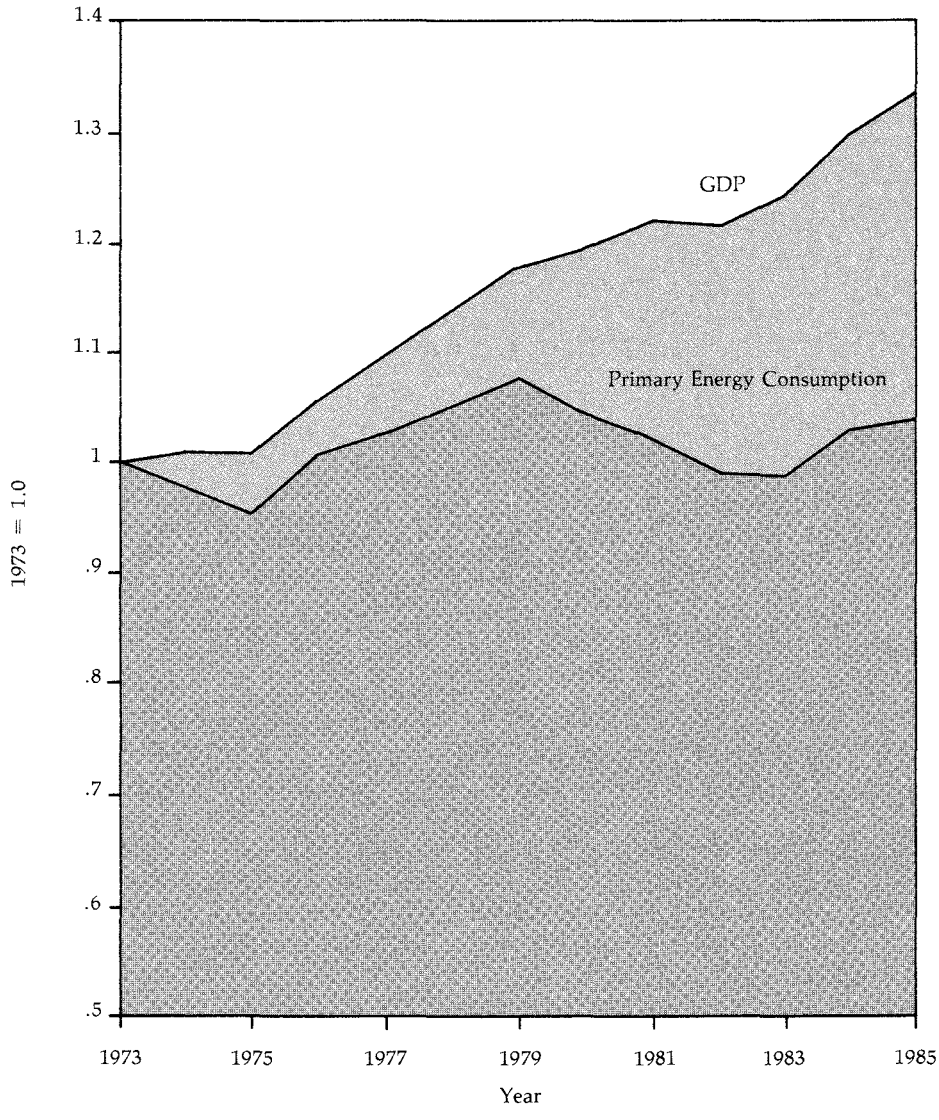
> *"Both the Republic of Korea and the Philippines, the two countries with by far the highest prices, do not seem to have suffered adverse economic consequences but have shown rates of economic growth that compare favorably with those countries in which petroleum products were heavily subsidized."*[47]

These analysts go on to point out that energy subsidies may have favored particular groups but did not improve aggregate social welfare. In other words, energy subsidies primarily redistributed income (though not necessarily to the poor) but did not help to generate it.

In many developing countries, energy pricing policy has been the most important determinant of a country's ability to adapt to external macroeconomic shocks.

In addition, a World Bank study of adjustment policies in thirty developing countries after the second oil price shock found that energy pricing policy was the most important

Figure 5. Gross Domestic Product and Primary Energy Consumption, OECD Countries, 1973 to 1985



Source: Energy for A Sustainable World, Goldemberg *et al,* World Resources Institute, (Washington, D.C., September, 1987)

determinant of a country's ability to adapt to external macroeconomic shocks.[48] Oil importers that raised domestic energy prices to reflect changes in the world energy market weathered the price shock best and experienced more favorable domestic adjustment.[49] By encouraging energy conservation, these countries reduced the outflow of income and redirected the savings in foreign exchange toward domestic development.

For perspective, the World Bank's study found that from 1979 to 1983 energy pricing policy had more effect on structural adjustment

than did exchange rate policy, monetary policy, and interest rate policy.[50] Although this study did not precisely quantify the effects of energy pricing policy, it leaves little doubt that energy taxes work better than energy subsidies. Countries that taxed energy consumption had fewer balance-of-payments problems when the oil price shock occurred and were thus better able to promote structural change and development.

These studies do not suggest that energy pricing policy is the driving force behind economic growth or that it outweighs such factors as domestic monetary and fiscal policy. Moreover, countries that pursue appropriate energy pricing policies are mostly the same ones with the most coherent overall economic policies so causes are hard to isolate. Yet, it can be concluded that raising energy prices to reflect their full costs does not itself impede economic growth and development. This study illustrates these findings with a larger data base and pricing data updated to 1983. *(See Figure 6.)*

Raising energy prices to reflect their full costs does not itself impede economic growth and development.

By comparing rates of economic growth and the average ratio of retail to border prices from 1973 to 1983, the relationship between energy pricing policies and economic growth can be assessed. The average ratio of retail to border prices reflects the degree of taxation or subsidies for petroleum products (depending on whether it is greater or less than one) and it is based on an average for four years—1974, 1977, 1980, and 1983.

For each group of countries—OECD, oil-exporters, and oil-importers—the relationship between energy pricing policy and economic growth is weak.[51] Although each fitted regression equation suggests that higher energy taxes are associated with lower rates of growth, the correlation coefficients are quite low and for none of the three groups can the alternative hypothesis that there is no relationship be rejected.[52] For all three groups of countries, large standard errors lead to confidence intervals for the estimates of the regression coefficients that include zero and positive values. In short, it is impossible to ascertain any simple relationship between economic growth and energy pricing policies, but there is no reason to believe that energy subsidies promote economic growth.

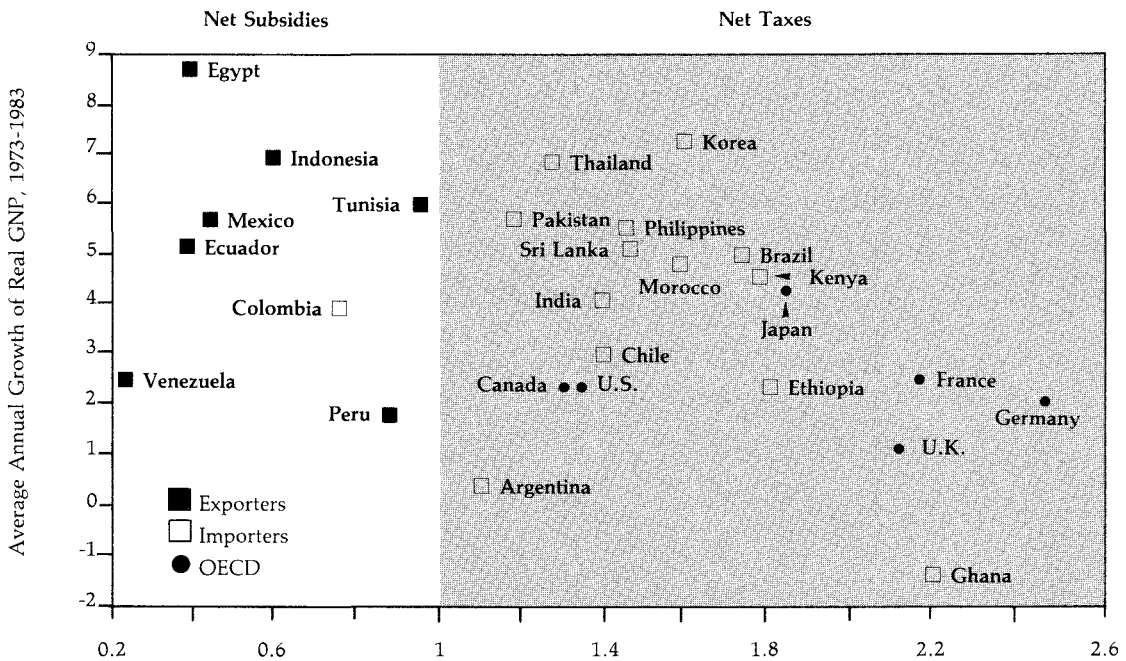
There is no reason to believe that energy subsidies promote economic growth.

Balance of Trade

Many countries subsidize industrial fuel consumption to enhance trade performance. By providing a competitive advantage to domestic manufacturing, they reason, energy price controls can help increase exports or displace imports. However, evidence suggests that this reasoning is misguided. Such subsidies actually provide minimal competitive advantages, and they also increase government deficits and borrowing requirements, which compound debt-servicing and balance-of-payments problems.

Removing energy subsidies does not substantially increase industrial production costs since labor and other inputs can be substituted for energy in the long run. For example, the World Bank study of Indonesia found that a 150 percent increase in energy prices would increase Indonesian manufacturing costs by only 2.1 percent on average.[53] Similar estimates for Canada show that doubling energy prices would increase average production costs by only 2 to 4 percent.[54] For 10 other industrial nations, slightly larger increases (3 to 7 percent) were estimated.[55]

Figure 6. Real Growth Rates of Gross National Product and Retail/Border Price Ratios, Annual Averages, 1973 to 1983**



* * Retail prices are a weighted average (by consumption shares) of the prices of the four primary petroleum products—gasoline, diesel oil, kerosene, and heavy fuel oil. Ideally, these retail prices would take into account the consumption of natural gas, electricity, and coal since in a few countries (e.g., coal in India and Korea) these fuels account for substantial shares of consumption. However, data limitations make this impossible. In any event, changes in petroleum prices are the best proxy for changes in retail energy prices—for the 22 OECD countries, from 1978-1984, the correlation coefficient between domestic petroleum prices and domestic energy prices is .89. In the developing countries, the correlation is likely to be higher since they are relatively more dependent on oil for commercial energy needs.

Fitted Regression Line	95% Confidence Interval for Slope of Line	Correlation Coefficient (x,y)
y = 5.82 - 1.01x [Exporters] (3.95)	-10.67, 8.66	-0.11
y = 6.87 - 1.91x [Importers] (1.82)	-5.84, 2.02	-0.29
y = 3.14 - 0.38x [OECD] (1.08)	-3.17, 2.41	-0.17

y = Average Annual GNP Change
x = Average Retail/Border Price
* = Statistically Significant at 5% Confidence Level
Numbers in Parentheses are Standard Errors

Source: World Resources Institute Calculations

What energy subsidies do is alter production patterns—making them more energy-intensive, more capital-intensive, and less labor-intensive. Unfortunately, this shift saves most industries little money. Subsidies that lower energy prices may substantially lower production costs for some energy-intensive industries, but they do not significantly influence overall trade balances. The misallocation of resources reduces the imports (or increases exports) of energy-intensive commodities, but it increases imports (or reduces exports) of less energy-intensive goods and services.

Energy subsidies make production patterns more energy-intensive, more capital-intensive, and less labor-intensive.

In any discussion of trade effects, it is important to distinguish between energy-importers and energy-exporters and between tradeable and nontradeable energy resources. Clearly, for oil-importing countries, any petroleum product subsidies will increase trade deficits. Either overvalued exchange rates or domestic price controls that effectively lower the price of oil imports must drain foreign exchange. According to one World Bank study, trade deficits increased most in those oil-importing countries that did not raise petroleum product prices in step with world price increases after 1979.[56]

Producer subsidies simply shift oil imports from the present to the future.

Subsidies for domestic oil production temporarily improve trade balances since domestic production displaces some imports. But, in the long run, domestic oil reserves are exhausted more quickly and imports increase. Producer subsidies thus simply shift oil imports from the present to the future.

Consumer and producer subsidies for nontradeable resources (such as coal in India and ethanol in Brazil), on the other hand, might displace oil imports and improve trade balances in the oil-importing countries. Several countries justify low prices for natural gas, electricity, and coal on this basis. Yet, no empirical evidence supports the argument that subsidies for these fuels substantially reduce oil imports.

In most developing countries pricing policies are so inadequate that natural gas and electricity supplies are not reliable and frequent shortages occur. Artificially low prices for these fuels disrupt supplies and necessitate more oil imports—the only easily traded energy resource. Subsidies for nontradeable energy thus don't necessarily reduce oil imports. In general, higher taxes on petroleum products would reduce oil imports more effectively than would subsidies for competing fuels.

For energy exporters, the relationship between subsidies for domestic energy consumption and trade performance is less obvious. Many oil-exporters justify energy subsidies on the grounds that they help diversify their export base: since more manufactured products and less oil are exported, total export earnings are less sensitive to changes in world oil prices. Although this logic sounds compelling, total export earnings do not necessarily increase over the long run since oil reserves, and hence future oil exports, are depleted more rapidly and imports of non-energy intensive products must increase.

One study of Tunisia illustrates that an oil-exporting country that removes energy subsidies can, over time, increase oil exports and improve trade performance.[57] In 1982, the World Bank's study found that eliminating energy subsidies and instituting other demand-management measures would greatly improve Tunisia's balance-of-payments. The debt-service ratio (interest payments on debt as a percent-

age of export earnings) and current account deficit would decline by 3 percent and 22 percent, respectively, if prices were rationalized. In fact, Tunisia has substantially reduced energy subsidies since 1982, and its current account balance has improved by 18.4 percent.[58] No doubt, even greater improvement would be possible in many of the other oil-exporting countries that rely more heavily on oil exports than Tunisia does.

Comparisons across countries show that energy subsidies and taxes have no appreciable effect on overall trade performance.[59] In most oil-importing developing countries, trade deficits have increased since world oil prices increased. Yet, as Figure 7 shows, the correlation between changes in trade balances and energy pricing policy in the oil-importing developing countries is weak. Similarly, in the OECD countries there is no apparent relationship.

