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Household Energy Supply and Use in Yemen:

Volume I, Main Report

Report

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JOINT UNDP / WORLD BANK
ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

PURPOSE

The Joint UNDP/World Bank Energy Sector Management Assistance Program (ESMAP) is a special global technical assistance partnership sponsored by the UNDP, the World Bank and bi-lateral official donors. Established with the support of UNDP and bilateral official donors in 1983, ESMAP is managed by the World Bank. ESMAP's mission is to promote the role of energy in poverty reduction and economic growth in an environmentally responsible manner. Its work applies to low-income, emerging, and transition economies and contributes to the achievement of internationally agreed development goals. ESMAP interventions are knowledge products including free technical assistance, specific studies, advisory services, pilot projects, knowledge generation and dissemination, trainings, workshops and seminars, conferences and roundtables, and publications. ESMAP work is focused on three priority areas: access to modern energy for the poorest, the development of sustainable energy markets, and the promotion of environmentally sustainable energy practices.

GOVERNANCE AND OPERATIONS

ESMAP is governed by a Consultative Group (the ESMAP CG) composed of representatives of the UNDP and World Bank, other donors, and development experts from regions which benefit from ESMAP's assistance. The ESMAP CG is chaired by a World Bank Vice President, and advised by a Technical Advisory Group (TAG) of independent energy experts that reviews the Programme's strategic agenda, its work plan, and its achievements. ESMAP relies on a cadre of engineers, energy planners, and economists from the World Bank, and from the energy and development community at large, to conduct its activities under the guidance of the Manager of ESMAP.

FUNDING

ESMAP is a knowledge partnership supported by the World Bank, the UNDP and official donors from Belgium, Canada, Denmark, Finland, France, Germany, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom. ESMAP has also enjoyed the support of private donors as well as in-kind support from a number of partners in the energy and development community.

FURTHER INFORMATION

For further information on a copy of the ESMAP Annual Report or copies of project reports, please visit the ESMAP website: **www.esmap.org**. ESMAP can also be reached by email at **esmap@worldbank.org** or by mail at:

ESMAP
c/o Energy and Water Department
The World Bank Group
1818 H Street, NW
Washington, D.C. 20433, U.S.A.
Tel.: 202.458.2321
Fax: 202.522.3018

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Energy Sector Management Assistance Program
(ESMAP)

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Preface

Yemen's Second Five Year Plan for Social and Economic Development (2001-2005) and Poverty Reduction Strategy Paper (PRSP, 2003-05) provide a framework to reduce poverty through national actions and development assistance. The PRSP recommends a gradual lifting of subsidies for petroleum products, phased to ensure that energy price reform does not aggravate poverty in a country with an already high percentage of poor people. The PRSP also promotes policies that will lead to better access to energy. This report deals with the relationship between energy policy and household welfare. By establishing the facts about household energy supply and use, the impact of new energy policies on the poor can be anticipated with greater confidence.

A household energy strategy forms an essential element of overall energy sector planning. At the request of the Ministry of Planning and International Cooperation (MOPIC), the joint World Bank/United Nations Development Program Energy Sector Management Assistance Program (ESMAP) carried out a study to examine the energy policies which would, if implemented, contribute to poverty reduction in Yemen. These policies aim to reduce energy costs and improve access to electricity and modern fuels while promoting more efficient energy use. With future fiscal revenues expected to fall due to a projected decline in crude oil production, subsidies are of particular concern. The study reviewed the main beneficiaries of energy subsidies and the likely impact of their removal.

This report, Volume I, summarizes the results of the study and outlines a number of policy options intended to achieve the energy sector goals of economic efficiency, financial cost recovery, environmental sustainability and social equity. A separate report, Volume II, a CD-Rom contains a set of ten annexes which accompany this report.

Abbreviations and Acronyms

ARC	Aden Refinery Company
BPL	below-poverty-line
cif	cost insurance freight
CPC	Ceylon Petroleum Corporation
CPI	Consumer Price Index
CSO	Central Statistical Organisation
DFID	Department for International Development, UK
ERR	economic rate of return
ESMAP	Energy Sector Management Assistance Programme
fob	free on board
FRR	financial rate of return
GAREWS	General Authority of Rural Electrification and Water Supply
GDP	Gross domestic product
GOY	Government of Yemen
HH	household
HBS	Household Budget Survey (1998)
HES	Household Energy Survey (ESMAP 2003)
IRR	internal rate of return (to equity investors)
LPG	liquefied petroleum gas
LRMC	long run marginal cost
MDG	Millennium Development Goals
MoF	Ministry of Finance
MOM	Ministry of Oil and Minerals
MOPIC	Ministry of Planning and International Cooperation
MRC	Marib Refining Company
NA	not applicable
NGO	Non-government Organization
PEC	Public Electricity Company
PPP	purchase power parity
PRA	Participatory Rapid Assessment (ESMAP 2003)
PRSP	Poverty Reduction Strategy Paper
SLF	system load factor
SWF	Social Welfare Fund
YGC	Yemen Gas Company
YOGC	Yemen Oil and Gas Company
YPC	Yemen Petroleum Company
YR	Yemeni Rial

Units of Measure

bbl	barrel (of crude oil)
GW	1000 MW
kg	kilogram
km	kilometre
kVA	kilovolt-amperes
kWh	kilowatt hour
kW	kilowatt
kVA	kilovolt-amperes
mcm	million cubic meters
MJ	megajoule
MW	megawatt
tpd	tonnes per day

Currency Equivalents

US$1.00 = 184 Yemeni Rial (YR) in October 2004. The exchange rate in December 2003, when the Household Energy Survey was carried out, was US$1.00 = YR178.

Acknowledgements

The preparation of the report would not have been possible without the cooperation and support of officials in MOPIC, the Central Statistical Organisation (CSO), the Ministry of Electricity, the Ministry of Oil and Mineral Development, the Yemen Gas Company (YGC), Yemen Petroleum Company (YPC) and the Public Electricity Company (PEC). The study team thanks Dr. Mutahar Al-Abbasi, Deputy Minister for Macro-Planning and Studies (MOPIC) who was the principal counterpart of the team. The study team thanks Dr. Amin M. Mohie al Din, Chairman, CSO; Eng. Aref Ahmed Taha, CSO; Eng. Abdul Moati Al-Jonaid, Managing Director, PEC; Eng. Ahmed Khaid Assabri General Director, Rural Electrification Sector, PEC; Taha A. al-Ahdal, Director General, Yemen Oil and Gas Company, YOGC; Mohammed Hussain Al-Baidani, Deputy General Manager YOGC; Lutf Abdullah Al-Thawr, Executive Managing Director YPC; and Eng. Anwar Salem Hassan, Executive Managing Director, YGC.

Special thanks are due to the people in the twelve villages where the Participatory Rapid Assessment (PRA) took place. They not only participated in the focus groups and in-depth interviews, offering candid responses and insights with great patience but also hosted the study teams throughout the duration of their stay.

The Norwegian Trust Fund for Environmentally and Socially Sustainable Development provided financial assistance for the study.

NHL Engineering, led by Dr. Ilham Basahi and Abdulla Basahi (Coral Engineering) designed and implemented the PRA; Dr. Abdul Karim Al Sayaghi, Head of Statistics, Department of Economics, Sana'a University and Dr. Mohammed Al Hawry, Department of Economics, Sana'a University were consultants for the design of the Household Energy Survey (HES 2003); and NHL Engineering were consultants for the HES field work and data processing.

In the World Bank team, the economic and financial analysis was completed by Peter Meier (Consultant). Meskerem Brhane (Social Scientist) advised on the design and implementation of the PRA. Voravate (Tig) Tuntivate (Consultant) advised on the design and implementation of the HES and supervised data entry and data cleaning. Somin Mukherji (Sr. Financial Analyst), Pepukaye Bardouille (Economist) and Pierre Audinet (Sr. Energy Economist) and T.G. Srinivasen (Senior Economist) reviewed the report. Franz Gerner (Energy Specialist) contributed analysis of the upstream petroleum sector. Anis Dani (Lead Social Scientist) reviewed the PRA. Doug Barnes (Sr. Energy Specialist) and Noureddine Berrah (Lead Energy Specialist) were peer reviewers for the report. Tjaarda Storm van Leeuwen (Lead Financial Analyst) reviewed the report and was engaged in follow-up discussion on the report findings and policy recommendations with the government. Richard Spencer (Sr. Energy Specialist) initiated the study. Kyran O'Sullivan (Sr. Energy Specialist) was task manager for the study. Special thanks to Ms. Nidhi Sachdeva for formatting the report and to Marjorie K. Araya for coordinating the publication process, both from ESMAP.

Executive Summary

1. The Government of Yemen asked ESMAP to undertake this study on household energy supply and use in Yemen with its particular focus on *energy access for poverty reduction* for two reasons.

2. The first was to establish to what extent energy use by households contributed to their poverty status. It was known (from the results of the 1998 household budget survey) that household access to electricity and modern fuels was low and that many households were dependent on biomass to meet their cooking needs. It was assumed that household energy use impacted poverty. For example, expenditure on basic cooking and lighting needs may cause certain households to reduce their consumption below a minimum threshold. In addition, collection of biomass might absorb an uneconomical amount of household members' time.

3. Secondly, the Government was considering reform measures for the energy sector to put it on a more sustainable footing by ensuring economic efficiency, financial cost recovery and environmental sustainability. These goals imply that energy consumer prices should reflect the economic cost of supply and that energy sector companies should recover their costs and earn sufficient return to attract investment to meet future demand. Policies therefore need to address loss-making entities such as the PEC and the large energy subsidies that are a significant burden on the Government budget. The Government was concerned to know the impact of these proposed policies on households before deciding on implementation. The study set out to predict the impact on households of the policy changes that are under consideration, in particular the potential reduction and eventual removal of subsidies.