For oil exporters, Figure 7 suggests that subsidies for domestic energy consumption enhance trade performance. But while lower energy prices might stimulate exports by such energy-intensive industries as those that manufacture ammonia, petrochemicals, and cement, they do so at the expense of *future* oil exports. Since the regression analysis is static, Figure 7 does not depict that low domestic prices reduce *future* oil exports, so it overstates the effect of lower domestic energy prices on exporters' trade performance.

Inflation

Many governments maintain energy subsidies to keep inflation down, but in practice, this strategy doesn't substantially reduce inflation. World Bank studies confirm that gradually eliminating even heavy energy subsidies would have only moderate inflationary effects. For every 10 percent increase in retail energy prices in Indonesia in 1983, inflation would increase by 1.5 to 2.0 percentage points.[60] In Egypt, increasing petroleum product prices by 23 percent per year for ten years (to reflect world market prices) would increase inflation by less than three percentage points annually. In the Philippines, 25 percent increases in energy prices would increase the cost-of-living by 2.5 percentage points.[61]

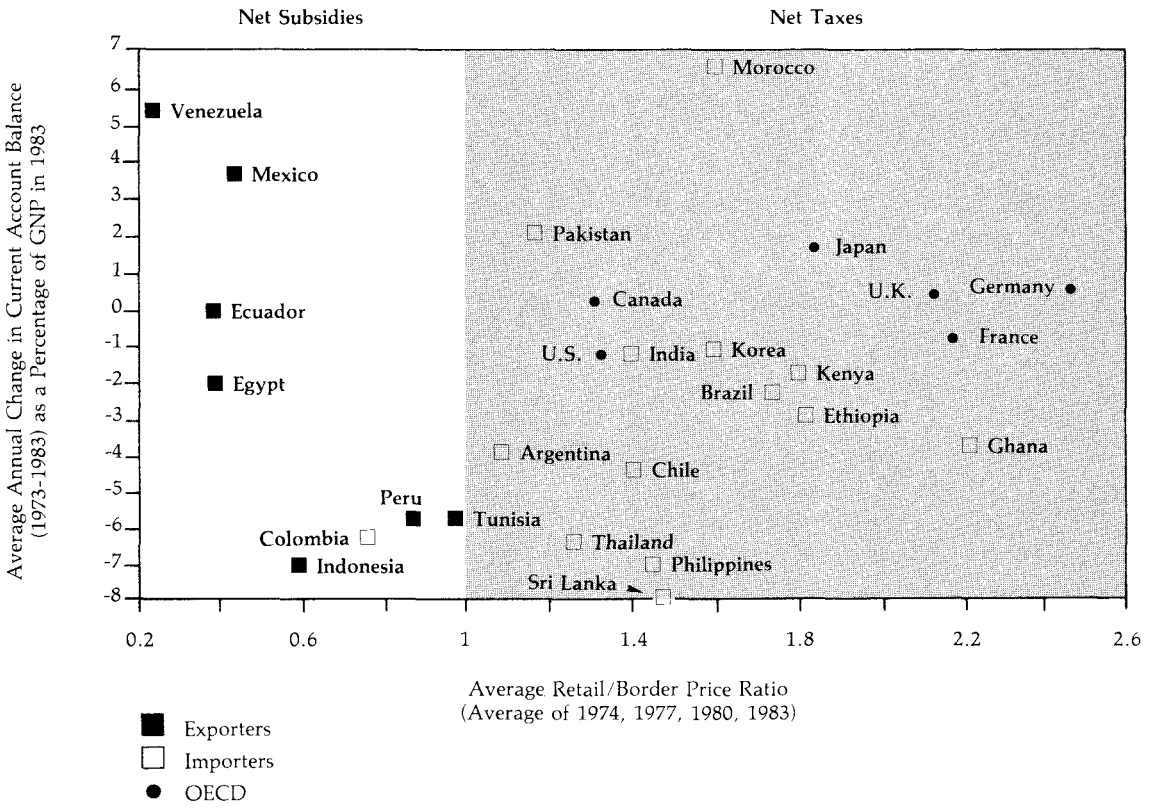
Since wood, charcoal, animal dung, and other noncommercial fuels comprise between 75 and 90 percent of all energy consumption in many of the poorest countries, eliminating commercial energy subsidies would not boost inflation much in these countries. Indeed, large segments of the domestic economy would hardly notice. Inflation can increase substantially only if the economy relies heavily on commercial energy and if the domestic money supply is increased to accommodate the increase in energy prices.

In Indonesia, for example, expanding the money supply to offset the contractionary effect of energy price increases would greatly increase inflation.[62] Increasing the money supply stimulates demand and industrial output but also—via a wage-price spiral—increases inflation by 4.0 to 10.0 percentage points when energy prices increase by 10 percent.[63] However, the *direct* effects of the energy price increase are no more than 2.0 percentage points. The U.S. experience in the 1970s also indicates the importance of policy responses to higher energy prices: expansionary monetary policy and real wage indexation fueled the inflation brought on by energy price increases.

Quite simply, countries that do not subsidize energy use it more efficiently than those that do.

The interdependence of energy efficiency, energy prices, and the inflationary pressures generated by energy price increases is also key to understanding the relationship between energy pricing policy and inflation. Quite simply, countries that do not subsidize energy use

Figure 7. Percentage Changes in Current Account Balance and Retail/Border Price Ratios, Annual Averages, 1973 to 1983



Fitted Regression Line	95% Confidence Interval for Slope of Line	Correlation Coefficient (x,y)
y = 6.10 - 14.10*x [Exporters] (4.81)	-25.85, -2.33	-0.80*
y = -5.10 + 2.06x [Importers] (3.03)	-4.49, 8.61	0.19
y = -0.93 + 0.52x [OECD] (1.06)	-2.20, 3.25	0.24

y = Average Annual Current Account Change (1973-1983)
x = Average Retail/Border Price
* = Statistically Significant at 5% Confidence Level
Numbers in Parentheses are Standard Errors

Source: World Resources Institute Calculations

it more efficiently than those that do, and therefore they are less susceptible to energy price shocks.[64]

Energy subsidies might reduce inflation temporarily. But once subsidies are lifted, the inflationary effect of any oil price shocks will be commensurately greater since energy use/GNP increases in the absence of strong conservation incentives—witness the painful experience of the United States during the 1970s. Profligate energy consumption in the decades before phased oil-price decontrol began in 1975 compounded the inflationary effects of rapidly increasing world oil prices.

Finally, intercountry comparisons of annual inflation rates and retail border price ratios indicate no strong relationships between overall inflation and energy pricing policy. *(See Figure 8.)* None of the results are statistically significant. Quite simply, other policies—among them, monetary, exchange rate, and fiscal policy—have far more bearing on domestic inflation rates than energy pricing policy and therefore the low correlations are not surprising.

Energy Efficiency

Aside from foregone revenues and other economic losses, energy subsidies usually induce wasteful energy consumption. The question for policy-makers is whether eliminating or reducing energy subsidies will significantly improve energy efficiency. The answer is yes.

Improvements in energy efficiency can be measured by changes in the ratio of energy use to GNP, which indicate how much more or less energy a country needs to accommodate economic growth. As Figure 9 indicates, those OECD countries with the highest energy prices use energy more efficiently than those with lower energy prices. In fact, according to one study, roughly 50 percent of intercountry differences in energy intensity among OECD nations can be explained by prices, while the other half are attributable to differences in climate, income level, and the composition of final output.[65]

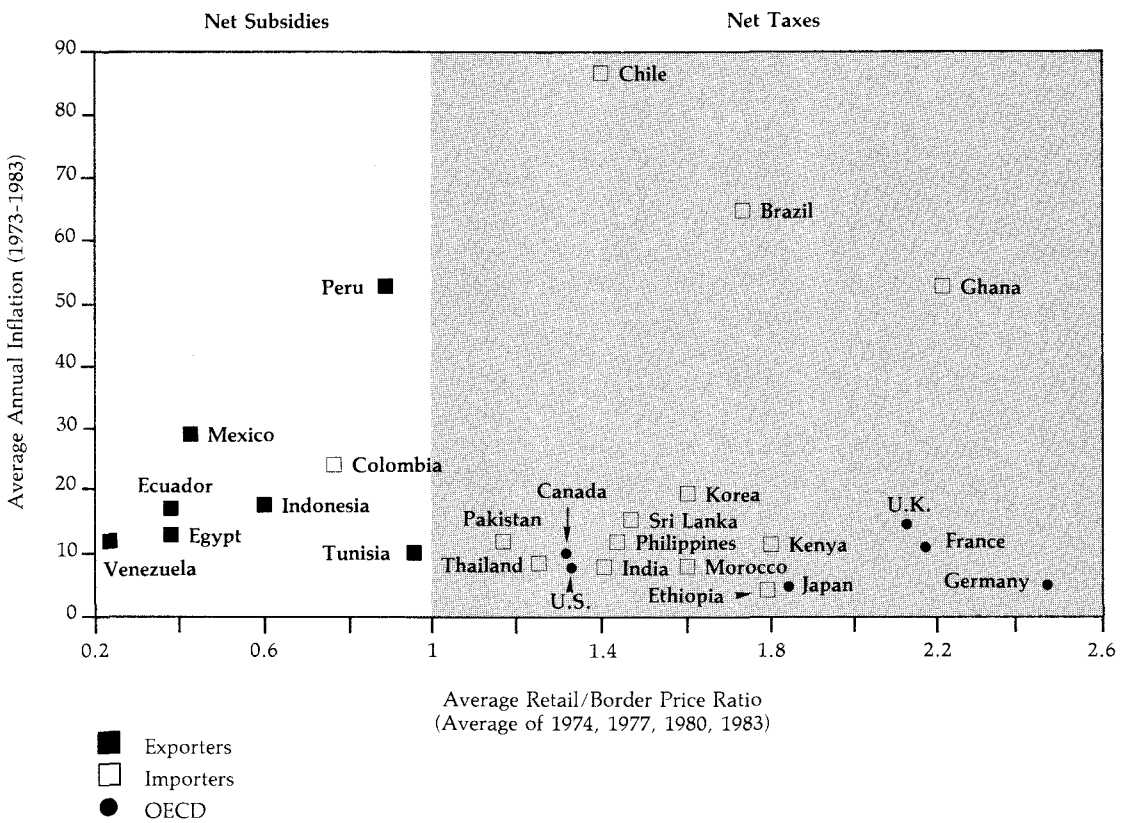
Roughly 50 percent of intercountry differences in energy intensity can be explained by prices; the other half are attributable to differences in climate, income level, and the composition of final output.

Another comparative study of conservation in the OECD countries and Eastern Europe found that pricing policy was the key determinant of energy intensity.[66] Eastern Europe experienced larger increases in energy demand because its pricing and conservation policies were inadequate. The OECD countries, on the other hand, emphasized energy demand management and realized greater gains in energy efficiency. In the OECD countries, real energy prices increased by 82.4 percent from 1973 to 1981, while in Eastern Europe real energy prices remained virtually constant—the main reason why Eastern European countries use 30 to 40 percent more energy per unit of GNP than countries in the West do.[67]

By and large, countries with higher energy prices use energy more efficiently. For the combined sample of exporters, importers, and OECD countries analyzed here, the relationship in 1983 between higher energy taxes and higher levels of energy efficiency is statistically significant.[68] Although Figure 10 depicts wide variations in levels of energy efficiency and pricing policies, higher energy taxes and prices do substantially improve efficiency.[69] Furthermore, as Figure 11 illustrates, countries with higher average energy taxes from 1973 to 1983 also experienced greater improvements in energy efficiency.

As for the relationship between changes in energy prices and improvements in energy effi-

Figure 8. Inflation Rates and Retail/Border Price Ratios, Annual Averages, 1973 to 1983

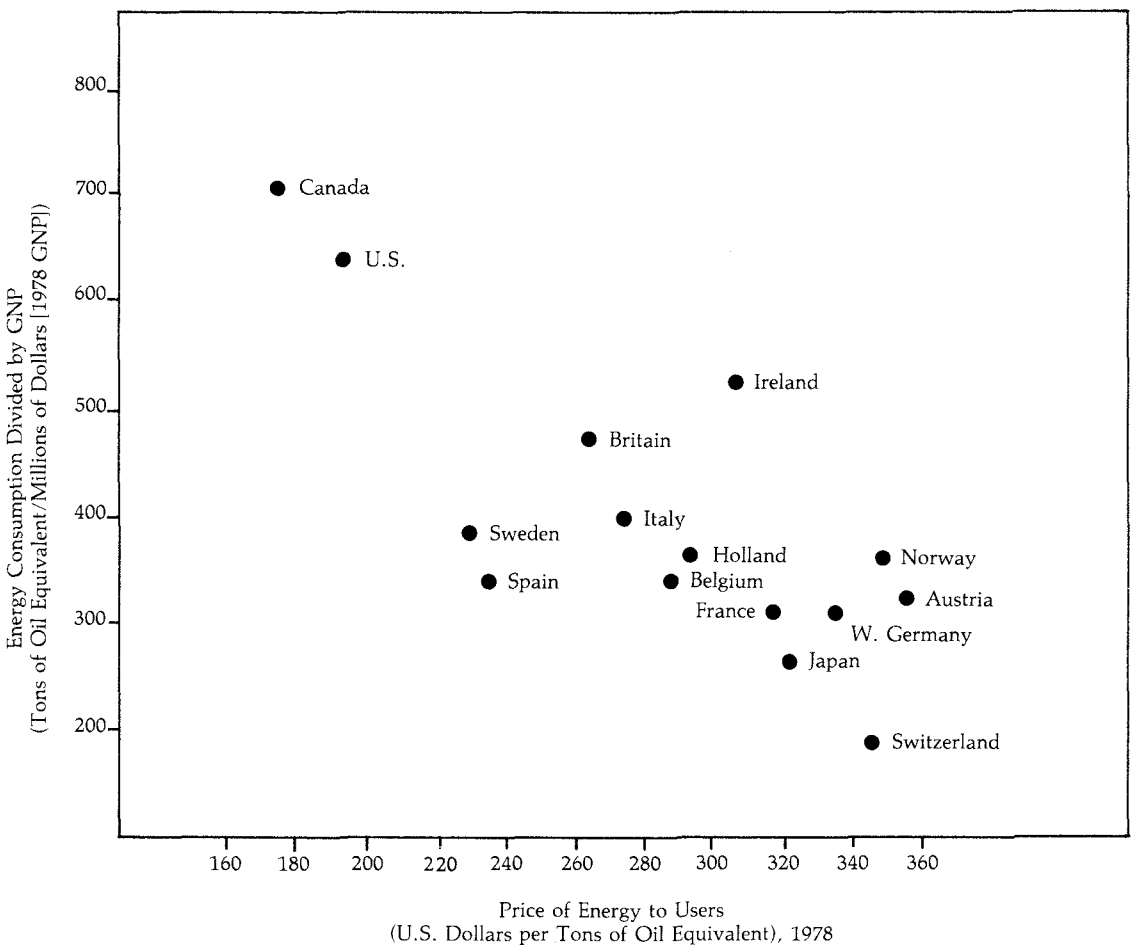


Fitted Regression Line	95% Confidence Interval for Slope of Line	Correlation Coefficient (x,y)
y = 9.96 + 20.80x [Exporters] (22.48)	-34.21, 75.81	0.38
y = 65.39 - 20.58x [Importers] (36.32)	-99.02, 57.86	-0.16
y = 8.89 - 0.21x [OECD] (4.03)	-10.58, 10.16	-.025

y = Average Annual Inflation (1973-1983)
x = Average Retail/Border Price Ratio
* = Statistically Significant at 5% Confidence Level
Numbers in Parentheses are Standard Errors

Source: World Resources Institute Calculations

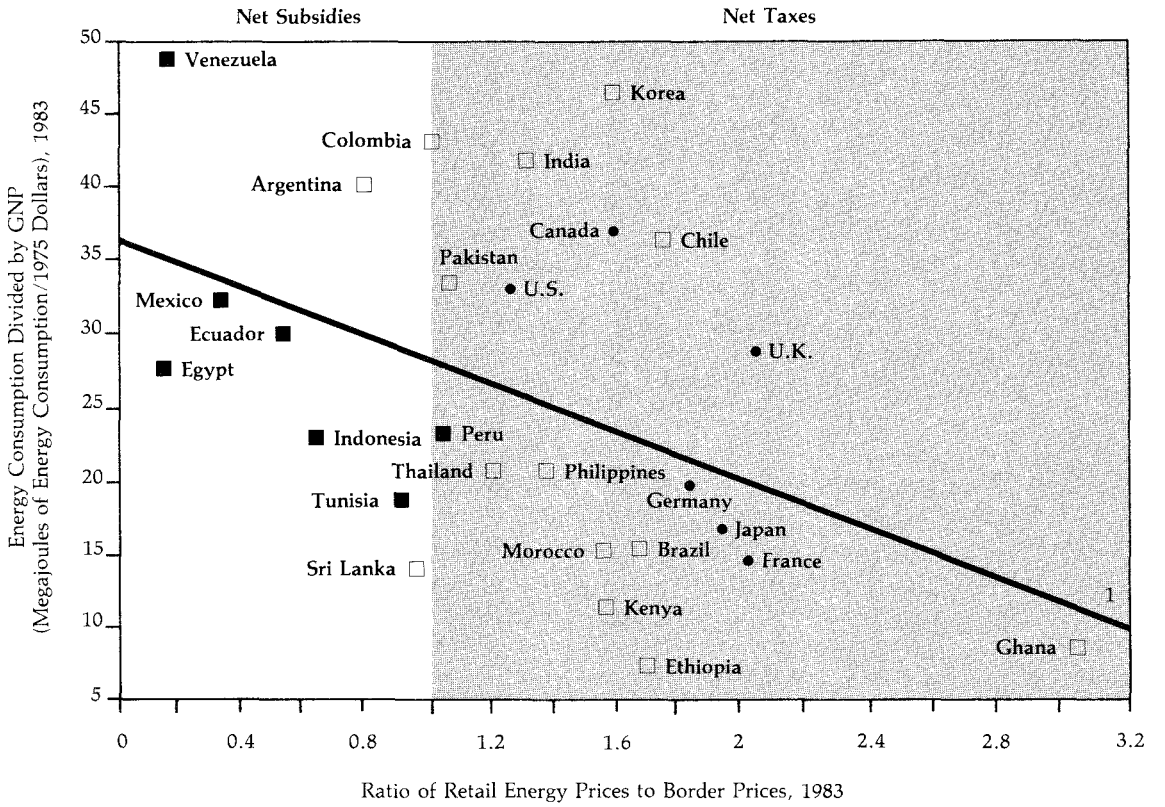
Figure 9. Commercial Energy Efficiency and Energy Prices, Selected Countries, 1978



Source: *The Economist*, (New York, 1981)

ciency, a 10 percent annual increase in real energy prices corresponds, on average, to a 1.4 percent annual improvement in energy efficiency.[70] This result squares with findings in other studies. For example, for the United States from 1972 to 1983 one study found that, for every 10 percent increase in real energy prices, energy efficiency improved by 1.9 percent.[71] In the United States, energy efficiency remained virtually constant from 1952 to 1972 while real oil prices declined, but it improved by 32 percent during the following decade—a powerful testament to the effects of energy prices on energy efficiency.

Figure 10. Commercial Energy Efficiency and Energy Prices, 1983



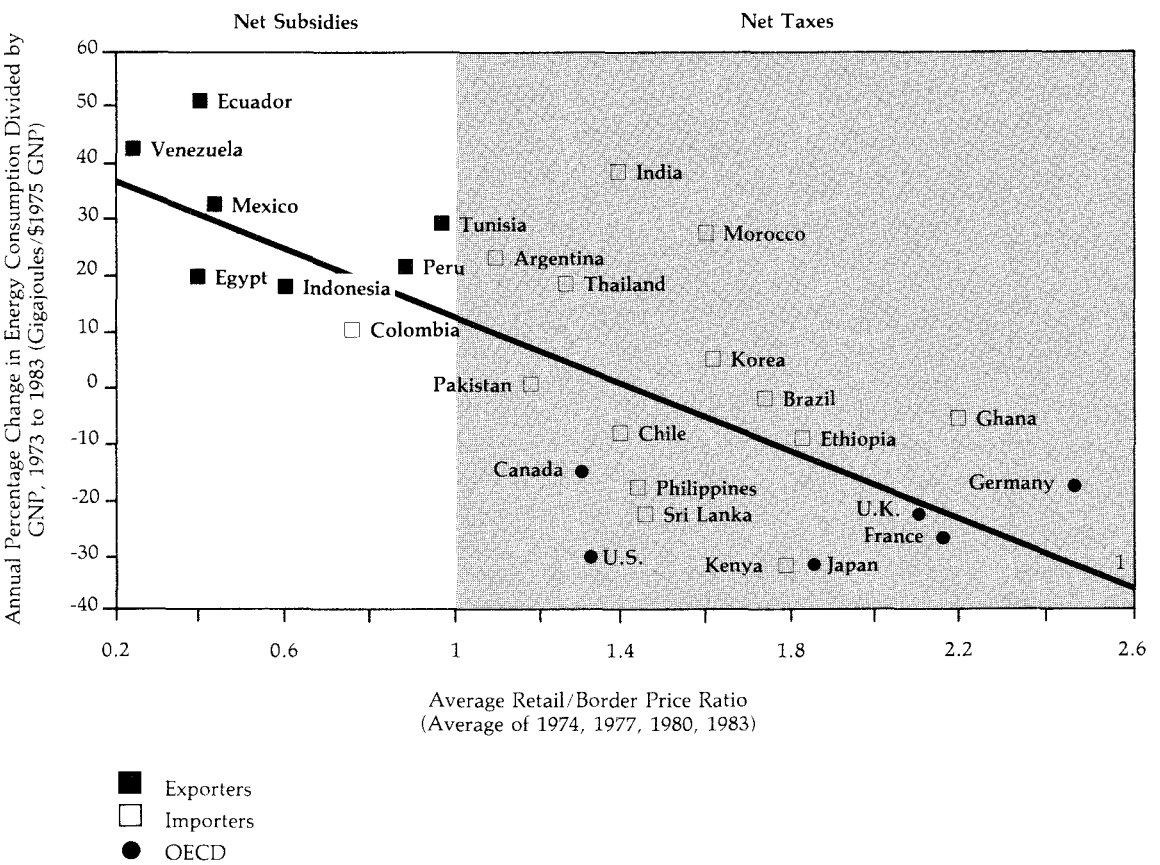
■ Exporters
□ Importers
● OECD

Fitted Regression Line	95% Confidence Interval for Slope of Line	Correlation Coefficient (x,y)
y = 37.09 - 8.18*x [All Countries] (3.26)	-14.88, -1.48	-.45*

y = Energy Consumption/GNP, 1983
x = Ratio of Retail Energy Prices to Border Prices, 1983
* = Statistically Significant at 5% Confidence Level
Numbers in Parentheses are Standard Errors

Source: World Resources Institute Calculations

Figure 11. Changes in Commercial Energy Efficiency and Retail/Border Price Ratios, Annual Averages, 1973 to 1983



Fitted Regression Line	95% Confidence Interval for Slope of Line	Correlation Coefficient (x,y)
[1] y = 43.11 - 29.93*x [All Countries] (5.57)	-41.39, -18.46	-0.73*

y = **Change in Energy Consumption/GNP Ratio (1973-1983)**
x = **Petroleum Retail/Border Price Ratio (average)**
* = Statistically Significant at 5% Confidence Level
Numbers in Parentheses are Standard Errors

Source: World Resources Institute Calculations

Government Revenues and Petroleum Subsidies

While petroleum taxes raise significant revenues in several oil-importing nations, petroleum subsidies lead to large economic losses in many oil-exporting countries. Large domestic subsidies reduce the foreign exchange earnings of these countries and, in turn, strain government budgets. In most cases, these losses total billions of dollars. *(See Table 10.)*

In China, consumer subsidies for heavy fuel oil and crude oil equal $5.4 billion. Combined with electricity subsidies of $8.9 billion and coal subsidies of $10.4 billion, total energy subsidies equal $19.4 billion—equivalent to 7 percent of China's GNP and 20 percent of its export earnings.[72] In Peru, petroleum subsidies alone totalled $301 million. These foregone revenues equal nearly 75 percent of all of the country's oil-export revenues and about 2 percent of GNP. They contribute substantially to Peru's increasing debt burden since large foreign exchange earnings are sacrificed.

Although Peru has striven hard to reduce energy subsidies, nearly doubling domestic petroleum prices between 1981 and 1983, the recent decline in the nation's economy and persistently high inflation have made it difficult to continue to increase domestic petroleum prices and reduce subsidies. In fact, because of high inflation and the appreciation of the U.S. dollar relative to Peru's sol, real retail petroleum prices fell by 5 percent between 1983 and 1985.[73]

Table 10. Energy Subsidies and Energy Exports in Selected Oil-Exporting Developing Countries, 1985[a]

Country	Energy Subsidies (Million $)	Energy Exports (Million $)	Energy Subsidies / Energy Exports	Energy Exports / Total Exports	Energy Subsidies / Total Exports
Bolivia (1983)	224	329[b]	68%	42%	29%
China	5,400[c]	6,600	82%	24%	20%
Egypt	4,000	2,000	200%	44%	88%
Ecuador	370	2,000	19%	64%	12%
Indonesia	600	9,000	7%	66%	5%
Mexico	5,000	15,000	33%	70%	23%
Nigeria (1984)	3,000	13,000	23%	90%	21%
Peru	301	410	73%	20%	15%
Tunisia	70	690	10%	41%	4%
Venezuela	1,900	13,000	15%	95%	14%

Source: World Resources Institute calculations based on the UNDP World Bank Energy Assessments, *The UN Energy Yearbook, 1984,* Li *et al., South* (A), International Trade Commission (ITC), and the US Embassy.

a. Economic subsidies = (Average Border Price – Average Retail Price) * (Total Consumption of Petroleum Products). Average border and retail prices are based on a weighted average of the prices of gasoline, kerosene, diesel fuel, and heavy fuel oil.

b. Primarily (99%) natural gas exports to Argentina.

c. These are subsidies for fuel oil and crude oil only. Estimate excludes $10.4 billion in coal subsidies and $8.9 billion in electricity subsidies.

Peru's economic travails illustrate the importance of exchange rates in petroleum product pricing. Since petroleum products are traded in dollars, countries must increase domestic energy prices substantially to reflect rapid currency depreciation. Otherwise, domestic energy prices will fall relative to the prices of other goods and services in the economy and energy consumption will increase commensurately.[74]

Peru and China are not the only countries suffering significant fiscal and economic losses because of energy subsidies. In Egypt, where energy prices are approximately 20 percent of the world average, petroleum consumption continues to increase 10 percent to 12 percent annually.[75] Petroleum subsidies cost the Egyptian government about $4 billion in 1985—twice the value of Egypt's petroleum exports. Excessive consumption at artificially low prices drains the nation's resources since subsidies equal 13 percent of GNP and 88 percent of export revenues.

Petroleum subsidies cost the Egyptian government about $4 billion in 1985—twice the value of Egypt's petroleum exports.

Egypt, the most extreme case among the countries studied here, exemplifies an energy-rich country whose domestic subsidies are only beginning to seriously constrain economic development. Stagnation has followed on the heels of high economic growth during the 1970s and early 1980s. Considering that Egypt has a 35 percent debt-service ratio, which is likely to rise with lower revenues from petroleum exports, domestic energy subsidies must be reduced if the country is to avoid debt rescheduling. Most likely, Egypt will become a net importer of energy by the early 1990s unless domestic energy consumption is restrained. Clearly, domestic energy subsidies not only represent a fiscal drain today; they are also speeding the depletion of Egypt's primary export commodity.

Petroleum subsidies are so large in several oil-exporting developing countries that they lead to significant economic and fiscal losses—losses that make the hard times brought on by recent decline in world oil prices harder.

Egypt's situation illustrates what is perhaps the most important finding of this study: petroleum subsidies are so large in several oil-exporting developing countries that they lead to significant economic and fiscal losses—losses that make the hard times brought on by recent decline in world oil prices harder. In Mexico, Nigeria, Ecuador, Venezuela, Peru, and Egypt, debt problems can be mitigated by increases in domestic energy prices.

If price controls were eliminated and subsidies reduced, more oil could be exported. Every subsidized barrel consumed domestically represents foregone foreign exchange earnings that could, under certain circumstances, be as large as the subsidy itself.[76] Skeptics might argue that the current glut in world oil markets reduces the value of additional oil exports, but any oil conserved can be exported later when its value may be higher.

For several countries, energy exports represent a large percentage of total exports and energy subsidies a high percentage of energy exports and total exports.[77]

As Table 10 clearly shows, energy subsidies figured prominently in the economies of many oil-exporting countries in 1985.[78] Moreover, in many such countries, oil-export revenues will fall because oil prices are lower and domestic reserves are increasingly limited. Exceptionally

high growth rates in domestic oil consumption during the last decade (thanks largely to heavy subsidies) have run down reserves.