4. For the purposes of the study, ESMAP undertook a detailed household energy survey (HES 2003) that provided quantitative data of household energy use and a participatory rapid assessment (PRA) that provided qualitative data of household energy use. Economic analysis of the data from HES together with qualitative insights from the PRA is presented in this study.

Main Findings

Access

5. Table 1 summarizes data on energy use, broken down by the top and bottom income deciles[1] of all households and by urban and rural households. Households typically use more than one fuel. For example, while 93% of urban households use liquefied petroleum gas (LPG), 46% also use kerosene and 24% use fuelwood. Even households with the highest incomes purchase some fuelwood for cooking and continue to use kerosene and LPG for lighting even though they have electricity grid access. Poor families use combinations of collected fuelwood, crop residue, dung,

[1] A decile is one tenth of all households. In this report, "decile" is used only with respect to household income. Households in the sample were sorted according to household income, from the lowest to the highest income. "Bottom decile" or "lowest decile" refers to the poorest tenth of Yemeni households; "top decile" or "highest decile" refers to the richest tenth of Yemeni households.

kerosene (probably as a starter fuel) and LPG. [2] Only 4% of all rural households and only 3% of the poorest households use diesel for pumping or in generators or for any other direct use. In major urban areas (Sana'a and Aden) almost all households (even the poorest) use some LPG. Thus the applicable model is that of households managing a portfolio of fuels for cooking and lighting to cope with supply disruptions and shortages, variations in prices and because wood is a preferred fuel for preparation of certain foods for reasons of taste.

Table 1: Access: Percentage of Households that Report Use of Each Fuel

	Urban	*Rural*	*Total*	*Lowest decile*	*Highest decile*
Electricity	92	42	53	22	82
PEC grid	80	23	36	11	62
Non-grid, incl. self-generation	12	19	18	9	19
No access to electricity	8	58	47	78	18
LPG	93	74	78	49	93
Diesel	13	4	11	3	34
Kerosene	46	83	75	92	57
Fuelwood	36	85	74	80	66
of which purchased	24	24	24	13	36
Charcoal	12	6	8	2	18
Dung	3	23	18	12	21
Crop residue	3	26	23	24	20
of which purchased	<0.5	1	1	<0.3	2

Note: Charcoal access is for cooking and heating use only (i.e. not for other uses of charcoal such as in pipes (hookahs). Use of gasoline was not queried in the HES.

6. Households normally rely on several means of cooking. Simple three stone fires are common, used by 47% of rural households in the lowest income decile and falling to 16% of households in the highest income decile. Consistent with LPG consumption patterns, ownership of LPG stoves is quite high in the lower income deciles (42% in the lowest) rising to 93% in the highest income decile in rural areas. Kerosene stoves, firewood stoves and firewood *tanoor* are used in all income groups both in rural and urban areas. Exposure to smoke from simple cooking fires is likely to contribute to the burden of respiratory disease and is likely to affect women and girls disproportionately since they usually cook. Poor households cook less than well-off households. They cook one or two meals per day whereas well-off households cook two or three.

7. Sixty percent of households using firewood spend 100 hours per month collecting it. Nineteen percent of households collect firewood for 200 hours per month. In 52% of all households (that collect firewood), adult women provide 100% of the collection labor. However, in 11% of households they contribute no labor, and in 14% they contribute 50%. There is a statistically significant relationship between

[2] Unless otherwise stated, references to "the poor" relate to the bottom 30% of households, i.e. the bottom three deciles or the poorest 900,000 households in Yemen. "Middle income households" relates to deciles four through seven, i.e. the middle 40%. "Relatively well off" relates to the top 30%. These are all relative rather than absolute terms. References to 'the very poor" relate to the bottom income decile, i.e., the poorest 300,000 households in Yemen.

the labor contribution of women and collection distance. As collection distances increase, the contribution of women decreases. Boys contribute no labor to fuelwood collection in 92% of all households, and only in very few cases do they make significant contributions. In 73% of all households (that collect fuelwood), girls do not participate at all. In 8% of households girls provide 50% of the total labor, and in 2% of households, girls provide 100% of the collection effort. The average distance for firewood collection is 2km with surprisingly little variation across governates. However, 30% of households report collection distances more than 3km.

Consumption

8. Table 2 summarizes consumption data, broken down by the top and bottom income deciles of all households and by urban and rural households. Electricity consumption by households connected to the PEC grid is double that of households that are supplied by cooperatives and the PEC isolated systems. This reflects superior grid supply reliability, higher household incomes in urban areas and higher tariffs for the PEC isolated system and cooperative supply. As expected, consumption of electricity and all the fuels with the exception of kerosene increase with income. LPG and kerosene are the fuels of choice for the poor, i.e. the poor who spend a substantial portion of their cash on energy purchases do so in order to consume LPG and kerosene. The fuel of necessity for the poor is biomass (fuelwood, dung and crop residues).

Table 2: Average Monthly Consumption of Electricity and Fuels by Households that Consume Electricity and Fuels

	Urban	*Rural*	*Total*	*Lowest decile*	*Highest decile*
Electricity PEC grid customers (kWh)	273	101	183	94	237
Electricity PEC isolated system customers	NA	74	74	56	154
Electricity coop customers	91	44	44	32	68
Electricity private suppliers	NA	45	45	40	53
LPG (kg)	25	26	26	20	36
Diesel (liters)	139	167	164	55	214
Kerosene (liters)	8	11	10	10	10
Fuelwood (kg)	72	125	113	145	100
Charcoal (kg)	7	25	15	8	24
Crop residue (kg)	66	77	76	16	148

Energy Expenditures and Prices

9. The classic pattern of changes in composition of expenditures with increasing income is confirmed from the survey results (Table 3). Households with the lowest decile of income spend 55% of their monthly expenditure on food, 14% on fuels (including purchased biomass) and 1% on electricity. In contrast, households with the highest decile income spend 36% on food, 5% on fuel, and 1.5% on electricity.

Table 3: Average Energy Expenditures, Rural and Urban Households: YR/month

	d[1]	*d[2]*	*d[3]*	*d[4]*	*D[5]*	*d[6]*	*d[7]*	*d[8]*	*d[9]*	*d[10]*	*average*
					Urban						
Total energy	1,815	2,295	2,345	2,422	2,479	2,853	2,890	2,948	3,075	4,256	2,917
Total	10,028	18,344	19,745	30,900	24,386	27,577	32,181	34,208	49,798	93,613	40,831
Energy as % of total	18.1%	12.5%	11.9%	7.8%	10.2%	10.3%	9.0%	8.6%	6.2%	4.5%	7.1%
					Rural						
Total energy	1217	1566	2197	2280	2187	2242	3339	3042	4964	6437	2805
Total	8320	15565	18157	18930	22654	27596	33146	32967	48985	90407	29743
Energy as % of total	14.6%	10.1%	12.1%	12.0%	9.7%	8.1%	10.1%	9.2%	10.1%	7.1%	9.4%

Note: c.f. Tables 3.3 and 3.4 for a full breakdown of energy expenditures by fuel and type of electricity source.

10. Actual prices paid by households are more than administered retail prices. For LPG sold in standard 11kg cylinders, the average price is 25 YR/kg whereas the official price is 18.63 YR/kg (205 YR per 11kg cylinder). The unit cost of LPG for lighting is 48 YR/kg, substantially higher than for cooking because it is sold in small bottles. For kerosene, the average price paid is 23 YR/liter with pronounced regional differences, varying from 31YR/liter (in Sana'a) to 20 YR/liter (in Shabwa). Rural households with electricity access (including those with access from the PEC, cooperatives & neighbors) pay on average very high unit prices (15 YR/kWh) compared to urban households (7YR/kWh). Th.

11. There is clear evidence of great willingness to pay for electricity. Those with no access spend an average YR880/month on electricity substitutes such as LPG and kerosene for lighting, candles and dry cell batteries. But those who *do* have access to the grid reduce their expenditure on substitutes to YR307/month, but incur an additional YR1,543/month on electricity. Those with self-generation – mostly the upper income decile households in rural areas with more than one wage earner – pay as much as YR4,000/month for (limited) service, in addition to YR1,365/month on electricity substitutes.

12. Nevertheless, high connection charges (YR15,000 for a household connection) represent a clear deterrent for the poor to connect to the grid, and rural electrification programs are unlikely to be successful unless credit facilities are extended to the poor to pay connection charges over 1-2 years. Moreover, electricity is still regarded as expensive and, as such, is reserved for high-value uses such as TV viewing and appliance use (for which there are no convenient substitutes), explaining the continued use of (cheap) kerosene and LPG for lighting. Despite increases in real incomes, the data show that over the last decade (1993 to 2003), while the number of PEC-connected consumers has increased from 512,000 to 996,000, average consumption per connection has *fallen* from 260 kWh to 229 kWh.

Calculation of Subsidies in 2003

13. The economic value of petroleum products in Yemen is their border price (i.e. cif Aden). For LPG, the economic value is the fob price that could be obtained at Aden (if LPG were exported) less the cost of transport from Marib to Aden. The retail cost (i.e. the prices paid at the distribution center gate) of petroleum products is substantially below economic cost for all fuels except residual fueloil. The system operated by the Ministry of Finance (MoF) compensates YPC for the difference between the actual revenue collected from sales at the administered retail price and the international price at which YPC buys products from the Aden refinery. Because the international price used is Rotterdam plus notional freight of $15/ton, rather than Gulf plus $7/ton (based on actual costs from the most likely source of imported products), a large part of what is stated to be the petroleum product subsidy to consumers is in fact a subsidy to the refinery (YR30 billion in 2003).