In fact, virtually all of the developing world's increase in oil consumption since 1973 occurred in the oil-exporting countries. From 1973 to 1983, petroleum product consumption increased by 64 percent in the developing countries, even though it stagnated in the non-oil producing countries.[79] To a large extent, this disparity reflects lower prices in the oil-exporting countries. For example, in Venezuela gasoline still only costs 18¢ per gallon while in Egypt and Ecuador one gallon costs about 50 cents.[80]

It is predicted that Nigeria (like Egypt) will become a net oil-importer by 2000 unless it curtails domestic consumption.[81] Others predict the same fate for China, Mexico, and Tunisia.[82] If oil consumption is not curbed, then the decline in oil-export revenues—together with the fiscal losses from energy subsidies—will thwart many exporters' attempts to service their debts and promote economic development.

Calculations by the Department of Energy (DOE) illustrate the importance of oil-exporters' conservation. DOE estimates that domestic demand as a percentage of total production will increase from 28 percent to 44 percent for Indonesia, Mexico, Nigeria, and Venezuela by 2000.[83] From 1984 to 2000, DOE estimates that the domestic oil requirements of these four countries will double and that exports will fall by 30 percent.

The World Bank's study of Indonesia estimates the potential for increased oil exports by reducing domestic energy subsidies and consumption. The study estimates that Indonesia's annual exports of crude oil and liquefied natural gas (LNG) would (given the level of subsidies in 1981) decline from 443 million barrels in 1980/1981 to 335 million barrels by 1990/1991. However, if all petroleum subsidies were eliminated, an additional estimated 72 million barrels per year (18 percent of domestic consumption) would be available for export. This would increase oil export revenues by 10 percent in 1991.[84]

To preserve future exports, Indonesia has more than doubled domestic energy prices since 1981. Oil consumption fell by 2 percent per year from 1982 to 1985 after increasing by 10 percent annually from 1976 to 1982.[85] Subsidies fell from $2 billion in 1982 to $600 million in 1985 and, by 1987, they are expected to total only $130 million. Similar gains are achievable in the other oil-exporting countries with the heaviest subsidies. In Egypt and Peru, price rationalization would reduce domestic energy consumption by an estimated 20 percent and 6 percent, respectively, by 1990.[86]

Such countries as Mexico, China, and Peru, which have high levels of domestic consumption relative to their oil exports, would stand to reap the largest foreign exchange benefits from domestic conservation. In China, a 5-percent reduction in domestic oil consumption would increase the exportable surplus by 25 percent and lead to a 6-percent increase in total export revenues. In Peru, Egypt, and Mexico, a 5-percent reduction in domestic use would increase exportable supplies by roughly 20 percent, 7 percent, and 4 percent, respectively.

As the numbers show, petroleum product subsidies impose significant economic and fiscal losses in several oil-exporting developing countries. Although most of these countries have reduced subsidies over the past five years, large subsidies remain. Without further reductions soon, excessive domestic energy consumption will deplete the exportable surplus of oil. Low oil prices have already made it increasingly difficult for Mexico, Nigeria, Egypt, Ecuador, and Venezuela to service their debts. Over time, the depletion of exportable reserves could have equally serious consequences.[87]

V. Microeconomic Effects of Energy Subsidies

Energy subsidies misallocate resources by encouraging producers and consumers to make uneconomic substitutions to take advantage of subsidies. The evidence on some important distortions associated with energy subsidies, their costs, and their economic and policy implications is compelling.

How Petroleum Subsidies Redistribute Income

Low energy prices are often justified by governments in developing countries on the grounds that they favorably affect the poorest families, who spend larger portions of their incomes on energy. But, since the rural poor (and many of the urban poor) use little commercial energy, commercial energy subsidies actually do little to improve their standard of living. In fact, these subsidies favor industrial and commercial users and the wealthier urban households who consume a disproportionate share of commercial energy.

The World Bank estimates that although households account for 45 percent of energy consumption in the developing countries, they account for only 10 to 20 percent of commercial energy consumption. On average, then, commercial energy subsidies must benefit industry, the transportation sector, and the consumers of their products.[88]

Most studies of petroleum subsidies in developing countries conclude that the cost-of-living would increase most among urban and upper-income households if subsidies were removed. Indeed, on average, energy subsidies appear to redistribute income from poor to rich. Particular subsidies that favor low-income groups are apparently more than offset by subsidies that favor middle-income and upper-income families.

Several recent World Bank studies assess how energy price increases affect household income. In Egypt, a 23 percent annual increase in oil prices would increase the cost-of-living index by 4.1 percent for upper-income households, 2.9 percent for middle-income ones, and 3.0 percent for lower-income families. In the Philippines, a 25 percent increase in petroleum prices would yield 2.3 percent cost-of-living increases for high and middle-income families and a 2.5 percent increase for lower-income ones.[89] Finally, for Indonesia, a 50 percent increase in energy prices translates into a loss of 2.5 percent of household income for urban households and only 0.99 percent for rural ones. To the extent that more wealthy families live in cities and consume much of the commercial energy, removing energy subsidies would help distribute income more equitably in Indonesia.

At least one analyst has also pointed out that if the energy consumption "embodied" in non-energy goods and services is taken into account, low-income families may not spend a much larger percentage of their income on

energy than high-income households do.[90] Direct energy expenditures as a percentage of household income in Mexico are 10 percent and 3 percent, respectively, for low-income and high-income families.[91] However, when indirect expenditures are included, low-income families spend between 15 and 20 percent of household income on energy while high-income ones spend 11 to 19 percent.[92]

In developing countries, the most common subsidies are for kerosene because lower-income families spend a greater percentage of their income on kerosene than better-off families do. In Peru for instance, the poorest third of the population spends 6.7 percent of its income on kerosene while the wealthiest third spends only 0.9 percent.[93] But, upper-income households consume more kerosene simply because they can afford more. Consequently, lower-income households receive fewer kerosene subsidies.[94] In Indonesia, urban households (which are generally more wealthy than rural ones) account for 18.9 percent of all households but receive 36.8 percent of the kerosene subsidy.[95] The poorest 40 percent of the population consumes only 20 percent of the kerosene and therefore receives only 20 percent of the subsidy.[96] In Ecuador, where all petroleum products are subsidized, the wealthiest 16 percent of the population received 60 percent of all energy subsidies in 1983.[97]

Subsidies and low taxes on diesel fuel also exemplify a well-intended but misguided pricing policy.[98] In the developing countries, diesel often costs less than gasoline because diesel is the primary fuel for public transportation which is used most heavily by the urban poor. Yet, most diesel is used to truck manufactured goods. For example, in India, 64 percent of all diesel is consumed by trucks, while buses use only 22 percent.[99] On average, trucks consume 40 to 64 percent of all transport fuel in the developing countries.[100] While low diesel prices do marginally benefit urban families (some of whom are poor), they mostly benefit those wealthy enough to buy manufactured goods.

On balance, such pricing polices are a clumsy, crude, and largely ineffective means of redistributing income. Price subsidies are a costly way to help the poor since fuel substitutions by industrial users and wealthy households undermine income redistribution. Recognizing as much, Sri Lanka launched an imaginative kerosene-stamp program that has significantly reduced kerosene subsidies without harming low-income households. In 1979, the Sri Lanka government tripled kerosene prices. To shield low-income users, it gave all qualifying households (more or less the lower 50 percent in income) entitlements to six free liters per month. This stamp scheme reached low-income consumers[101] and preserved conservation incentives since kerosene used in excess of the entitlement had to be purchased at market prices.

The conservation and fuel substitution gains were substantial in Sri Lanka: kerosene consumption fell by 25 percent between 1978 and 1980, after increasing by 18 percent in the previous two years.[102] Over time, the value of the entitlements has not increased as quickly as kerosene prices, so remaining kerosene subsidies have gradually been reduced. The administrative costs have been dwarfed by the revenue savings. According to World Bank estimates, the kerosene-stamp program saved the Ceylon Petroleum Corporation an estimated $17 million in 1982, or 60 percent of the total kerosene subsidy ($28 million).[103]

As the facts make plain, policies that reach the poor more effectively—and primarily—must replace subsidized fuel prices if energy pricing policies are to redistribute income effectively. Even so, redistribution will be limited in many developing countries since the poorest families (both urban and rural) rely mainly on traditional energy sources.

How Petroleum Subsidies Affect Consumer Decisions

Energy subsidies lead to economic losses by distorting individual and institutional behavior. Excessive fuel consumption, costly and improper

fuel substitutions, and the costly capital substitutions sometimes needed to take advantage of energy subsidies all lead to losses. Some of the most common interfuel substitutions include diesel for gasoline in the transportation sector, the adulteration of gasoline and diesel with kerosene in industry and transportation, and substitutions between coal and heavy fuel oil in manufacturing.

Most of the countries studied here maintain diesel and gasoline prices that do not reflect international prices. While the two fuels cost about the same on the world market, most developing countries keep retail diesel prices well below 75 percent of gasoline prices. *(See Table 2.)* Here again, the primary rationale is that gasoline is used mostly by families wealthy enough to own cars while diesel is the primary fuel for public transportation. However, relatively low diesel prices also encourage the "dieselization" of the vehicle fleet and lead to large economic losses in the transportation sector.

In Indonesia, where diesel prices are still only 50 percent of gasoline prices, gasoline consumption grew by 9.4 percent per year between 1970 and 1980 while diesel sales grew by 19.6 percent annually.[104] During the same period, diesel-engine vehicles accounted for an increasing share of all vehicles—63 percent of all buses and 47 percent of all trucks in 1980, up from 22 and 21 percent, respectively, in 1970.[105] In Brazil, diesel vehicles accounted for 45 percent of the commercial vehicle fleet in 1979, compared to only 27 percent in 1970. During these nine years, gasoline prices tripled while diesel prices only doubled, so the price differential between gasoline and diesel increased from 17 percent to 130 percent.[106]

In India and Sri Lanka, relatively low diesel prices—50 percent and 60 percent of gasoline prices, respectively, in 1985—also encourage owners of private vehicles to switch from gasoline to diesel. In Sri Lanka, the proportion of diesel-burning vehicles in new registrations increased from 14 percent to 38 percent in just two years (1978 to 1980).[107] In India, the average taxi driver can save $1200 by retrofitting a gasoline-operated taxi with a diesel engine. If prices weren't distorted, however, this substitution would *cost* the driver $200.[108] Clearly, these price differentials encourage fuel and equipment substitutions—especially in taxis and other vehicles that use large quantities of fuel. Although converting gasoline-powered vehicles to run on diesel might improve fuel efficiency, the switch is not always economic.

Keeping diesel prices far below gasoline prices diverts benefits from users of public transportation since diesel can easily be substituted for gasoline in industry and private transportation. In all countries, consumers of goods transported by truck benefit from low diesel prices, as do owners of private vehicles in Sri Lanka and India. No doubt, these users exert political pressure to keep diesel prices low.

Relatively low diesel prices also make trucks artificially more attractive than railways for freight transport. In India, railways' share of total freight transport fell from 84 percent in 1961 to 64 percent in 1981.[109] This shift was largely due to lower diesel prices, which benefit trucks more than trains since, in India, trucks consume six times as much diesel fuel as trains.

As a rule of thumb, the intended effects of lower fuel prices or energy subsidies will be undermined whenever large-scale fuel substitution is possible. To discourage these substitutions, other regulations may be needed. For example, in Sri Lanka the license fee for diesel automobiles is three times that for gasoline cars. More efficient and equitable than imposing such offsetting regulations would be raising diesel taxes and using the additional revenues to subsidize public transportation.

Another reason why many countries do not raise diesel prices is that such increases can boost the consumption of kerosene, a heavily subsidized substitute.[110] Some of the revenue

from higher diesel taxes would be offset by more kerosene consumption and subsidies unless kerosene prices were also increased. Yet, the perceived equity considerations make it difficult to raise diesel and kerosene prices simultaneously. Instead of raising both towards parity with gasoline prices, many countries keep diesel and kerosene prices low to discourage the substitution of kerosene for diesel. One exception is Sri Lanka, which doubled diesel prices when it tripled kerosene prices in 1979. By substantially raising the prices of both fuels, Sri Lanka encouraged conservation and discouraged uneconomic fuel substitutions.

Economic Efficiency and Equity in Electricity Pricing

By increasing electricity tariffs to reflect the costs of providing additional service, countries that subsidize electricity would realize several benefits. Perhaps most important, prices ration electricity far more effectively than brownouts and supply outages. Since many agricultural, commercial, and industrial operations depend on continuous and stable electricity supplies, the unreliability of electricity supplies in many developing countries leads to large economic losses. If prices were increased, existing generating capacity would more likely meet demand and fewer power outages would occur.

According to one recent estimate, these losses approached $2 billion in Brazil in 1980.[111] Schramm estimates that industrial outage costs are $3 per kWh not supplied, while outage costs for the residential and commercial sectors are $1.50 per kWh not supplied. Given effective power outage rates of 20 percent of supply for industrial electricity and 15 percent for residential and commercial electricity, net economic losses are $1.0 billion for industry and $0.7 billion for residential and commercial users. For perspective, *total* revenues for Brazil's electricity sector were only $518 million in 1980.[112]

As Table 11 shows, removing electricity subsidies would also yield significant savings in many other countries. Given the high costs of new power plants, it can be up to three times cheaper to reduce end-use demand and improve transmission and distribution systems than it is to add more generating capacity.[113] Required investments could be financed through higher electricity prices and reduced subsidies.

Electricity demand is high in many countries, but it also varies greatly by time-of-day and season. Much generating capacity is needed to meet demands that arise only a few hours per day or a few weeks per year. If peak users aren't charged for the costs of peak service, resources will be misallocated: additional generating capacity will be needed and peak users will be more heavily subsidized than off-peak ones.

A recent World Bank survey of twenty of its power projects found that only six systems had adopted time-of-use pricing and only three systems had seasonal rates.[114] Clearly, opportunities for improving natural resource management by rationalizing electric power tariffs are great. In general, raising average electricity prices to equal long-run marginal costs is necessary but not sufficient to eliminate subsidies, provide proper incentives, and reduce consumption. The structure of electricity tariffs must also be changed to reflect differences in peak and off-peak demand.

In general, raising average electricity prices to equal long-run marginal costs is necessary but not sufficient to eliminate subsidies, provide proper incentives, and reduce consumption.