14. Because the Yemeni retail price is so much lower than international prices and the retail prices in neighboring countries, subsidies may be lost to smuggled exports. On the basis of an econometric model it was estimated that about 7% of the 2003 reported domestic diesel demand was exported due to this price differential. A reduction in the diesel subsidy would significantly reduce this incentive.

15. The net subsidy on petroleum products is the difference between the retail price at the gate of the distribution center and the economic price to which distribution costs and taxes have been added (Table 4). In 2003, the total cost to Government of petroleum products subsidies was YR97 billion. This amounts to 13% of all Government spending and 63% of development spending. In the case of LPG which is mostly produced in Marib where the gas is provided free to YGC, no actual monetary transfer from the Government to YGC occurs. However the foregone revenue to the Government still constitutes a subsidy.

Table 4: Petroleum Product Subsidies in 2003

		LPG	*Gasoline*	*Kerosene*	*Diesel*	*Fueloil*
Economic price incl. taxes	[YR/liter]	31.8	41.6	40.3	39.8	32.8
Actual retail price (incl. taxes)	[YR/liter]	10.2	35.0	16.0	17.0	31.0
Net subsidy	[YR/liter]	21.6	6.6	24.3	22.8	1.8
2003 consumption	[million liters]	1158	1414	135	2475	1001
Accounting subsidy	[billion YR]	25.1	9.3	3.3	56.3	1.8
% of total subsidy	[%]	26%	10%	3%	59%	2%
% of import parity price	[%]	32%	84%	40%	43%	94%
% of 2003 Govt. expenditure	[%]	3%	1%	0%	8%	0%
% of non-oil GDP	[%]	2%	1%	0%	4%	0%
% of 2003 development spending	[%]	16%	6%	2%	37%	1%

16. In addition there is a real cost to society as a whole that results from petroleum product subsidies, a cost that economists call "deadweight losses". This loss to the economy (Yemeni society as a whole) occurs because the incremental cost of the subsidy to Government exceeds the incremental benefit to consumers. This was estimated to be in the order of 13% of the subsidy, i.e. YR13 billion in 2003. The estimate is dependent upon price elasticity assumptions. This estimate assumes –0.3.

Households and Energy Subsidies

17. Households benefit from subsidies in two ways. First, they gain a *direct* benefit since they pay less than the full cost when they purchase fuels. The corollary is that households would incur a welfare loss if the subsidies on petroleum products were reduced or removed altogether. In the report, the welfare loss is expressed as the change in expenditure as a percentage of total household expenditure in each decile.

18. Second, households benefit from *indirect* effects, of which there are several. The indirect benefit to households of petroleum subsidies is mainly through the diesel subsidy since diesel is an input to the production of other goods such as food and transport services which are cheaper than they would be if diesel was priced at economic value. For example, since significant amounts of diesel are used by PEC, electricity prices are lower than they would otherwise be. An upper bound to the value of the diesel subsidy to PEC was estimated to be 13% of the average tariff.

19. Since higher income households consume more LPG and diesel than lower income households, most of the subsidy goes to higher income households. As shown in Table 5, the total amount of the subsidy is unequally distributed across the income groups with higher income deciles receiving a greater proportion of the total subsidy amount. This is more marked in the case of diesel than LPG. In fact, households in the highest income decile receive 40% of the diesel subsidy. Households in the two lowest income deciles receive only 2% of the total diesel subsidy. Since kerosene is mainly consumed by poor households, the amount of the total subsidy for kerosene is distributed more equally.

Table 5: Proportion of the *Direct* Petroleum Product Subsidies Received by Each Income Decile

	d[1] lowest income decile	*d[2]*	*d[3]*	*d[4]*	*d[5]*	*d[6]*	*d[7]*	*d[8]*	*d[9]*	*d[10] highest income decile*
LPG	5%	7%	9%	7%	10%	10%	12%	11%	13%	16%
Kerosene	13%	13%	13%	9%	9%	9%	11%	8%	7%	7%
Diesel	1%	1%	4%	4%	6%	3%	12%	13%	17%	40%

20. If prices of all petroleum products were raised to their economic levels, then the estimate of the impact on the different income deciles is as shown in Table 6. The *direct* impact of adjusting fuel prices on the various income groups can be calculated by applying the difference between the economic price and the actual price paid for each of the various fuels to the consumption data for each income decile. Since almost all kerosene and LPG is purchased directly by households, the *indirect* impacts attributable to these fuels are minimal.

21. The *indirect* impact of diesel subsidy removal would best be estimated by application of an input-output model – an accounting framework that could be used to predict price changes in all goods consumed in Yemen as a result of changes in the diesel price. In the absence of such a model an *upper bound* of the increase in the cost of non-energy goods can be estimated by calculating how food prices would be

impacted if all the diesel not consumed by PEC and by households is assumed to be consumed in the production and transport of food. Since food accounts for 54% of household expenditure in the lowest decile and 36% in the highest decile, the poor would be affected disproportionately if food prices rose as a consequence of higher diesel prices. Since all diesel not consumed by PEC and households is not in fact only consumed in the production and transport of food, the actual indirect impact will be less than presented here (which is why these are *upper bound* calculations of the indirect impacts).

Table 6: Impact of Bringing Petroleum Products to their Economic Price as % of Present Household Expenditure

	d[1] lowest income decile	*d[2]*	*d[3]*	*d[4]*	*d[5]*	*d[6]*	*d[7]*	*d[8]*	*d[9]*	*d[10] highest income decile*
LPG	6.5%	4.8%	5.1%	4.3%	4.8%	4.2%	4.1%	3.5%	3.1%	2.0%
Kerosene	2.4%	1.3%	1.0%	0.9%	0.6%	0.5%	0.5%	0.5%	0.2%	0.1%
Diesel direct impact only	0.4%	0.1%	0.8%	0.8%	1.0%	0.4%	1.3%	1.4%	1.3%	1.6%
Diesel indirect impact only	5.0%	4.7%	4.4%	4.2%	4.5%	4.4%	4.0%	4.0%	3.6%	3.2%
Electricity (as a result of diesel subsidy removal)	0.2%	0.2%	0.2%	0.3%	0.2%	0.3%	0.3%	0.2%	0.3%	0.2%
Total	14.4%	11.1%	11.5%	10.4%	11.1%	9.8%	10.2%	9.7%	8.5%	7.1%

Note: The HES survey may have underestimated total household expenditure by as much as 30%. Applying this adjustment to the calculations in the table above would reduce the impacts by this same amount.

22. The aggregate effects of eliminating subsidies on each of the fuels are regressive, i.e. the poor’s energy expenditures would rise by a greater proportion than the non-poor’s. In the lowest decile, the indirect impact dominates, while in the top decile, the indirect impact accounts for only 50% of the total, with a much larger direct impact (much of which is diesel for self-generation and agricultural irrigation by farmers in the highest income deciles).

23. Sectors that make direct diesel purchases such as transport and farming would be affected by removal of the diesel subsidy. So too would water sellers engaged in groundwater abstraction and distribution. Urban wholesale bulk water costs would increase by about 12% if the entire diesel subsidy were removed. This translates into an increase from about YR600 to YR664 for a tanker delivery ($3.5m^3$) or less than a 2% increase. In the case of water in 10-liter plastic containers that is presently sold for about YR40 (with container return) per container, the price increase would be less than YR1.

24. There is widespread expectation across all sections of Yemeni society that diesel price rises would raise the cost of non-energy items, i.e. that the consumer price index (CPI) would show a significant increase. The PRA carried out as part of the ESMAP study and additional qualitative research (PSIA) conducted by the Department for International Development (DFID) revealed very clearly that the poor

feared increases in food and water prices, even if they did not purchase diesel directly. Past diesel price rises took place in 1997 (a 67% increase from 6 to 10 YR/liter) and in July 2001 (a 70% increase from 10 to 17 YR/liter). Examination of the CPI in the months immediately before and immediately after these price rises provides a guide to what might be the impact of future diesel price rises. The price rises in 1997 and 2001 coincided with a one-time increment of the CPI of between 2-4% and 7% respectively. These are *upper bounds*, which assume that the entire deviation from the general trend was attributable to diesel price increases alone. However, there are regular seasonal fluctuations in inflation rates attributable to normal food price rises in summer, and therefore the actual contribution of diesel price alone is likely to have been less.[3]

25. It is likely that businesses and retailers would use the opportunity to increase prices by more than the increase in diesel cost in an attempt to increase profits. However, it may be assumed that any such behavior is likely to be a short-lived phenomenon, as the increased margins are competed away.

26. The immediate impact of reduced subsidies on the poorest groups is likely to be that they are pushed back to using biomass, which not only has undesirable impacts on the environment (pressure on woodland resources) and on health (smoke emissions from burning biomass are a leading cause of respiratory disease), but will also impose increasing time burdens on poor families for fuel collection.

27. In summary, the present delivery of subsidies in Yemen results in heavy costs to economic efficiency, unsustainable burden on Government finances, wasteful habits on the part of consumers, and adverse environmental effects. Subsidies usually have the intent of protecting poor consumers from the full cost of payment and are proposed with equity and environmental goals in mind. However unless they are very carefully designed and administered, they not only fail to achieve these goals but also become a great burden on the Government budget. This is the case with energy subsidies in Yemen.

Policy Options and Recommendations

Petroleum Product Pricing System Reforms

28. The distortions of the present subsidy structure require redress, not just in the interest of macroeconomic and fiscal imperatives, but because the subsidies limit the ability of the supply companies to serve demand effectively. **Reform is required not merely in the reduction of subsidies, but in improving their transparency, and in instituting a permanent system that automatically adjusts prices in line with world market trends.** Small, regular changes (once a month or once a quarter) are desirable, with a published price based directly on border prices – such pricing

[3] These effects do not take into account the price response of consumers. If the price of diesel were to increase, farmers would moderate their use of diesel; there would be incentive to use more efficient pumps and use them more sparingly. In the transport sector trucks would be dispatched more carefully, and so on. PEC would use less diesel and more fueloil (which it could do at some of its more modern units) – all of which would tend to reduce the above impacts.

systems have been introduced in a number of countries and the report provides the details of the Sri Lanka experience.

29. There are a number of risks associated with rapid or gradual subsidy removal. As shown in Table 7, elimination of all petroleum product subsidies would have significant impacts on the poor if implemented rapidly. Rapid removal would only be feasible if social protection measures were effective. If the pace is too gradual, there is risk of policy reversal if each price increment is met with public opposition. **It is recommended that the Government of Yemen (GOY) considers a phased program of eliminating petroleum product (including LPG) subsidies.**

30. The economically most efficient way to deliver a subsidy is through direct support of the poor so that they can be assisted without distorting the consumption choices of the entire economy. The Social Welfare Fund (SWF) is the Government's main targeted social assistance program. However, its targeting mechanisms are imperfect. The World Bank Poverty Update concluded that just 4.7% of the target group (defined as the very poor) received SWF transfers and that 57% of those benefiting were not in the target program. Thus although in theory, cash transfers through the SWF are a mechanism to compensate the poor for energy price increases it would only be effective if targeting of the SWF can be improved. Since 1997 GOY has expanded the number of beneficiaries of the program by nearly six-fold to reach 650,000 cases in 2004. Under a new policy initiative, reforms have been formulated to improve the poverty focus by reducing the eligible categories from 15 to 5 and apply means-testing for all categories. Implementing the detailed reforms prepared under the new policy initiative would greatly help in better targeting the poor. The same considerations for cash transfers would apply to a voucher scheme for a subsistence quantity of monthly kerosene or LPG purchases by the poor. There would be additional practical difficulties with a voucher scheme, as vouchers may be easier to falsify. **Therefore the design of better social protection mechanisms is a policy measure that can complement the program to phase out petroleum subsidies.** The Poverty Update (World Bank, 2002) made recommendations on the measures that needed to be undertaken in this regard.

31. The findings of the World Bank PRA and additional qualitative research carried out by DFID reveal a perception that is widespread in all sections of society that fuel and electricity price subsidies benefit the poor and that price increases will impact the poor indirectly through rises in goods and services for which fuels are inputs. The necessity for subsidy removal for fiscal reasons is poorly understood. The limitations of the SWF in compensating the poor are widely accepted. Press reports of proposed subsidy removal characterize the policy as donor imposed. The Government should continue with the efforts it is already making to **communicate the economic rationale for subsidy removal to parliamentarians and the public.**

32. **Border prices should be calculated on the basis of what actual cost would be if products were imported**, which in the case of Yemen means Platts Gulf plus freight of about $7/ton, not Rotterdam plus $15/ton. The latter pricing basis overestimates true economic cost. Taxes, distribution margins, and payments to earmarked funds (such as road and bridge maintenance) should be added in a transparent manner. It is also recommended that since heavier lorries that use diesel

cause the bulk of road and bridge damage, the maintenance fund should be levied not just on gasoline as is presently the case but also on diesel.

33. **The pricing system (and any change in subsidy on diesel) should address *all* fuels**. At present, kerosene is 97% of the diesel price (when expressed as YR/MJ). If the diesel price were raised to its (2003) economic price of 37YR/liter and kerosene left unadjusted, then kerosene would be 45% of the diesel price. Experience from other countries suggests that this would result in large-scale dilution of diesel with kerosene. Similarly LPG presently costs 87% of diesel; if the LPG price is not adjusted, LPG would then be 40% of the cost, which will be an incentive to use LPG in pumps sets. Therefore if only diesel subsidies are eliminated, the incentives to divert LPG and kerosene as diesel substitutes will increase, making shortages of these fuels in remote areas more likely. Subsidies therefore should be eliminated on all petroleum products if even greater distortions are to be avoided. If diesel subsidies are removed and other fuels are left unadjusted, distortions of the present system will only be amplified. Since kerosene is easily substituted for diesel – if the price differential between kerosene and diesel widens, kerosene will be used in place of diesel in transport and in stationary engines. Similarly, if the price differential between the LPG and diesel widens diesel LPG will be used in cars and in stationary engines.

34. In order to minimize the impact on households, it is therefore recommended that the elimination of subsidies be achieved through an immediate large one-time increase that significantly reduces the subsidy and that thereafter prices be adjusted quarterly over a period of two years through an automatic price setting mechanism as outlined above. This phased approach, which would allow households a satisfactory period of time to adjust their expenditure patterns without large shocks, could be structured along the following lines.

35. The main features of the reform of petroleum pricing would be as follows:

- The price-setting formula should be transparent and published. The Government should announce a timetable for eliminating subsidies on all petroleum products and LPG, with prices to increase by a constant increment every quarter until such time as the retail price reaches its economic price.
- The retail price lags should in time behind the world price by one quarter based on the assumption that the long-term international price will return to the 2003 level. The price should be set at the average of the previous quarter.
- The economic price for all products should be reached within a reasonable time period, i.e. within two years. If world prices fall from the present level in late 2004, then the economic price would be reached sooner. If international prices rise, the resulting quarterly increase would continue until such time as the international price is reached. Prices should be adjusted only if the calculated increment is greater than 2 YR/liter.

- The pricing formula smoothes out large daily and monthly fluctuations on world oil markets, and follows the longer-term trend, thereby giving proper signals to consumers.
- The price formula should be based on Platts Gulf plus freight (not Platts Rotterdam)

36. Furthermore, a rational pricing system should reflect the quality of fuel, which is a particular problem for PEC purchases of heavy fueloil. Deliveries of high sulfur fueloil (a consequence of refining cheap, heavy crude oil) carry the same cost as deliveries of low sulfur fueloil. This distorts the efficiency of both the refinery and PEC: the refinery because it has no incentive to deliver better quality; and PEC because poor quality fuels impose additional costs because of corrosion. Guidance on the discounts to be given for high sulfur fueloil should be based on differences between Platts quotations for 3.5% and1% sulfur on international spot markets: this is typically between 1-2 $/bbl (equivalent to 1 to 2 YR/liter).

37. Policies to improve household access to and affordability of modern energy services have to recognize that removing current high levels of subsidies will, in the first instance, push households down the energy ladder to increase their use of fuels such as fuelwood and other biomass.

38. Private distributors already have a strong incentive to provide credit facilities for LPG purchases for commercial reasons. According to YGC, most bottling operations presently operate far below capacity. Since the price structure reimburses bottlers according to the number of bottles they sell, recovering the up-front investment is largely dependent on bottle throughput. It is therefore in the interest of the bottlers and of retailers to encourage take-up of LPG by as many households as possible, so that they provide a steady stream of bottle purchases, and hence cash flow to the bottler and retailer. The costs of providing credit facilities evidently offset the increased income from higher bottle throughput. Such behavior of bottlers and retailers is not widespread practice and in 2003 YGC had a program to disseminate the experience of bottlers and retailers in markets where such credit facilities had been provided. YGC's program to encourage this practice of extending credit facilities for cylinder purchase should be sustained.

39. It has been proposed that the up-front costs of LPG access (the cost of the purchase of the LPG cylinder) be subsidized through a Government program. While the high up-front cost of LPG cylinders is a significant barrier to LPG use, a Government program to subsidize LPG cylinder purchase may not bring about increased LPG consumption by poor households. In other countries where LPG cylinders have been provided free of charge, even as part of a well-targeted program, the low incomes of the poorest groups severely constrained their ability to purchase LPG refills so their consumption remained very low. So if such a scheme was to be implemented in Yemen, several conditions would first have to be met. It would be necessary to target intended beneficiaries and to establish that they would consume significant amounts of LPG if given a free or partly subsidized LPG cylinder or cook stove.

Sustainable Biomass Production and Use

40. Under any scaled-up program to improve access to modern fuels, a proportion of poor households will continue to depend on biomass fuels. **Development of sustainable harvesting and of wood resources and their regeneration, development of fuelwood markets and an improved cook stove program (combined with improved kitchen practices) needs to be part of the Government's household energy strategy.** A comprehensive energy strategy would include a policy framework that provides incentives for private operators to engage in the production, distribution and sale of improved stoves. Improved stoves, by raising energy efficiency to 20-30% compared to about 10-15% or less for the traditional design of stoves in use today, the 3-stone fire (*massad*) and the enclosed *mawqad,* can reduce substantially the quantity of firewood required for cooking and heating.

41. Elements of an improved cook stove program may include criteria for approving stove projects, credit facilities for stove makers and promotional support. Monitoring and evaluation would include evaluation of acceptance and adoption of improved cook stoves, and changes in fuelwood use and in indoor air quality and exposure of household members to harmful emissions from cook stoves. Many such programs in other countries have not been successful. The design and implementation of an improved cook stove program that meets all the criteria of a successful program is a considerable challenge.