Peak users aren't the only beneficiaries of differential subsidies. *(See Table 12.)* In most countries, residential consumers are the most heavily subsidized customer class. Residential

Table 11. Decreases in Electricity Demand and Economic Subsidies if Prices are Increased to Reflect Marginal Costs*

Country	Percentage Decrease in Demand	Electricity Consumption (Million kWh)	kWh Savings (Millions)[1]	Reduction in Economic Subsidies (Millions $)[2]
Bangladesh	35	4,292	1,502	135
Bolivia	37	1,680	622	36
China	42	377,240	158,440	8,903
Ethiopia	68	753	512	96
India	48	131,036	62,897	4,324
Morocco	37	6,409	2,371	301
Peru	55	10,675	5,871	324
Senegal	18	636	114	6
Tanzania	5	867	43	4
Uganda	85	313	266	21
United States	27	2,511,965	678,230	60,538

Source: World Resources Institute: Calculations based on Table 4, UNDP/World Bank Energy Assessments, and *The UN Energy Yearbook, 1984.*

* A long-run (generally, a 5-10 year response period) price elasticity of demand of −1 is assumed. Estimates vary widely (e.g., from −1.32 in Indonesia to −.80 in Mexico) [World Bank, Berndt and Samaniego]. Short-run (1-2 year response period) elasticities are necessarily much lower since substitution possibilities are limited by the shorter length of the response period.

[1]Based on the midpoint formula for calculating price elasticity.

$$E_D = \frac{(Q_2-Q_1) / (.5 * (Q_1 + Q_2))}{(P_2-P_1) / (.5 * (P_1 + P_2))}$$

$E_D = -1$, $P_2 = 1$, P_1 = LRMC/Average Revenues from Table 4
Q_1 = Consumption in Column 2, Q_1-Q_2 = kWh Savings in Column 3

[2]Reductions in economic subsidies represent reductions if prices are increased to reflect marginal costs. They are equal to (LRMC—Average Revenues) * Total Electricity Consumption. LRMC and average revenues are based on Table 4.

rates are usually lower than commercial and industrial rates even though the costs of providing service to residential users is higher on a per kWh basis. Although residential customers rarely use all of the capacity available to them, maintaining this capacity for peak use adds to service costs. In effect, attempts to protect residential customers from higher electricity costs make rate structures even more inefficient.

Can electricity prices below replacement costs be justified in the developing countries in the name of equity for lower-income families? And are greater per kWh subsidies for residential users justified? No. In most developing countries, only a small percentage of the rural households that comprise 70 to 80 percent of the population are even wired for electricity, while industrial and commercial use account for some 70 percent of electricity consumption.[115]

Table 12. Ratio of Average Revenues to Marginal Cost by Customer Class

Country		Residential	Commercial	Industrial
Brazil	(1983)	0.56	0.80	0.76
Costa Rica	(1984)	0.26	0.71	0.67
India	(1983)	0.37	n.a.	0.87
Peru	(1983)	0.33	1.24	0.45
United States	(1984)	0.66	0.77	0.73

Source: Kosmo, deLucia, UNDP/World Bank Energy Sector Assessments.

What's more, electrified households tend to be comparatively wealthy; at any rate, the initial hook-up costs are high relative to income. In India, only 10 to 15 percent of all rural households have electricity, and these households have incomes two to four times those of households without electricity.[116] In Mexico, in 1980, only 2 percent of urban households had no electricity, compared to 40 percent of rural households.[117] In China, 300 million out of 800 million rural residents have no electricity, and industry consumes 70 percent of all electricity.[118] More generally, rural per capita consumption of electricity is, on average, only one-fourth of urban consumption.[119] Moreover, among urban households, wealthier families consume more electricity and other commercial fuels and thus benefit more from subsidies. *(See Table 13.)*

Of course, electricity subsidies do benefit rural *users* in many countries. In Brazil, China, Ethiopia, and Tanzania, for example, rates are nearly uniform nationally. Yet, in China, average generating costs vary from 2.6¢ to 4.7¢/kWh.[120] Rural users must be more heavily subsidized since it clearly costs more to provide electric service to remote regions. Arguably, these subsidies may be necessary for rural electrification and rural development, but until more rural households in such countries as China, India, and Brazil can afford electricity, rural subsidies will benefit only a small percentage of the rural population and lead to significant economic losses.[121] India provides a compelling example.

India has always subsidized agricultural electricity heavily. One study of thirteen states found that industrial rates were close to marginal costs, domestic rates were about 40 percent of long-run marginal costs, and agricultural prices were only 20 percent of long-run marginal costs.[122] Clearly, the heaviest per-unit subsidies go to agriculture, which accounts for approximately 14 percent of India's energy consumption.[123] One study estimates that the costs of these subsidies approaches $4 billion, annually.[124]

Most agricultural energy subsidies go to the owners of electric pumpsets for irrigation, which account for approximately 75 percent of power consumption in Indian agriculture.[125] Yet, only four million comparatively affluent farmers who have irrigated fields and enough acreage to justify the expense of private irrigation supplies own pumpsets—not enough to justify such large revenue losses.

Subsidies for agricultural electricity also create excess demand for electricity and disincentives for investment in conservation, diesel pumps, and biogas plants and gasifiers. More important, high demand can make power supplies unreliable, forcing many farmers to maintain back-up pumps (usually diesel). Overinvestment in back-up pumps, in turn, annually costs an estimated $320 million.[126]

On balance, the electricity subsidies that pervade developing countries are expensive and

Table 13. Principal Cooking Fuels of World Populations, 1976

Populations	Percentage of Population Using		
	Commercial	Wood fuels	Dung and crop wastes
Africa South of Sahara			
Urban nonpoor	83	17	0
Urban poor	0	100	0
India			
Urban nonpoor	67	33	0
Urban poor	0	57	43
Rest of South Asia			
Urban nonpoor	75	25	0
Urban poor	0	67	33
East Asia developing (Pacific)			
Urban nonpoor	73	27	0
Urban poor	50	50	0
Middle East & North Africa			
Urban nonpoor	100	0	0
Urban poor	50	50	0
Latin America & Caribbean			
Urban nonpoor	100	0	0
Urban poor	50	50	0

Source: Joy Dunkerley *et al., Energy Strategies for Developing Nations,* p. 49.

inequitable. By reducing these subsidies, countries can help stabilize electricity supplies, reduce wasteful consumption, promote equity, and recover substantial revenue losses.

Do Producer Subsidies Promote Energy Self-Sufficiency?

Many countries heavily subsidize energy production. In the United States, expensing of drilling costs and depletion allowances costs the Treasury $4 billion per year.[127] Supposedly, such tax benefits enhance energy self-sufficiency by promoting the development of indigenous resources. But this argument is flawed since fossil fuels are depletable.

Producer subsidies for fossil fuels do not reduce dependence on foreign energy supplies. At best, they defer it. By encouraging more rapid depletion of its fossil fuels, the United States will increase its future dependence on foreign energy supplies. Dependence may initially drop because domestic production will be artificially high, but imports must eventually increase because high levels of production cannot be sustained.

Some economists claim that subsidies for new energy sources might even increase import dependence.[128] First, they claim other productive sectors of the economy will substitute energy for labor since more labor is needed to

produce the subsidized energy. Second, energy consumption is "embodied" in the capital and materials used to develop new energy sources. Since both of these effects reduce the net energy yield of subsidies to new energy sources, the yield for new sources can be negative.[129]

Incentives play an important role in reducing energy imports. But, as a rule, these incentives should encourage lower demand for fossil fuels rather than increased supplies since demand reductions are sustainable while supply increases of exhaustible resources are not. The United States spent billions of dollars in the early 1980s on a synfuels program that produced nothing, when it would have been far more sensible to increase petroleum taxes to restrain petroleum demand. Now, world oil prices well below 1980 levels and a persistent budget deficit make a petroleum tax even more attractive than subsidies for alternative fuels.

The experience of the United States since 1960 makes it clear that demand management (primarily oil-price decontrol from 1975 through 1981) has been the driving force behind oil-import reductions. During the 1960s, oil imports increased in spite of import quotas and increasing domestic production. Domestic production peaked in 1970, however, and U.S. dependence increased to an all-time high of 44 percent of consumption by 1977.[130] During the 1970s, tax benefits, high world oil prices, and large Alaskan reserves did not boost U.S. production greatly; the physical and economic constraints on domestic production were simply too great. Not until oil prices were completely deregulated did the United States oil-import dependence markedly decline—from 37 percent in 1980 to 27 percent by 1985. Raising prices and encouraging conservation made the difference, not increasing production.

Producer subsidies have also proven inadequate in Brazil. Over the past decade, Brazil has embarked on an ambitious program to convert its automobile fleet to ethanol-fueled vehicles and thereby reduce oil imports.[131] To encourage people to buy these vehicles, the government guarantees that ethanol prices will not exceed 65 percent of gasoline prices. With world gasoline prices falling, however, subsidies to ethanol producers cost Brazil $650 million in 1985[132] and were expected to increase to $2 billion in 1986.[133] Now, Brazil faces an unpleasant choice—pull the subsidies out from under the ethanol industry and the automobile industry (which would have to retool substantially to produce more gasoline-fueled vehicles) or incur larger losses from continued subsidies.[134]

Although ethanol subsidies helped to reduce Brazil's fuel imports (from $10 billion in 1980 to $5 billion in 1985), politically powerful ethanol producers and private automobile owners reaped most of the benefits. More important, these estimates overstate gains in foreign exchange because Brazil has had to import $3 billion in foodstuffs that Brazilian farmers stopped planting to grow sugarcane as an ethanol feedstock. Opponents of ethanol subsidies claim that farmers' shift from food production to fuel production has all but offset fuel-import reductions.[135]

Energy autarky was and will continue to be a costly proposition for Brazil, as it is for most countries—even the largest and most richly endowed.

The Brazilian government has spent over $8 billion on an industry that only recently achieved $2 billion in annual sales.[136] Energy autarky was and will continue to be a costly proposition for Brazil, as it is for most countries—even the largest and most richly endowed. Brazil has not subsidized petroleum consumption since the early 1970s, but its ethanol subsidies have proven misguided and costly. However politically unpopular, higher taxes on petroleum products would have reduced Brazil's fuel imports at lower cost and without saddling the country with an uneconomic industry.[137]

Increasing Natural Gas Supplies

Throughout the world, natural gas pricing is heavily regulated, and most of these regulations reduce production incentives. In the United States, natural gas is the only primary energy source still subject to federal price controls. Approximately 45 percent of U.S. natural gas production is still regulated.[138] As a natural monopoly, the distribution of natural gas through pipelines may merit regulation, but there is no economic justification for price controls on production.

Reducing producers' incentives to explore for and develop gas is one of the most counterproductive distortions of price controls. Current regulations encourage gas producers to find and develop the deepest and most expensive reserves and to pass over the low-cost "old" gas that is still subject to price controls. Deregulation would encourage developers to tap the lowest-cost reserves first and would help arrest the trend of declining natural gas production. Since 1975, natural gas production in the United States has declined 14 percent.[139]

Gradual oil price decontrol from 1975 to 1981 successfully rationalized consumer and producer incentives without increasing inflation much. Phased decontrol of natural gas prices should be equally successful.

By making more lower-cost U.S. gas available, natural gas deregulation would displace some oil imports. Given recent concern over falling world oil prices' effects on U.S. oil imports, decontrol should continue now. Substituting natural gas for oil would help check increases in U.S. oil imports while low world oil prices buffered any adverse inflationary and distributional effects of natural gas decontrol. Gradual oil price decontrol from 1975 to 1981 rationalized consumer and producer incentives without increasing inflation much. Phased decontrol of natural gas prices should be equally successful.

In the developing countries, increasing natural gas prices to reflect replacement costs would encourage conservation and more efficient utilization of natural gas. Moreover, higher producer prices would also encourage substitution of previously unavailable natural gas for heavy fuel oil and coal since natural gas has a substantial cost advantage over these competing fuels. In addition, higher producer prices would raise revenues and help finance the expansion of natural gas networks in many developing countries. Benefits would also include more efficient energy use, less air pollution and global warming, and improved balance-of-payments. Such oil-importing countries as Bangladesh, Pakistan, and India could displace some oil imports by substituting domestic natural gas, and such oil-exporters as Indonesia, Nigeria, Mexico, and China could free up additional oil for export.[140]

Expanding gas supplies could also help arrest deforestation in some poor countries. For example, in Bangladesh, where forests have been largely depleted and fuelwood accounts for 83 percent of urban biomass consumption, the delivered price of natural gas is considerably lower than that of fuelwood.[141] Urban consumers would switch to gas even at the higher prices required to make more gas available. Given that only 40 percent of all households use natural gas in Dacca, opportunities for fuelwood substitution appear substantial in urban areas. However, in rural areas where natural gas delivery costs are higher and most biomass fuels are crop residues and dung, there is less potential for displacing wood fuel consumption.

China's experience vividly illustrates how low natural gas prices reduce production incentives. From 1978 to 1983, average production costs increased by 59 percent while prices increased by only 25 percent.[142] During this same

period, the average rate of return fell from 14 percent to −22 percent, and gas production fell by 16 percent. Seven of the country's eight largest gas enterprises lost money since prices were 8 to 15 percent below average costs.

In general, raising natural gas prices might increase consumption while, for example, raising the price of petroleum products might not because of differences in the export potential of these two fuels. Since petroleum products are easily traded, low domestic petroleum prices merely encourage more oil imports (or, for oil-exporters, reduced exports) to meet the excess domestic demand for petroleum products. Natural gas, however, is rarely traded because the costs of liquefying gas and transporting it safely can be prohibitive. Therefore, domestic shortages created by low gas prices require the substitution, and often importation, of petroleum products and coal. If gas distribution networks are expanded, higher natural gas prices in the gas-producing countries would reduce or eliminate these natural gas shortages and generate tangible environmental and economic benefits by reducing oil and coal consumption, even in the face of lower world oil prices.

The cases of Bangladesh and Pakistan (each of which meets 39 percent of its commercial energy needs with natural gas) further illuminate the importance of increasing natural gas prices to reflect opportunity costs. In Pakistan, the average price of natural gas was $1.70/mcf in 1984 while the equivalent border price of fuel oil was $4.25/mcf.[143] Clearly, even doubling natural gas prices would not prompt consumers to substitute fuel oil for natural gas as long as fuel oil is not subsidized.[144] But, raising gas prices would increase natural gas supplies since the additional revenues could finance expansion of gas supplies and distribution networks. Because natural gas has a substantial cost advantage in Pakistan, raising its price to encourage more production could lead to the consumption of more natural gas and less heavy fuel oil, especially if subsidies on heavy fuel oil were reduced. This switch would affect Pakistan's balance-of-payments favorably since petroleum imports equal 49 percent of all merchandise exports.[145]

In Bangladesh, steps have been taken to rationalize gas prices. Prices were increased by 20 percent in both 1985 and again in early 1986.[146] Still, natural gas pricing in Bangladesh does not reflect opportunity costs. The power and fertilizer industries buy more than 70 percent of all natural gas, but pay rates ($.52/mcf) that are only one-third of those paid by other industrial and commercial users.[147] Large cross-subsidies to these sectors exacerbate the national gas utility's financial problems and lead to supply shortages. As in the case of electricity tariffs, setting gas prices to reflect capacity demands would be a far more efficient rationing method than occasional supply disruptions.

If natural gas pricing is reformed, gas production and utilization would increase, provided that gas distribution networks are expanded. But until natural gas prices are linked to the price of the fuels they would displace, and until producer prices are raised to reflect opportunity costs, supply constraints will persist and countries will continue to use coal and oil—dirtier and more expensive fuels.

Environmental Benefits of Rationalized Energy Pricing

Many of the world's most serious environmental problems stem from commercial energy consumption and production. Damage to forest and aquatic ecosystems from acidic deposition, widespread air pollution in densely populated areas, land disturbance and water pollution from coal and petroleum extraction, and the environmental impacts of large hydroelectric projects all beleaguer heavy energy-using countries. In addition, the health and safety risks associated with nuclear power and nuclear waste disposal and the possibility of a "greenhouse effect" taking hold as carbon dioxide and other greenhouse gases accumulate in the atmosphere trace back to commercial energy production and consumption patterns.[148]

Eliminating or reducing subsidies to the most polluting fuels would be a major step towards making headway against these environmental problems. By encouraging energy conservation, more rational pricing policies would mitigate the environmental stress associated with energy use and buy the world precious time to solve these problems.

The relationships between energy pricing policies, energy consumption, and environmental quality are important. Specifically, tax incentives for energy development favor the most heavily polluting fossil fuels—petroleum and coal. In the United States, the world's largest energy producer, direct tax benefits to the oil and gas industry totalled at least $4 billion in 1985, and some estimates run as high as $12 to $16 billion.[149] Oil and gas subsidies for producers equal an estimated 3 to 6 percent of final retail prices.[150] For the coal industry, tax benefits could be as high as $1.75 billion and tax benefits are equivalent to 12 percent of retail prices.[151]

Natural gas, the most environmentally benign fossil fuel, receives the smallest incentives for additional exploration and production in the United States. Remaining price controls limit the substitution of gas for oil and coal. As Table 14 clearly demonstrates, substituting natural gas for oil or coal (as, say, a heating fuel or industrial feedstock) would reduce CO_2 and other greenhouse gas emissions and their effect on global warming. This substitution would also reduce SO_2 emissions and the attendant problems of air pollution and acid rain.

Finally, by eliminating or substantially reducing electricity subsidies, lower electricity consumption would also improve the environment. Globally, large-scale conservation could substantially reduce emissions of sulfur oxides, nitrous oxides, toxic air pollutants, and greenhouse gases.[152] Environmental damage to coastal waters from thermal pollution cast off by power plants and to inland waters from hydroelectric dams would also be reduced. In addition, curbing electricity use would decrease the pollution associated with coal mining, petroleum transport, and nuclear waste disposal.

Table 14. CO_2 Emissions From Fossil Fuel Combustion (Millions of Tons Per Exajoule)

Natural Gas	13.8*
Oil	19.7
Coal	23.9*
Shale Oil	47.6

Source: Irving Mintzer and Alan Miller, *Illustrations of a Warmer World: Modelling the Future Buildup of Greenhouse Gases,* World Resources Institute, unpublished manuscript.

*Considering that the end-use of natural gas is more efficient than that of coal, the per-kWh emissions of natural gas are only about one-third those of coal.

Energy subsidies harm human health and the environment in the developing world too. In China, pricing coal far below marginal opportunity costs impedes the coal industry's ability to finance modernization, which, in turn, constrains China's ability to limit the environmental damage that stems from coal mining. In addition, emissions from coal burning have contributed significantly to urban air pollution in China.[153] Smog from industrial and household use has been reported in parts of Northeast China. In Beijing alone, winter sulfur dioxide emissions increased by 38 percent during the 1970s and average dust levels (total suspended particulates) were 0.5 milligrams per cubic meter—seven times the U.S. air quality standard.[154] Water pollution also afflicts China's coal-producing areas. All six of the principal rivers in Shanxi Province are polluted. More particularly, wastewater discharged after coal washing has led to phenol concentrations of from 10 to 300 times the approved standards.[155]

Finally, since China accounts for roughly 16 percent of world coal consumption, it contributes significantly to such transboundary pollution problems as global warming. If China continues its coal-pricing reforms, then the entire world stands to benefit from reduced emissions. Without price reforms, consumers will burn more coal and China's coal enterprises will lack the revenues needed to improve environmental protection and safety procedures.

Oil-pricing policies also contribute to pollution in many developing countries. Low prices for transport fuels, for instance, encourage the operation of private and commercial vehicles in some countries, clearly contributing to the air pollution and congestion that plague such major cities as Lagos and Mexico City.[156] Higher fuel prices would discourage vehicle use and help relieve air pollution and congestion in these and other cities.

Some analysts contend that commercial energy subsidies further environmental protection in developing countries by encouraging the substitution of commercial energy for wood, thus reducing rural deforestation. Specifically, kerosene was heavily subsidized in Indonesia and Peru because it was considered a close substitute for wood in cooking and heating. In Indonesia, however, kerosene and wood were not substitutes in the areas where deforestation was a problem, so kerosene subsidies proved misguided.[157] Most rural households in Indonesia use wood for heating and cooking, while only 15 percent of all rural homes use kerosene for cooking.[158] Consequently, the kerosene subsidies had virtually no effect on rural energy consumption patterns. Although urbanites use it for cooking, kerosene is used primarily for lighting in rural areas.

Most of the kerosene subsidies benefited urban households that account for only 2 percent of wood consumption in Java—not enough to affect deforestation significantly. Evidently, arresting rural deforestation in developing countries will require *direct* policies to increase fuelwood supplies and the efficiency of fuelwood use, not such indirect policies as kerosene subsidies.[159] Higher kerosene prices influence kerosene consumption, but have little effect on wood fuel consumption.[160]

VI. Conclusion and Policy Recommendations

The intermittent energy crisis of the last decade-and-a-half notwithstanding, only within the last five years has significant progress been made on the most effective mechanism for energy demand management—rational energy pricing. Although many countries have reduced or eliminated commercial energy subsidies, remaining subsidies for petroleum products, electricity, natural gas, and coal cost billions of dollars in economic losses annually.

Balance-of-payments pressures were probably the impetus for energy pricing reforms in the oil-importing countries. At any rate, though some petroleum products (mainly kerosene and heavy fuel oil) are still cross-subsidized, virtually all oil-importing countries now tax petroleum products. Many oil-exporting developing countries, however, still subsidize *all* petroleum products. No doubt, this historically reflected low production costs, but with recent declines in oil export revenues and aggravated debt problems, pressure to reduce domestic subsidies is growing. Many exporters will soon face serious balance-of-payments problems if they don't curb domestic oil consumption and preserve exports.

Subsidies of the other commercial energy sources—electricity, natural gas, and coal—are even more pervasive. In almost all of the countries studied here, prices do not reflect opportunity costs. So far, few countries employ time-of day and seasonal pricing and most keep average electricity prices below marginal costs. Prices for natural gas, in general, and for coal in India and China are also too low. All of these subsidies discourage energy conservation and increase pressure on the environment.

By eliminating or reducing remaining subsidies now, while inflation rates and oil prices are reasonably stable, countries that subsidize energy production or consumption can minimize the transition costs to more rational energy pricing and reap significant economic and environmental benefits. Governments should not sit by and do nothing since any future increases in world oil prices will make existing energy subsidies even more costly, and further strain the resource base that is crucial for economic growth and development.

All countries that subsidize commercial energy consumption should gradually raise domestic energy prices. The experience of the 1970s demonstrated that energy subsidies do not promote economic growth and development. Gradual and frequent price increases over three to five years are preferable to large, abrupt increases since gradual adjustment mitigates the inflationary impact of removing subsidies and causes fewer dislocations in the more energy-intensive sectors of the economy. Domestic energy prices should certainly be adjusted several times per year to reflect changes in energy markets.

Given the political difficulties involved, domestic oil prices should not be changed every time the world oil market changes. But, government officials appear to be no better than the world energy market at determining appropriate energy prices; indeed, previous attempts to bottle up energy price increases did nothing for economic performance.[161] Should world oil prices increase dramatically soon, governments should raise retail prices commensurately. Although rapid price increases do impose some hardship, domestic adjustment is smoother in the absence of price controls and energy subsidies. With oil imports again rising the world economy will be more susceptible to oil price shocks. Oil-importing countries would be wise to consider the lessons of the 1970s—raising domestic prices as world oil prices gradually increase could help forestall future price shocks.

The past decade painfully demonstrated that improvements in energy efficiency stem mainly from higher energy prices. Countries that subsidize energy consumption and production therefore undermine all other demand-management policies that encourage conservation. Education programs, regulatory standards, and research and development in conservation technology should be supported to maximize energy efficiency, but all will fail without adequate economic incentives for investments in energy conservation.

Simply raising energy prices to border prices or marginal production costs is not enough. Energy products should be taxed to reflect the external costs (such as those of pollution) of energy consumption and production and the security risks of energy-supply disruptions. For oil, taxes are preferable to import fees since the latter speed the depletion of domestic oil supplies. Import fees and energy supply subsidies may temporarily defer, but they will ultimately increase, dependence on imported fuels.

To help stabilize energy markets, governments must pay more attention to the prices of electricity, natural gas, and coal—all of which are far more distorted than oil prices. Effective demand-management requires that tariff structures reflect the costs of meeting peak electricity demand and that natural gas prices provide incentives for expanding gas supplies and distribution networks. As oil's share of world energy consumption declines, the efficient pricing of these other commercial fuels can only become more urgent.

To help stabilize energy markets, governments must pay more attention to the prices of electricity, natural gas, and coal—all of which are far more distorted than oil prices.

In developing countries, most energy subsidies do not benefit the poor since wealthier households and industrial and commercial users consume disproportionate amounts of commercial energy. Relying on targetted subsidies instead of general price subsidies would correct this inequity. Allocation schemes similar to the kerosene stamp program in Sri Lanka or subsidies for mass transit instead of diesel fuel would benefit mainly the poor and would not induce undesirable substitutions of diesel and kerosene by trucks, wealthier households, and industrial and agricultural users.

By redirecting the funds spent on energy subsidies, governments could mitigate the impacts of energy price increases on lower-income groups. Tax rebates or investments in improving the energy efficiency of equipment used by the poor (kerosene lanterns and stoves, for instance) are two alternatives.[162] Such policies are preferable to price subsidies because they discourage energy consumption and large-scale fuel substitutions.

With world oil prices increasing and domestic inflation rates substantially lower than in the past, countries should move now to rationalize

energy prices and reform the structure of energy pricing. Free of price controls, domestic prices could increase more steadily with any future increases in world energy prices. What's more, the economic and political costs of transition might never be lower, and reduced subsidies would provide a global insurance policy against the price shocks that many foresee for the 1990s.

Although conservation by the United States and other large consumers would have the greatest effect, conservation in the developing nations is also important since these countries are expected to use more energy as they industrialize. Indeed, the developing countries' share of the world's commercial energy consumption is expected to increase from 20 percent in 1980 to 25 percent in 1995, and these nations are expected to account for 95 percent of the non-communist world's growth in oil consumption over the next decade.[163] Considering that non-OPEC production is expected to peak in the early 1990s, and that the importance of such smaller OPEC and non-OPEC exporters as Nigeria and Mexico will decline as a result, commercial energy subsidies, particularly in the oil-exporting countries, do have global implications for all nations' collective energy future.

As the curators of publicly owned resources, governments cannot be expected to simply relinquish their control of energy markets. Moreover, because pricing policies may have multiple and sometimes contradictory objectives—including enhancing revenues, stabilizing prices, increasing economic efficiency, promoting equity, reducing pollution, and reducing fuel imports—the effects of any policy changes must be carefully weighed. Nonetheless, the overriding rule for energy pricing policy should be to maximize economic efficiency. When prices must deviate from opportunity costs to satisfy other policy objectives, they should induce minimal behavioral distortions and substitutions. In this way, losses of revenue, employment, environmental quality, and other "goods" are minimized.

Since many countries have already eliminated petroleum product subsidies and reduced losses, energy price reform is not a pipedream. Governments, led by energy and finance ministers, should seize the present opportunity to further reduce commercial energy subsidies since the costs of these subsidies far outweigh the benefits. It is also important for such multilateral development agencies as the World Bank, the Inter-American Development Bank, and the Agency for International Development to continue to use their influence on developing countries to reduce energy subsidies. At stake is the opportunity to improve natural resource management, encourage energy conservation, reduce environmental pressures, alleviate fiscal burdens, and promote economic growth.

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Notes

1. Commercial energy generally refers to the conventional fuels—oil, natural gas, coal, and electricity—that are bought and sold in the marketplace. Traditional or noncommercial energy forms include wood, charcoal, and other biomass fuels that are traded infrequently and are consumed largely by nonmarket sectors of the world economy.

2. Conoco, Inc., 1986. "World Energy Outlook Through 2000."

3. Petroleum Economics, Ltd., 1986. "Oil Requirements and Supplies in the Developing World."

4. Marginal cost estimates are based on detailed calculations of energy costs, operation and maintenance expenses, and capital and interest costs. For a detailed discussion of long-run marginal cost calculations and methodology, see Munasinghe and Warford, and Turvey and Anderson.

5. The exact price will depend on a number of factors including demand elasticities and the expected lifetime of available reserves. See Munasinghe and Schramm for a more detailed discussion of the pricing of nontradeable resources.

6. Countries might also employ multiple exchange rates to allow oil imports at more favorable rates of exchange. Krapels estimates that the Brazilian central bank was providing a 39 percent exchange rate subsidy to the national oil company (Petrobras) in May of 1983. At that time the "official" exchange rate was CR$477/$US while the "petroleum" exchange rate was CR$293/$US. In the Sudan, in 1984, the Bank of Sudan made dollars available to the General Petroleum Corporation (Sudan's National Oil Company) at the lowest possible exchange rate in order to minimize the company's oil import costs. [Krapels(A)].