Electricity Sector Reforms for Improved Access

42. The GOY's target in the PRSP for electricity access by 2005 is for 40.3% of all households (98.2% of urban households and 22.2% of rural households) to have access to the national grid. The Government is presently working on the National Development Plan for Poverty Reduction to be completed by June 2005, which is to be based on the Millennium Development Goals (MDGs). Experience from other countries demonstrates that goals for increased rates of energy access and rural electrification must be premised on cost recovery to ensure that energy service providers are financially healthy. Although the economic cost of supply in different areas of the country is not known[4] it is undoubtedly the case that the costs of grid expansion in rural areas will be high given the nature of Yemen's topography and the small and dispersed electricity loads in rural areas that are concentrated in the evening for household lighting demand.

43. Although the cost of rural electrification can be reduced by employing technologies and technical standards appropriate to the low level of demand, the costs of off-grid systems are likely to be less than that of grid extension. Furthermore affordability is likely to continue to be a constraint for poorer households who, even as their incomes increase, will sometimes choose not to spend the little cash that they have on electricity purchases.

[4] In this connexion a detailed tariff study is also recommended. This would address issues in the present tariff structure, including a first tariff block that is far too high (at 200 kWh/month) to serve its real purpose of serving as a lifeline tariff (most other countries have a first block of between 25 to 50 kWh/month). However, in the absence of a comprehensive tariff study that clearly establishes the economic costs of service at different voltage levels and in different regions of the country, specific recommendations for reform cannot be made.

44. Poor people benefit from rural electrification even when they do not have a household connection. They benefit from the improved services when post offices, local government offices, clinics and trading centers are electrified. Yemen needs to improve coordination between electrification programs and other sector programs focused on rural development so that delivery of electricity services is part of a package of complementary rural services.

45. Taking account of these considerations, a comprehensive energy policy (which would be reflected in the National Development Plan for Poverty Reduction to be completed by June 2005) should **embrace targets for electrification of social institutions and reliability and competition in the supply of energy services in rural areas. Achieving these targets will require improved coordination between electrification programs and other sector programs focused on rural development.**

46. PEC alone will not be able to shoulder the challenge of rural electrification in Yemen. Cooperatives and private suppliers which today play a limited role can, in the future, play a much bigger role. The Government will need to draw on international experience when designing a model for rural electrification in Yemen. In the interests of equity, there may be a case for subsidizing electricity connections for target households. However, the case for subsidy could equally be extended to LPG cylinder purchase. It could be questioned why any Government resources should be spent on energy subsidies when the basic needs of the poor are not being met? Cash transfers, if well targeted, could allow the poor to make energy purchasing decisions for themselves. In any case, if some form of subsidy in the sector were to be maintained **it should shift from a subsidy of consumption to a capital subsidy of the cost of connection.**

Summary of Energy Policy Recommendations

47. The policy matrix (Table 7) summarizes the policy recommendations of the study.

Table 7: Summary of Policy Recommendations

Policy	*Rationale*	*Likely impact on the poor*
Implement a phased program for eliminating petroleum product (incl. LPG) subsidies. The economic price for all products should be reached within a reasonable time period, i.e. within two years. The price setting formula should be transparent and the Government should announce a timetable for eliminating subsidies. This report suggests a formula (para 35) with prices to increase by a constant increment every quarter until such time as retail prices reach their economic price. The retail prices would lag world price by one quarter. Price should be set at the average of the previous quarter and the price formula should be based on Platts Gulf plus freight (not Platts Rotterdam) YGC's program to encourage LPG bottlers and retailers to extend credit facilities for cylinder purchase should be sustained.	o Fiscal burden on Government is unsustainable o Little of the subsidy reaches the poor o Subsidies distort resource allocation o LPG diverted into transportation and other applications o Present system of *ad hoc* increases leads to periodic fiscal crises: long-term solution requires regular (but also small) adjustments o A significant proportion of the present subsidy goes to the refinery, not consumers.	o Impact is regressive: poorest groups hit proportionately higher than richest groups. o Households can more easily adapt to small (even if regular) increases than to sudden shocks.
Social protection mechanisms should be an integral element of the program to phase out petroleum subsidies.	o In principle, the economically optimum way to protect the most vulnerable against removal of subsidies is cash transfers.	o Social protection mechanism will only be effective if targeting can be improved.
Ensure sustainable harvesting of wood resources and their regeneration. Design an improved cook stove program to improve efficiency of cooking, reduce the quantity of fuelwood consumed and expenditure by households on fuelwood purchases.	o The very poor will continue for some time to depend on biomass for the majority of their cooking needs.	o Efficient use of biomass cooking fuel reduces time burden of collection and the disease burden from exposure to smoke from cooking fires.
Revise PEC tariff to reflect cost of supply (LRMC). Allow new customers to pay connection charge over 12 months. Reduce the first block ceiling from the present level of 200 kWh/ month to a level that represents the amount of electricity to meet basic household needs for lighting (about 30kWh) that is priced below cost and as such represents a lifeline for poor consumers.	o PEC does not recover its costs and subsidies for rural electrification are not transparent. Existing first block structure benefits over 50% of all PEC consumers and serves no income distribution benefit.	o Better targeted lifeline rate benefits the poor, and encourages use of electricity for lighting
Put in place an institutional and regulatory system that facilitates new service providers including cooperatives for rural electricity service delivery and that is adapted to Yemen conditions	o PEC cannot achieve costs recovery and at the same time greatly expand connections in rural areas. Different organizational models for service delivery should compete for limited Government subsidies.	o Private and cooperative service providers will be more likely to provide options for service that are better adapted to rural consumers. They are likely to introduce better adapted design standards, payment options and technologies.

1

Introduction

Background

1.1 In 1991 the ESMAP Household Energy Strategy Study recommended that the former Yemen Arab Republic (i.e. the Northern) should (a) improve the management of wood fuel (b) accelerate the substitution of LPG for wood fuel (c) reduce the cost of the supply of electricity in rural areas. At that time, LPG use was limited and constrained by a poor distribution system, shortage of bottles and lack of safety regulations. The Study recommended a comprehensive program to remove these constraints, encourage private sector participation in the transport and distribution of LPG, institute programs for sustainable biomass management and the promotion of rural power supply. The main goal of large-scale substitution of LPG for fuelwood has been largely met: today, 78% of all households report some use of LPG, as against 42% in 1989.

1.2 The GOY requested ESMAP to undertake a detailed household energy survey and provide an economic analysis of its main findings. The survey was designed to inform the Government on the distributional impacts of energy policy interventions, in particular the proposed reduction of petroleum product subsidies.

1.3 While the main focus of the study was to assess the general impact of policy options on households, and especially poor households, three main points are emphasized in the approach:

- to establish the underlying facts, so that predictions about how policies affect the poor can be made with more confidence (e.g. establish the likely impact of proposed diesel price increases).
- to identify positive policy changes that can achieve more than one goal without affecting social equity (e.g. such as linking fueloil price to sulfur content).
- to suggest mitigation measures for policies that perform well on economic and environmental goals but which disproportionately affect the poor (e.g. when removing petroleum product subsidies, price increases should occur at times of the year when other components of the CPI fall due to normal seasonal cycles, thereby avoiding sharp spikes in the CPI).

1.4 It is suggested that the framework of changes in Yemen's energy policy should be governed by these main goals:

- *economic efficiency*, which requires electricity tariffs and petroleum product prices to reflect the true economic costs of supply to achieve an optimum allocation of available resources.
- *financial cost recovery*, which requires that energy sector entities not only recover their costs, but earn a sufficient return on equity to attract private investment in the sector to ensure that future demands can be met by expanding supply.
- *environmental sustainability*, which requires consideration of environmental costs even if not reflected in market transactions.
- *social equity*, which requires that better-off consumers, and the Government, contribute to the costs incurred by the poorest sections of society.

Methodology

1.5 The study at its concept stage consisted of four major components: stakeholder development and capacity building, a PRA, the HES, and economic analysis.

Stakeholder Development and Capacity Building

1.6 The stakeholder development and capacity building component was intended to assist in ensuring that GOY poverty reduction goals – and those concerned with achieving them - were central to the work program. It was intended at the concept stage that a "core counterpart group" for the study would be formalized and it was intended that it would comprise representatives of the various government ministries including Planning and International Cooperation, Local Affairs, Oil and Mineral Development, Electricity and Water, and Environment, as well as academia and women's representatives. The core counterpart group would ensure consultation with stakeholders. The group would have reviewed the study report and in particular the policy recommendations which would form the basis for future Government actions in the sector.

1.7 Although a core counterpart group was not formalized, consultation with Government and non-Government representatives took place during the course of implementation of the study. The study was initiated on October 7 & 8, 2002 at a workshop composed of 20 experts from the then[5] Ministry of Planning and Development; Ministry of Electricity and Water; Ministry of Oil and Mineral Development; Ministry of Local Affairs, Ministry of Environment and Tourism the Women's National Committee and academia. This workshop endorsed the scope of the study and the analytical approach. On January 26, 2004, after the HES fieldwork was completed, a meeting was chaired by Deputy Minister Al-Abbasi, MOPIC, with participation of PEC, Local Government, Ministry of Environment, Ministry of Finance, YPC and YGC at which the mission presented its work program and the framework for the economic and financial analysis with which to test policy options.

[5] The current designation of Ministries (reflecting the changes made on ministerial portfolios following the 2003 election) is contained in the list of Abbreviations and Acronyms.

During its September 2004 mission, the study team discussed the draft findings of the economic and financial analysis with counterparts in MOPIC, YGC, YPC, PEC and other agencies. The mission presented its findings in the following group meetings.

- DFID sponsored Stakeholder Analysis meeting with Government and civil society representatives on September 12, 2004
- Meeting of Infrastructure Thematic Group for PRSP, MOPIC with representatives of Government and civil society on September 15, 2004
- Meeting of Government and civil society representatives sponsored and chaired by the PRSP Monitoring Unit of MOPIC to discuss the distributional impacts of energy subsidies on September 22, 2004.