7. deLucia, R., 1985. *Energy Pricing in Developing Countries: Theory and Case Studies,* Report prepared for World Resources Institute, December, 1985.

8. For an analysis that argues that oil price shocks had little effect on economic growth during the 1970s and early 1980s see "Energy and Economic Performance: How Important are Oil Price Shocks?" by Douglas R. Bohi, Resources For the Future, 1986.

9. See "Energy Taxes and Optimal Tax Theory" by Michael Boskin and Marc Robinson in the *Energy Journal,* Volume 6, 1985 for a detailed discussion and bibliography on the optimal taxation of energy.

10. Cambridge Energy Research Associates (CERA), 1985. *World Oil Trends: A Statistical Profile;* Dunkerley, J., Ramsay, W., Gordon, L. and Cecelski, E., 1981. *Energy Strategies*

for Developing Nations, Johns Hopkins University Press, Baltimore.

11. The percentage distribution of fuel consumption varies widely among countries. Generally, gasoline is relatively more important in the OECD countries while kerosene's share of consumption is minimal compared to that in the developing countries. For example, in the United States the percentage distribution of fuel consumption is approximately: gasoline-58%; kerosene-1%; distillates-28%; and heavy fuel oil-13%. In Indonesia, the percentage shares are 16%, 25%, 28%, and 31%, respectively. [United Nations].

12. If an oil exporter is subject to export quotas (e.g., because of agreements within OPEC), then world prices overvalue the opportunity cost of domestic consumption. This is because increases in exports would violate the agreement and drive export prices below their "agreed upon" level. In this case, the true opportunity cost is given by the future value, not the present value, of exportable supplies [Schramm (B)].

13. Clearly, border prices will vary among countries depending on the costs of shipping, the origin of oil imports, and handling costs at the border. For landlocked countries, border prices may be substantially higher. For example, Uganda's border prices were 15 to 20 percent higher than those for the rest of the countries studied here. For the most part, however, border prices do not vary by more than 5 to 10 percent among countries.

14. Import quotas might also lead to retail prices that exceed border prices. In this case, consumption is not "taxed" since the scarcity rents accrue to domestic producers rather than to the government. Still, the effect on domestic consumption is equivalent to a tax since higher domestic prices curtail consumption.

15. Berndt, E. & Samaniego, R., 1984. "Residential Electricity Demand in Mexico: A Model Distinguishing Access from Consumption," *Land Economics,* University of Wisconsin-Madison, Vol. 60, No. 3, August 1984; Li J., Wang Y. & Liu W., 1985. *Resource Pricing for Sustainable Development in China,* a report prepared for World Resources Institute, October 1985.

16. Mashayekhi, A., 1985. "Natural Gas Pricing in Developing Countries," *Natural Resources Forum,* Vol. 9, No.1, January 1985.

17. International Trade Commission, 1985. *Potential Effects of Foreign Governments' Policies of Pricing Natural Resources,* USITC Publication 1696, May 1985.

18. Natural gas use in developing countries is expected to increase at a faster rate (8.5 percent annually through 1995) than the use of any other primary energy sources [World Bank (A)]. By 1995, natural gas will provide 12 percent of commercial energy needs in developing countries [Bourcier and Shirazi]. However, much of this consumption increase will occur in a relatively small number of gas-rich countries, including the Persian Gulf countries, Bangladesh, Pakistan, Indonesia, Mexico, Venezuela, China, and Algeria.

19. Li *et al.,* 1985.

20. deLucia, 1985.

21. World Bank, 1983a. *The Energy Transition in Developing Countries,* Washington, D.C.

22. United Nations, 1983. *UN Energy Yearbook 1983,* New York; World Bank, 1983a.

23. World Bank, 1983a.

24. World Resources Institute, 1986. *World Resources 1986: An Assessment of the Resource Base that Supports the Global Economy,* New York: Basic Books, Inc.

25. The Chinese Technical-Economic Research Council study provided to the World Resources Institute calculated the rational price for coal at approximately 56 yuan/ton ($20/ton) in 1984. The average price, however, was only 22 yuan/ton, or 39 percent of marginal costs. The World Bank study of China's energy sector calculates a slightly higher long-run marginal cost for coal production and transport—65 to 70 yuan/ton. However, the Bank's study also found that mine-mouth prices were 60 percent of the long-run marginal costs of *production* in Shanxi province, where production costs range from 36 to 44 yuan per ton [World Bank (B)].

26. Li *et al.*, 1985.

27. Li *et al.*, 1985.

28. The calculation follows: If LRMC = 56 yuan/ton then the subsidy is (56 – 22 yuan/ton) * ($1 / 2.8 yuan) * (708 million tons) = $8.6 billion. If LRMC = 70 yuan/ton then the subsidy is (70 – 22 yuan/ton) * ($1 / 2.8 yuan) * (708 million tons) = $12.1 billion. The average estimate is $10.4 billion.

29. World Bank, 1985a. *Domestic Coal Pricing: Suggested Principles and Present Policies in Selected Countries,* World Bank Energy Department Paper No. 23, Washington, D.C., 1985.

30. World Bank, 1985a.

31. The advantage of a two-tier pricing system is that market signals are provided for at least some portion of coal consumption and production. However, all consumers have an incentive to overstate their needs in order to receive higher quotas. In this way lower prices would apply to larger amounts of consumption. Indeed, if users obtain larger quotas, energy consumption might increase rather than decrease. Clearly, there are high costs to implementing, reviewing, and administering these quotas—especially if they need to be reduced.

32. World Bank, 1985a.

33. Bhatia, R. 1985. "Energy Pricing in Developing Countries: Role of Prices in Investment Allocation and Consumer Choices," In *Criteria for Energy Pricing Policy,* Corazon Morales Siddayao, ed., Graham and Trotman, London; deLucia, 1985.

34. World Bank, 1985a.

35. Bhatia, 1985.

36. Bhatia, 1985.

37. World Bank, 1985a.

38. Bhatia, 1985.

39. World Bank, 1985a; deLucia, 1985.

40. World Bank, 1985a; deLucia, 1985.

41. Here, the discussion covers only such tradeable energy resources as petroleum. In the section on trade balances such non-tradeable energy sources as natural gas and electricity are briefly discussed.

42. A partial equilibrium microeconomic framework is used here to demonstrate the effects of various energy subsidies.

43. In most developing countries the existence of parastatal national oil companies blurs the distinction between producers and government. If producer prices are set too low, the national oil company will lose money. However, if producer prices are not controlled and consumers are subsidized, then the federal treasury loses revenues.

44. If the country is a substantial energy producer, its producer subsidies may apply to a substantial portion of world energy production. In this case, some of the producer

subsidies might be passed on to energy consumers since a large increase in world energy supplies would lower world oil prices. Whether producer subsidies have this effect in any country is unclear since the noncommunist country with the largest share of world oil production (the United States) accounts for a relatively small but still significant share of world oil production—15 percent.

45. Analysis by Pindyck and others shows that increases in energy prices can lead to substantial increases in employment in the long run. For most industrialized countries, a 10 percent increase in energy prices increased employment by anywhere from 6 to 10 percent [Pindyck]. The World Bank study of Indonesian pricing policy found that on average, a 10 percent increase in energy prices would lead to a 1.5 percent increase in employment.

46. Arguably, this result is unique to the industrialized nations. Energy consumption can fall as countries shift from manufacturing to service-oriented economies since energy becomes a less important production input. For developing countries, however, energy consumption is much more likely to increase with economic growth and industrialization.

47. Sankar, T.L. and Schramm, G., 1982. *Asian Energy Problems,* Asian Development Bank Survey, Praeger Publishers, New York.

48. Balassa and McCarthy addressed the policy responses to four external shocks—the increase in world oil prices, the slowdown in the world economy after 1978, the increase in interest rates beginning in 1978, and the softening of commodity prices. Their analysis assessed alternative policy responses from 1979 to 1983.

49. Balassa and McCarthy define domestic adjustment as the ratio of the sum of balance-of-payments effects of export promotion, import substitution, and macroeconomic policies to the balance-of-payments effects of external shocks. A ratio below one indicates that domestic policies did not offset the balance-of-payments effects of external shocks.

50. Balassa, B. and McCarthy, D. 1984. *Adjustment Policies in Developing Countries,* World Bank Staff Working Paper No. 675.

51. In Figure 6, both exporters and importers cannot be included in the same regression equation. The increase in world oil prices increased GNP in the oil-exporting countries while it retarded growth in the rest of the world. Therefore, since exporters generally subsidize domestic energy consumption, their inclusion in the same regression analysis would bias the results toward the conclusion that energy subsidies promote economic growth.

52. These results are based on single-variable regression analysis. More robust models would include other explanatory variables but the focus in this paper is on the importance of energy prices. In any event, it is unlikely that any omitted explanatory variables significantly affect the results. Only if the omitted variables are highly correlated with the retail/border price ratio will the estimated coefficient be biased. If the omitted explanatory variables are not highly correlated with the retail/border price ratio, the standard errors will be overstated and lead to unduly conservative conclusions concerning the statistical significance of the estimated coefficients.

53. Julius, D., 1986. "Domestic Pricing of Petroleum Products: Efficiency and Equity Impacts in Developing Countries," *OPEC Review,* Spring 1986.

54. Fuss, M.A., 1977. "The Demand for Energy in Canadian Manufacturing," *Journal of Econometrics,* 1977.

55. Pindyck, R.S., 1979. *The Structure of World Energy Demand,* MIT Press, Cambridge.

56. Balassa and McCarthy, 1984.

57. Dinh, H.T., 1984. *Oil and Gas Policies in Tunisia, A Macroeconomic Analysis,* World Bank Staff Working Paper No. 674.

58. World Bank, 1984 and 1987. *World Development Report,* Washington, D.C.

59. Since many of the oil-exporting countries necessarily experienced large increases in export revenues as world oil prices rose, regression analysis must treat each group separately. Although several of the smaller oil-exporting countries (Tunisia, Egypt, Peru, and Indonesia) did experience declines in trade balances from 1973 to 1983, this ostensibly occurred because rapid increases in oil revenues triggered even larger increases in borrowing and imports.

60. Julius points out that energy expenditures consume roughly 10 percent of Indonesian household expenditures. Thus, it is not surprising that increasing energy prices by 10 percent increases inflation by 1.5 to 2.0 percentage points. Strict multiplication (.10 * .10) would suggest only a 1 percent increase, but this would understate the increase in inflation since higher energy prices would also increase the prices of food and manufactured products.

61. Julius, 1986.

62. Julius, 1986.

63. Julius, 1986.

64. Balassa and McCarthy, 1984.

65. Nivola, P.S. 1986. *The Politics of Energy Conservation,* Brookings Institution, Washington, D.C.

66. Dobozi, I., 1983. "The 'Invisible' Source of 'Alternative' Energy: Comparing Energy Conservation Performance of the East and West," *Natural Resources Forum,* Vol 7, No. 3.

67. *Ibid.*

68. For this analysis there is no *a priori* reason for treating all three groups of countries separately. Unlike the macroeconomic relationships depicted in Figures 6, 7, and 8, commercial energy efficiency should not depend on importer or exporter status. Arguably, OECD countries should be treated separately since low income countries use relatively more traditional energy, but the data show that *commercial* energy efficiency ratios are generally no lower in low-income countries. In any event, separate regressions do yield statistically significant results for the OECD countries and oil-exporters, but not for the oil-importers. A combined sample of all non-OECD countries also yielded statistically significant results.

69. A second regression that employed the average ratio of retail to border prices (from 1973 to 1983) as the independent variable was also run. The results were virtually identical to those in Figure 10, which employed the 1983 ratio as the independent variable. Using the average ratio allows the analyst to ascertain whether pricing policy over the entire decade appreciably affected energy efficiency in 1983. Not surprisingly, countries with higher levels of average taxation from 1973 to 1983 also used energy more efficiently in 1983.

70. A separate regression analysis suggests that a 10 percent annual increase in real energy prices corresponded to a 14.7 percent increase in energy efficiency from 1973 to 1983. To obtain the annual change in energy efficiency we take $(1.147)^{.1}$ = 1.0138—a 1.4 percent annual change.

71. Gever, J., Kaufmann, R., Skole, D. and Vorosmarty, C., 1986. *Beyond Oil: The Threat to Food and Fuel in the Coming Decades,* Ballinger, Cambridge, Massachusetts.

72. If the consumer subsidies on each fuel were simply added to obtain total energy subsidies, substantial double-counting would occur since large amounts of energy are traded between energy producers. For example, part of the electricity subsidies include the fuel oil and coal subsidies to power producers (about $2.8 billion) that are effectively transferred to electricity consumers by tariffs that are set below marginal costs.

73. Like Argentina, Bolivia, and other countries that experienced hyperinflation, Peru could not increase retail petroleum product prices as quickly as its currency depreciated. So, in dollar terms, real and nominal prices fell even though the nominal price in local currency increased. In Bolivia, the decline in the value of the peso between 1981 and 1983 led to a decrease of over 50 percent in the domestic price (in real dollars) of petroleum products.

74. The problem is best understood with an example. If the price of gasoline is 75¢ per gallon on the world market and one dollar trades for 800 Mexican pesos, then Mexico should charge domestic consumers 600 pesos per gallon. If the peso then depreciates to 1000 pesos/dollar while the price of a gallon of gasoline remains at 75¢, Mexico should increase the price of domestic gasoline to 750 pesos to maintain constant dollar prices. If it keeps the price at 600 pesos, the price effectively falls to 60¢ per gallon.

75. *South,* 'Special Report on Egypt,'' April 1986.

76. Foregone foreign exchange earnings equal the value of the economic subsidy if the price elasticity of demand for domestic oil is unitary. Although this might be possible over a period of several years, the short-run price elasticity is much smaller. The proof follows, assuming that production is constant and that all oil not consumed domestically is exported at the world price, which remains constant—i.e, foreign demand has an infinite price elasticity. Let

P_1 = Subsidized Domestic Price
P_2 = World Price
D_1 = Domestic Oil Demand at P_1
D_2 = Domestic Oil Demand at P_2
X_1 = Exports at P_1
X_2 = Exports at P_2
R_1 = Export Revenues at P_1
R_2 = Export Revenues at P_2
S = Economic Subsidy at P_1

We know that:

$(P_2 - P_1) * D_1 = S$, $P_2 * X_1 = R_1$, $P_2 * X_2 = R_2$, $D_1 + X_1 = D_2 + X_2$

and we wish to ascertain the relationship between $R_2 - R_1$ and S.