1.8 The findings of this report and its recommendations were presented to the Government in December 2004. An immediate issue and the focus of discussions was the phasing out of petroleum product and LPG subsidies and the likely impact of this on inflation and increased expenditures on energy and other staple goods. The report findings and recommendations are an important analytical basis for follow-up work planned by the World Bank. This work includes studies and actions to implement (i) gas for power development (ii) continued reform of the electricity sector (iii) appropriate institutional and associated policy and regulatory framework for rural electrification (iv) development of renewable energy resources (v) sustainable fuelwood supply and use.

The Participatory Rapid Assessment (PRA)

1.9 The PRA provided qualitative and quantitative information on the ways in which people use energy and cope with energy poverty. It was carried out between December 2002 and February 2003 in the four governates where most of the poor are concentrated: Taiz, Ibb, Sana'a and Hodeida (57% of the nation's poor are found in these, and the governates with the highest incidence of poverty are Taiz and Ibb). The PRA was conducted first to provide information for the design of the HES questionnaire.

1.10 The PRA allowed direct consultation with communities in nine locations to understand patterns of energy use. Twelve teams composed of four researchers each conducted gender segregated focus group discussions and in-depth interviews with key men and women informants such as sheiks, community leaders, elected representatives, shop owners, energy suppliers, teachers and health workers. Geographic and poverty mapping, stakeholder analysis and participant observation was carried out. The approach allowed researchers to observe energy use behavior and to seek explanation from users of the range of choices they have over energy sources and service providers and of the selections they made. It explored the attitudes of users on the choices they face, their level of satisfaction with the energy services they can obtain and what they would like to see changed. Energy use in community institutions such as health centers, schools and municipal offices was also investigated.

The HES 2003

1.11 A nationally representative HES 2003 provided data on household electricity and the different energy forms, their supply characteristics, prices paid, and their end uses. The HES sampled 3,540 households in December 2003 to January 2004. The CSO was closely involved in the sampling design and the survey was conducted by a group of Yemeni experts and consultants with the additional assistance of an international household survey expert. The survey covered all but two governates for which effective access was not possible for the survey teams (Al-Jowf and Al-Mahara). Annex 10 in Volume 2 provides details of the design of the HES.

1.12 The HES was complemented with supply side data and information collected during the course of the study from PEC, YGC and YPC. Annex 10 in Volume 2 discusses the issues involved in the reconciliation of the survey data with the supply side information.

Economic and Financial Analysis

1.13 Economic and financial analysis of the household and supply survey data provided combined cost benefit, financial, macroeconomic and policy linkages information. Analysis was focused on the distributional impact of energy policies such as petroleum product subsidies. The present report is for the most part based on this economic and financial analysis.

Scope

1.14 The report is organized in two volumes. The main findings and policy recommendations are presented here in Volume 1. Volume 2 contains a series of annexes on each of the fuels which provides greater detail of the findings of the HES as well as notes on the methodology of the HES and the PRA.

1.15 In Volume 1, the Executive Summary summarizes the study findings and recommendations. Additional detail on these can be found in the individual chapters. Chapter 2 reviews the energy markets and the formal and informal institutions engaged in energy supply. Chapter 3 reviews patterns of household energy use and the energy services that households seek from the electricity and fuels they use. Chapter 4 reviews the prices that households pay and the amount of expenditures they make on electricity and fuel purchases. Petroleum product subsidies are examined in detail in Chapter 5. Reform of petroleum prices at the time the study, was a priority sector issue for the Government and thus one receiving the attention of senior policy makers. The analysis in Chapter 5 therefore provides guidance on the implementation of petroleum product (including LPG) subsidy removal.

1.16 Volume 2 provides details of the PRA and HES methodologies and approaches. It discusses survey coverage, sample design, training of survey personnel and data processing. It discusses lessons that were drawn from the conduct of the PRA and HES and indicates what improvements might be made to the methodology and approach. Volume 2 also contains additional data and findings on each fuel from the HES.

2

Household Energy Markets and Institutions

Fuelwood and Other Biomass Markets

2.1 Wood is still widely used as fuel by almost all social categories in all locations, even in urban areas. Nevertheless, the availability, cost and quality of wood varies with geographical location. Generally, highlands enjoy better quality wood, while in the plains people must use a mixture of dry branches and twigs. In the highlands, all households (well-off as well as poor) use fuelwood for heating during the cold season.

2.2 There are no standard units for wood sold, but it is referred to as a "load" or *huzma*. The monthly consumption of wood by poor and very poor social categories ranges between 10 to 20 loads per month although very poor households may consume more, as was seen in Uthmah, where the average consumption was 30 *huzma*. Dung and crop residues are for the most part collected rather than purchased while substantial fractions of fuelwood are purchased (Table 2.1).

Table 2.1: How do Households Obtain Biomass Fuels, as % of Households Using Fuels?

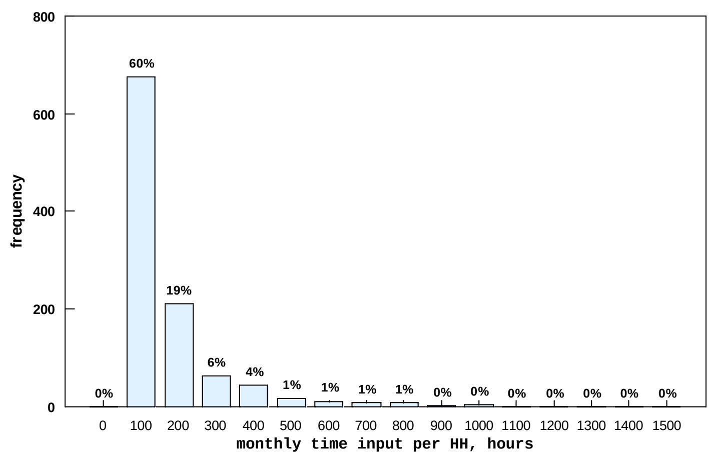
decile	*Fuelwood*			*Crop residue*			*Dung*		
	Purchase only	*Purchase and collect*	*Collect only*	*Purchase only*	*Purchase and collect*	*Collect only*	*Purchase only*	*Purchase and collect*	*Collect only*
1	11	6	83	1	99			100	
2	18	14	68	2	93	5		94	6
3	12	14	74	1	93	6		96	4
4	22	13	65		94	6	1	98	1
5	22	7	72	1	89	10	5	91	5
6	34	6	61		100		3	96	2
7	21	9	70		97	3		99	1
8	33	12	55		98	2		95	5
9	30	12	58	1	91	9		98	2
10	44	10	47	2	89	9	2	98	
All deciles	24	10	66	1	94	5	1	96	3
Rural	19	11	70						
Urban	61	7	32						

As percentages of HH who use the fuel in question

2.3 Since firewood has sometimes to be collected at significant distances from villages, men and boys accompany women and girls. Although most of the collected wood is carried on girls' and women's heads, longer distances could involve using donkeys to transport larger quantities. Poor households without such animals can only transport smaller quantities and thus have to make more frequent trips to farther locations over longer periods of time.

2.4 The frequency distribution of the monthly time budget of households for collection of firewood is shown in Figure 2.1 (c.f. Annex 9, Volume 2 for additional data and discussion)[6]. The figure shows that 60% of households that collect firewood do so for 100 hours per month and 19% of households do so for 200 hours per month. This monthly time budget is *not* correlated with collection distance, though it is weakly correlated to family size as one would expect (scale economies in cooking mean that the heat input to cooking is not in linear proportion to the number of people eating the meal).

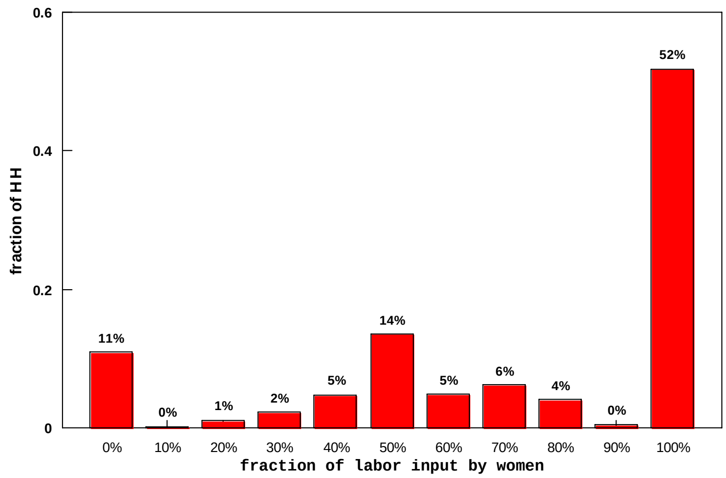
Figure 2.1: Monthly Household Time Budget for Fuelwood Collection (for Households Collecting Firewood)



2.5 The labor input of adult women is shown in Figure 2.2. In 52% of all households that collect firewood, adult women provide 100% of the collection labor. However, in 11% of households, they contribute no labor, and in 14% they contribute 50%. There is a statistically significant relationship between the labor contribution of women and collection distance (c.f. Fig A9.11, Volume 2): as collection distances increase, the contribution of women *decreases*. This confirms the anecdotal evidence of men wishing to accompany women where collection distances are long.

[6] Note that obtaining accurate estimates from individuals on time use and distances with respect to firewood collection is often problematic in household surveys. Information on time use was collected in both the HES and PRA for this study and in some respects the results were not consistent.

Figure 2.2: Labor Input of Women

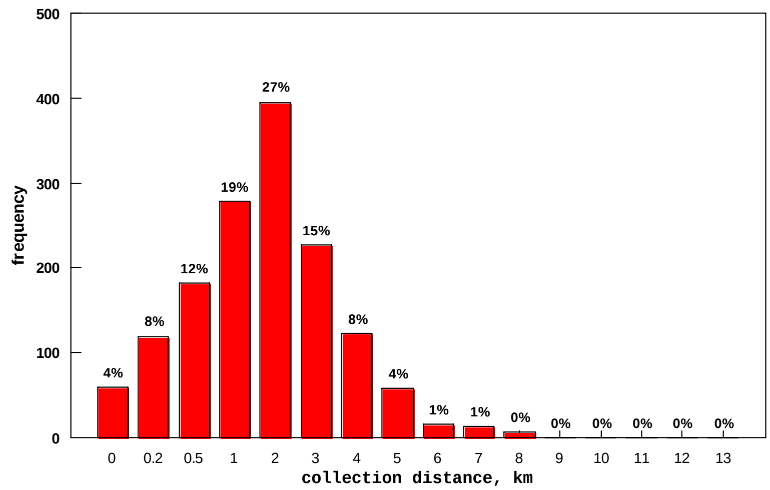


2.6 Boys contribute no labor to fuelwood collection in 92% of all households, and only in very few cases do they make significant contributions. In 73% of all households (that collect fuelwood), girls do not participate at all; in 8% of households, girls provide 50% of the total labor, and in 2% of households, girls provide 100% of the collection effort. The pattern for men is very similar to boys, with 75% of households reporting no contribution of (adult) men. These results from the HES are further elaborated in Annex 9, Volume 2.

2.7 Poor urban households are also forced to revert to wood collection to meet their cooking energy needs and this wood is often of very poor quality. Children and adults cut wood from bushes and trees, combining it with wood from carpentry workshops. Poor urban households also collect other discarded materials such as cartons, paper, plastic, etc, to mix with wood.

2.8 Figure 2.3 shows the distribution of fuelwood collection distances: the average is 2km. However, 30% of households report collection distances more than 3km. There is surprisingly little variation across governates (c.f. Figure A9.3, Volume 2). Sana'a City is the outlier, with an average reported distance of 4.8 km (however only 18 sample households reported collecting fuelwood in Sana'a city). The PRA reported that in Mutheikhra, Utmah and Jabl Yal Yazid collection involved climbing in areas that are unsafe due to the nature of the terrain and that there had been instances of severe injury or even death from falls or rock slides.

Figure 2.3: Distribution of Fuelwood Collection Distances



2.9 When women collect wood from communal land, they generally do not pay for it. Increasingly, however, population growth and transformation of land tenure rights are restricting availability of fuelwood. Poor families – those without land of their own – are experiencing restrictions in their access to wood where landowners have reclaimed land after the reunification. They sometimes cope by making unauthorized wood collection which also leads to communal tensions.

2.10 Although wood is mainly cash free, households do occasionally buy wood, especially during the rainy season when efficiently burning wood is scarce. The cost varies geographically and is generally more expensive in urban areas than in rural areas. In Uthma, for instance, 15-20 loads of purchased wood costs between YR750 and YR1000, sufficient for a month's cooking. A Toyota pickup load of wood or a *hamla* costs between YR3000 and YR4000s. Those most likely to purchase wood live in district capitals or urban areas where wood is not available for collection. In urban areas, households pay YR50-80, sufficient for one day's cooking, but the costs increase to YR100-120 in the rainy season when dry wood is scarce. Wood is logged and sold by men. Women do not generally sell the wood they gather.

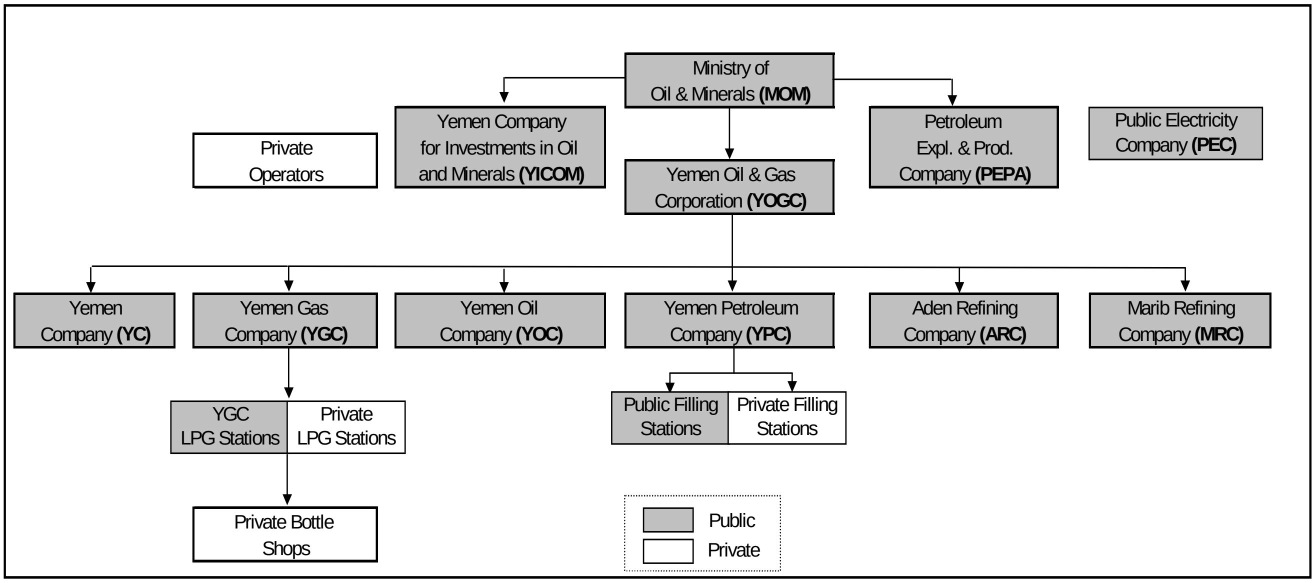
2.11 The very poor receive hay and dung as part of their compensation for taking care of the fields or cattle. Dung is dried over a week long period. In the plains, it is not widely used and is for the most part a poor household's energy source. In the highlands, however, even the wealthy use it and appreciate its slow and relatively efficient ability to burn under low oxygen, high altitude conditions. Hay is also used as a burning agent among very poor households which they collect as their in-kind payment for agricultural work.

Petroleum Product Markets

2.12 The oil and gas sector in Yemen is dominated by the state. The GOY is involved in all parts of the oil and gas chain, including oil production, refining, distribution and marketing of petroleum products.

2.13 Private companies are involved in upstream oil exploration and production activities, the filling and distribution of LPG bottles, and the distribution of petroleum products. Figure 2.4 shows the current industry and ownership structure for the oil and gas sector in Yemen.

Figure 2.4: Oil and Gas Industry and Ownership Structure



Source*: World Bank*

2.14 YOGC supplies Aden Refining Company (ARC) and Marib Refining Company (MRC) (the two refineries in operation in Yemen) with crude oil to refine oil products for the domestic market and exports the remaining Government share. All Yemeni crude oil for the two refineries comes from Hunt's Marib field. About 90% of the processed crude at ARC is Marib Light. The remaining proportion is non-Yemeni crude oil. MRC exclusively supplies the domestic market. In contrast, ARC trades in both the domestic and international market. ARC has the import and export monopoly of oil products in Yemen. ARC carries out "crude swaps", exporting high quality crude from Marib and importing sour and heavy crude. ARC also exports high quality oil products and imports lower quality products to supply the Yemeni market.

2.15 YPC is the single buyer of petroleum products from ARC and MRC and is the monopoly distributor of oil products to filling stations and large industrial customers (Figure 2.5). Prices for refined petroleum products from ARC and MRC are administered and regulated. From MRC, petroleum products are priced spot fob Italy prices (Platts) plus operating costs. ARC charges fob Rotterdam prices plus a notional freight of US$17/ton. There are publicly and privately-owned filling stations in Yemen. YPC is the exclusive supplier of fuel and diesel to the power generators of PEC and other industrial and commercial customers. In 2003, YPC sold petroleum products equivalent to US$ 710 million in value.

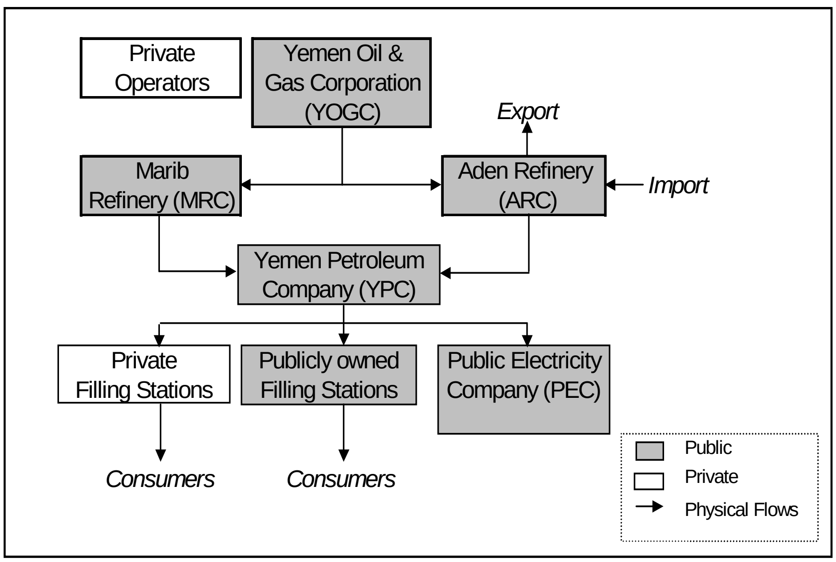
2.16 Table 2.2 provides an overview of the quantities and value of sold petroleum products by YPC in 2003. In 2003, YPC sold about 5.2 million liters of gasoline, diesel, kerosene and fueloil at a value of US$710 million. In dollar values, gasoline accounted for the largest share with a value of US$273 million followed by diesel valued at US$214 million.