If $R_2 - R_1 = S$, then:

$P_2 * (D_1 - D_2) = P_2 * (X_2 - X_1) = R_2 - R_1 = S = (P_2 - P_1) * D_1$

therefore

$P_2 * D_2 = P_1 * D_1$

The left-hand side of this equality represents total domestic expenditures on oil when domestic prices are not subsidized while the right-hand side represents domestic expenditures at the subsidized price. Therefore, if the two sides are equal, demand must be unitarily elastic. Similarly, it can be shown that the gain in foreign exchange earnings (R2 – R1) is greater (less) than the economic subsidy (S) if demand is elastic (inelastic). If domestic demand is perfectly inelastic (price elasticity of demand is zero) then there will be no change in domestic consumption or exports and no gain in foreign exchange earnings. However, eliminating domestic subsidies will still reduce existing fiscal deficits.

77. It is also true, however, that the decline in world oil prices during 1986 reduced petroleum product subsidies in many oil-exporting nations. Price reform was not needed to reduce subsidies. Now, the critical question is whether the *structure* of domestic oil pricing in the oil-exporting countries will change so that domestic prices will reflect any future increases in world oil prices. Although substantial reform has been documented since 1981 and world oil prices have fallen, the 1970s demonstrated that oil-exporters were most reluctant to raise domestic oil prices when world oil prices rose.

78. Although detailed data are not available for 1986, it is clear that the ratio of energy exports to total exports is lower since world oil prices fell. Similarly, lower world oil prices reduce the ratio of energy subsidies to energy exports assuming that domestic prices (in real dollars), domestic demand, and the volume of exports remain constant from 1985 to 1986. Let

P_w = The world price of oil
Q_w = Oil Exports
P_d = The domestic price of oil
Q_d = Domestic Oil Demand

$$\frac{\text{Energy Subsidies}}{\text{Energy Exports}} =$$

$$\frac{(P_w - P_d) * Q_d}{P_w * Q_x} = \frac{(P_w * Q_d) - (P_d * Q_d)}{P_w * Q_x} =$$

$\frac{Q_d}{Q_x} - \frac{P_d * Q_d}{P_w * Q_x}$ and this ratio must decline when P_w falls.

The distinction between real dollar prices and prices in local currencies is important here since world oil prices are expressed in dollars. In Mexico, Ecuador, and Venezuela, nominal petroleum product prices (in local currency) increased during 1986. However, exchange rate depreciation largely offset these increases in Mexico and Venezuela since their national currencies depreciated by 25 and 33 percent, respectively, from January to August. In Ecuador, exchange rate appreciation roughly doubled the dollar price of petroleum products over this same period. For Mexico and Venezuela, therefore, currency depreciation increased subsidies, while in Ecuador, subsidies were further reduced.

79. Farrell, T., 1985. "The World Oil Market 1973-1983, and the Future of Oil Prices," *OPEC Review,* Winter 1985.

80. *The Economist,* July 25-31, 1987.

81. Iwayemi, A., 1984. "Nigeria's Internal Petroleum Problems: Perspectives and Choices," *Energy Journal,* Vol. 5, No. 4.

82. Dinh, 1984; Gordon, A., 1984. *Energy Policy in Developing Countries,* ERG Paper 002, Energy Research Group, Ottawa, Canada; World Bank, 1985b. *China: The Energy Sector,* Annex 3 to *China: Long-Term Development Issues and Options,* Washington, D.C.

83. Unpublished data provided to World Resources Institute.

84. Since this study was conducted before Indonesia initiated recent price increases, the estimates overstate the gains which would be realized from continued price increases.

85. Embassy of the United States, 1986. *The Petroleum Report for Indonesia,* Jakarta, Indonesia, July 1986.

86. Julius, 1986.

87. At least four of the crude-oil-exporting countries (Ecuador, Nigeria, Indonesia, and Tunisia) actually must import refined products because domestic demand cannot be met by existing refinery capacity. These products are imported at world prices and then resold at subsidized domestic prices. In 1983, the subsidy on imported products in Ecuador was $130 million or 27 percent of the total subsidy to domestic consumption ($480 million). [World Bank (D)].

88. World Bank, 1983a.

89. Julius, 1986.

90. Dunkerley, J., 1986. *Some Notes on Energy and Income Distribution,* unpublished manuscript, January 1986.

91. These estimates are based on an adaptation of household energy consumption data for Mexico City in 1979. Low-income families comprise the bottom 16 percent of the population in terms of income, while high-income ones include the top 7 percent.

92. Dunkerley notes that there was virtually no change in income distribution in the United States following the oil price increase in 1974. So, there is reason to believe that the regressivity of general energy price increases is also overstated in the United States.

93. Julius, 1986.

94. Of course, since lower-income households spend a greater percentage of their income on kerosene, kerosene subsidies represent a larger share of lower-income families' incomes. However, since upper-income families receive larger subsidies, the income gap widens. For example, suppose one family has $100 in monthly income and another has $1000. Further assume that the low-income family receives $10 in kerosene subsidies (a 10 percent increase in income), while the wealthier family (because of greater kerosene consumption) receives $50 in subsidies (5 percent of income). Clearly, the low-income family has experienced a larger percentage increase in income, but the gap between rich and poor has widened.

95. Pitt, Mark M. 1985. "Equity Externalities and Energy Subsidies: The Case of Kerosene in Indonesia," *Journal of Development Economics,* Vol. 17.

96. Dapice, D.O., 1984. "Petroleum Product Demand in Indonesia," *Business News,* No. 27.

97. World Bank, 1984. *Ecuador: An Agenda for Recovery and Sustained Growth,* Washington, D.C.

98. Although Table 3 classifies only one country (Argentina) as a diesel subsidizer, relatively low taxation of diesel fuel serves the same purpose, especially since the need to recover road-user costs argues for higher taxation on transport fuels. If gasoline taxes are very high, then diesel taxes can be lower and still meet revenue requirements (e.g., India, Pakistan, and Indonesia). The relatively lower taxes on diesel help keep the costs of operating public transportation down, but also encourage the substitution of diesel for gasoline.

99. Reddy, A., 1981. "A Strategy for Resolving India's Oil Crisis," *Current Science,* January 20, 1981.

100. World Bank, 1983a.

101. Bhatia estimates that before the stamp program more than 50 percent of the kerosene subsidies went to groups for which they were not intended. Although the subsidies were intended to aid the rural poor, who use it primarily for lighting, kerosene was increasingly used as an industrial heating fuel and as a cooking fuel by wealthier urban households [Bhatia].

102. Munasinghe, M. and Schramm, G., 1983. *Energy Economics, Demand Management, and Conservation Policy,* Van Nostrand Reinhold, New York.

103. Bhatia, 1985.

104. World Bank, 1983b. *Indonesia: Selected Issues of Energy Pricing Policies,* Washington, D.C.

105. *Ibid.*

106. Dunkerley, J. and Hoch, I., 1986. "The Pricing of Transport Fuels," *Energy Policy,* August 1986.

107. Bhatia, 1985.

108. Bhatia, 1985.

109. Reddy, 1981.

110. In diesel engines, kerosene can be as much as 20 percent of the fuel mixture without impeding engine performance or increasing maintenance costs. In some industrial uses, like process heat, substitution can be one-for-one [World Bank (C)]. Adulteration of diesel with kerosene is pervasive in Peru, Indonesia, and Thailand [Julius].

111. Schramm, G., 1985. "Operationalizing Efficiency Criteria in Energy Pricing Policy," In *Criteria for Energy Pricing Policy,* Corazon Morales Siddayao, ed., Graham and Trotman, London.

112. *Ibid.*

113. World Bank, 1983a; Goldemberg, J., Johansson, T., Reddy, A. and Williams, R., 1985. "An End Use Oriented Global Energy Strategy," *The Annual Review of Energy,* Annual Reviews Inc.

114. These numbers are based on unpublished data provided to the World Resources Institute by the World Bank with the understanding that specific tariff structures in individual countries would not be discussed.

115. World Bank, 1983a.

116. Cecelski, E. and Glatt, S., 1982. *The Role of Rural Electrification in Development.* Discussion Paper D73-E, Resources for the Future, Washington, D.C.

117. Berndt and Samaniego, 1984.

118. Leonard, S., 1985. *Energy in China: Policies, Problems and Prospects,* Congressional Research Service, August 1985. World Bank, 1985b.

119. Cecelski and Glatt, 1982.

120. Li *et al.,* 1985.

121. Some argue that more effective targetting of subsidies would provide substantial benefits to a larger number of rural electricity users. For example, Bhatia argues that electricity subsidies for community services (e.g, study rooms, radio rooms) would provide more benefits to the rural poor than subsidized electricity prices for electricity, which most of them do not consume [Bhatia].

122. deLucia, 1985.

123. Bhatia, 1985.

124. Although India's State Electricity Boards have raised agricultural tariffs substantially over the past five years, increases in input costs and continuous shortfalls in generation have negated the revenue gains from these increases [Bhatia].

125. Bhatia, 1985.

126. Bhatia, 1985.

127. Joint Committee on Taxation, 1986. *Estimates of Federal Tax Expenditures for Fiscal Years 1987-1991,* March 1896.

128. Baumol, W. and Wolff, E., 1981. "Subsidies to New Energy Sources: Do They Add to Energy Stocks?" *Journal of Political Economy,* Vol. 89, No. 5, October 1981.

129. *Ibid.*

130. Department of Energy, 1986. *Monthly Energy Review,* Washington, D.C., May 1986.

131. *South,* 'Special Report on Brazil,'' July 1986.

132. Geller estimates that imported gasoline costs were $41 per barrel in 1983 while ethanol production costs were between $50 and $56 per barrel [Geller]. Since production was 50 million barrels (7.95 billion liters), the producer subsidy was $450 to $800 million—($9-$16) * (50 million barrels) in 1983.

133. *South,* 1986; Riding, A., 1986. ''Slump in Oil Prices is Troubling Brazil,'' *New York Times,* March 17, 1986.

134. This example also illustrates how one subsidy can constrain the pricing of other fuels. As world oil prices have fallen, Brazil has actually had to raise gasoline prices to protect ethanol producers. These increases have been politically unpopular in the face of declining world oil prices and other domestic austerity measures; but without them, ethanol prices would have to fall even further below production costs ($37 to $50 per barrel) and lead to larger revenue losses. In addition, Brazil must ban imports of diesel vehicles to protect its ethanol industry.

135. *South,* 1986.

136. Riding, 1986.

137. One study of ethanol in the United States reached similar conclusions [Stauffer]. Stauffer found that displacing imported oil with ethanol would cost $60 to $70 per barrel and that the subsidies would primarily create large windfalls for ethanol producers.

138. It is beyond the scope of this report to discuss highly complex U.S. natural gas price controls. See the *Energy Journal* (Vol. 3, No. 4) for a detailed discussion of natural gas regulations.

139. *Petroleum Economist,* November 1986.

140. In some cases, low natural gas prices lower potential exports of natural gas. For example, Mexico (which ceased exporting natural gas to the United States over a pricing dispute in November 1984) could sell natural gas to the U.S. for $3.40/MCF, but domestic Mexican prices are only $1.70 to $1.80/MCF. In 1982, before increasing its natural gas prices, Mexican natural gas prices were only 11 percent of U.S. prices [International Trade Commission]. Although natural gas and petroleum subsidies do provide advantages to Mexico's energy-intensive export industries (e.g., steel, cement, ammonia, lime), they probably don't entirely offset losses in natural gas subsidies, which are at least $1 billion per year at present consumption levels.

141. Prior, M.J., 1986. ''Fuel Markets in Urban Bangladesh,'' *World Development,* July 1986.

142. Leonard, 1985; Li *et al.,* 1985.

143. Mashayekhi, 1985.

144. Pakistan, however, does heavily subsidize fuel oil to keep down the costs of manufacturing and electricity generation. In 1984, fuel oil prices were only 54 percent of border prices, or roughly equivalent to $2.30/MCF [Mashayekhi].

145. World Bank, 1983a.

146. deLucia, 1985.

147. Mashayekhi, 1985.

148. Mintzer, I., 1987. *A Matter of Degrees: The Potential for Controlling the Greenhouse Effect,* World Resources Institute, April 1987.

149. Joint Committee on Taxation, 1986; Morgan, R.E., 1985. ''Federal Energy Tax Policy and the Environment,'' Environmental Action Foundation.

150. Mackenzie, J., 1986. "Leveling the Energy Playing Field," unpublished mimeo, 1986.

151. Mackenzie, 1986; Morgan, 1985.

152. Mintzer, 1987.

153. Li *et al.*, 1985; World Bank, 1985b.

154. World Bank, 1985a.

155. Li *et al.*, 1985.

156. In Nigeria, for example, Iwayemi estimates that motor vehicle registrations increased 741 percent from 1970 to 1977. During this period, petroleum product prices increased by less than 5 percent while the consumer price index quadrupled. In the past few years, however, Nigeria has substantially raised petroleum product prices.

157. Dick, H., 1980. "The Oil Price Subsidy, Deforestation, and Equity," *Bulletin of Indonesian Economic Studies*, November 1980; Pitt, M.M., 1985. "Equity Externalities and Energy Subsidies: The Case of Kerosene in Indonesia," *Journal of Development Economics*, Vol. 17; World Bank, 1983b.

158. Dapice, 1984.

159. In its study of kerosene subsidies in Indonesia, the World Bank argues that, in the long run, eliminating kerosene subsidies might encourage reforestation since even small initial increases in fuelwood demand and fuelwood prices would provide better incentives for reforestation and forest management. In addition, some of the revenues saved by reducing kerosene subsidies could be redirected to reforestation programs.

160. Miller, A., Mintzer, I. and Hoagland, S., 1986. *Growing Power: Bioenergy for Development and Industry*, World Resources Institute, April 1986.

161. Because data for 1986 are inadequate, it was not possible to address the opposing question: should countries lower domestic oil prices as world oil prices fall or use the opportunity to increase petroleum tax revenues? It is not clear that lowering oil prices in the United States contributed substantially to economic growth in 1986 [Mork].

162. Reddy argues that rural electricity should be subsidized since it is 200 times more efficient than kerosene for lighting [Reddy]. However, the costs of increasing electric service (at least from large grids) to rural areas is too high to justify the extensive subsidies that would be necessary. A possible alternative would be to provide rural electricity on a decentralized basis in order to reduce wiring costs.

163. World Bank, 1983a; Petroleum Economics, Ltd., "Oil Requirements and Supplies in the Developing World," 1986.

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