Table 2.2: Quantity and Value of Sales of YPC in 2003

	Gasoline	*Diesel*	*Kerosene*	*Fueloil*	*Total*
Sold (‘000 liters)	1,495,227	2,444,426	253,012	1,001,920	5,194,586
Value (Million YR)	50,570	39,649	7,943	33,269	131,432
Value (Million US$)	273	214	43	180	710

Source: *Ministry of Oil and Minerals, Annual Reports of the Corporation and Affiliated Companies, 2003*

Figure 2.5: Industry Structure for Petroleum Products



Source: *World Bank*

2.17 In 2003, Yemen had 29 publicly-owned and 2,114 privately owned fuel filling stations. Diesel accounted for the largest proportion of petroleum products sold, followed by gasoline and fueloil.

2.18 Table 2.3 illustrates the general trends in LPG and petroleum product consumption. It shows a sharp divergence in growth rates among the various fuels. Over the past decade, consumption of kerosene and gasoline has barely changed. Consumption of diesel and electricity has more than doubled growing at an average annual rate of 9.2% and 6.3% respectively, while LPG consumption (from Marib) has tripled growing at an average annual rate of 10.4%. Over the same period, the population has grown from 13.85 million to approximately 19.2 million (3% per annum on average) and gross domestic product (GDP) has grown by 5.4% per annum on average. The high LPG growth rate can be attributed to the success of the strategy to promote LPG use over fuelwood for cooking.

Table 2.3: Petroleum Product Consumption 1992-2003

	Gasoline	*Diesel*	*Kerosene*	*Aviation fuel*	*Fueloil*	*LPG (from Marib)*
	[mill liters]	[mill liters]	[mill liters]	[mill liters]	[mill liters]	[tons]
1992	1253	1030	149	103	724	89,200
1993	1329	1038	161	105	814	107,067
1994	1332	1023	147	93	589	232,815
1995	1458	1083	172	102	808	261,106
1996	1391	1175	169	93	909	279,790
1997	1422	1271	164	107	912	324,011
1998	1325	1313	150	98	930	348,856
1999	1317	1458	140	113	1060	412,894
2000	1352	1698	137	151	1135	462,783
2001	1384	1891	139	136	1116	505,823
2002	1413	2222	138	128	1077	587,994
2003	1495	2444	134	119	1002	624,813
Annual growth rates, 93-03	1.2%	9.2%	-0.8%	2.5%	5.4%	10.4%

LPG

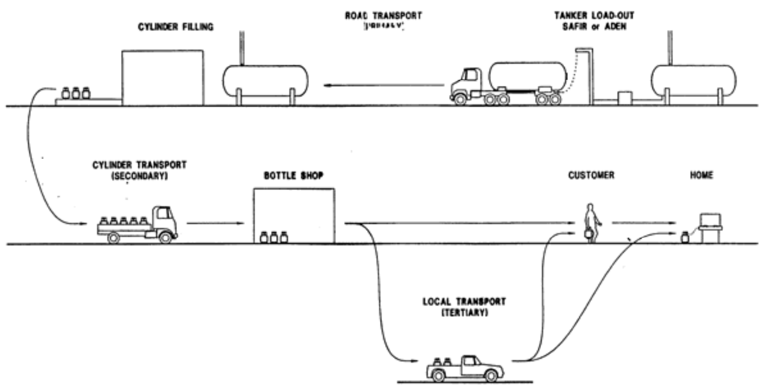
2.19 A dramatic shift from fuelwood to LPG has occurred over the past decade. This strategy of encouraging household use of LPG was adopted by Yemen on the basis of several considerations, including concerns over deforestation, the heavy time burden on rural women and children for fuel wood collection, the health impacts of using fuelwood for cooking, and the strong preference expressed by all income groups for LPG as the most desired fuel for cooking.

The LPG Supply Chain

2.20 The main entity in the supply chain is YGC, a subsidiary of the Government-owned YOGC. LPG is produced by separating it from the gas produced in association with the crude oil at Marib. The gas treatment plant is owned by the Government, and operated as part of the Yemen-Hunt oil complex at Marib. The Aden refinery also produces LPG.[7] However, while LPG delivered to YGC at Marib is at no cost to YGC, the cost of LPG sold to YGC by the Aden refinery is still under negotiation (the refinery is requesting payment at the border price).

[7] LPG is *not* produced at the Marib *refinery* (but only from the Marib gas processing plant).

Figure 2.6: The LPG Supply Chain



2.21 YGC owns and operates the bulk storage and tanker loading facility at Safir. There are presently 420 heavy tankers averaging loads of 23 tons of LPG, and the tanker loading facility has a capacity of 85 tanker-trucks per day. The present rate of loading is 72 trucks/day. The tanker-trucks are privately owned (except for a few tanker-trailers owned by YGC which are leased to private operators).

2.22 LPG is delivered to 71 filling stations (of which 64 are privately owned and 7 owned by YGC). The typical filling station has 50 tons of storage, but presently operates at only 40% capacity (c.f. Table A6.1, Volume 2) and average throughput has declined from some 13,500 tons/year in 1994 to only 7,700 tons/year in 2000. This follows from the sharp increase in the number of filling stations built by the private sector in response to the prospects for a rapidly growing business and guaranteed returns. Local bottle shops and tertiary distribution are entirely in private sector hands.

2.23 YGC is responsible for the maintenance of cylinders (for which it receives a margin of 3 YR/cylinder, see Table A6.11, Volume 2). Filling stations are responsible for the return of damaged bottles to YGC, who repair or replace them, as necessary.

The LPG Market

2.24 The bulk of LPG use is for domestic cooking, but there are few data on the extent of other uses. Some LPG is delivered to larger establishments (for hotels, or heating chicken broiler houses) in bulk form, and some LPG filling stations offer larger cylinders (also used in restaurants). Over the past year, a significant number of restaurants have converted from cylinders to bulk supply replenished by small road tankers.

2.25 The largest non-domestic use is likely to be for road transport, as there is a high incentive to convert gasoline cars to LPG given the difference in price. LPG consumption of the transport sector is estimated at 10% of the total.[8] This is driven

[8] According to YGC, most car filling stations are owned by owners of LPG bottling stations.

entirely by the present retail price differential between gasoline (35 YR/liter) and LPG (10.25 YR/liter). However, there is no reliable information on the number of conversions that have actually occurred and inferring LPG consumption from lower-than-expected growth in gasoline demand is beset with a number of practical difficulties.

2.26 Based on discussions with officials of the YGC, the composition of LPG consumption for 2003 can be taken as 87% for households, 8% for transport, and 5% for agriculture, hospitals, restaurants and hotels, government, and military. However, the transport share is increasing and for 2004 may be taken as 10% of the total. An estimate of the breakdown of 2003 consumption is shown in Table 2.4.

Table 2.4: 2003 LPG Consumption

		1000 tons
Marib		625
Aden refinery		6
Total sales	100%	631
Consumption		
Domestic	88%	555
Transport	7%	44
Other	5%	32

2.27 Table 2.5 shows the cost of energy expressed in terms of cost per unit of calorific value. At present retail prices, LPG is by far the cheapest form of energy in Yemen. It has a 61% cost advantage per MJ over gasoline (and hence the incentive for conversion of gasoline powered automobiles) and a 13% advantage over diesel.

Table 2.5: Cost Per Unit of Energy

		LPG	*Gasoline*	*Kerosene*	*Diesel*	*Fueloil*
Cost per liter	[YR/liter]	10.2	35.0	16.0	17.0	31.0
Net calorific value	[MJ/liter]	24.5	32.4	34.4	35.4	38.9
Cost per MJ	[YR/MJ]	0.42	1.08	0.47	0.48	0.80
Advantage of LPG	[YR/MJ]		0.66	0.05	0.06	0.38
	[%]		61%	10%	13%	48%

2.28 As result of LPG's cost advantage, it is reported that farmers are running irrigation pumps with a mix of 30% LPG and 70% diesel. Increasing amounts are used for powering fridges (reflected in the household survey: 0.6% of households use LPG for this purpose). Small gasoline engines (e.g. those powering pumps on water bowsers) are being converted to LPG. LPG is also being used for space heating.

Increasing LPG Access to the Poor

2.29 The high start-up cost of LPG (for purchase of the initial cylinder and for an LPG stove) is a significant obstacle to higher access rates among the poor: the initial purchase cost of a cylinder is YR2,500-3,000. And even where poor households do have access, LPG is used sparingly (a rural household in the lowest 10% income decile using LPG consumes 24kg/month, compared to 42kg/month in the top decile). Unlike kerosene, which can be bought in very small quantities, LPG must be bought in 11kg increments, which the poor often find difficult.

2.30 Therefore it has been proposed that the up-front costs of moving to LPG should be subsidized. However, private distributors already have a strong incentive to provide credit facilities to families in this situation for very straightforward commercial reasons. According to YGC, most bottling operations presently operate far below capacity. Since the price structure reimburses bottlers according to the number of bottles they sell, recovering the up-front investment is largely dependent upon bottle throughput. It is therefore in the interests of the bottlers to move as many households to LPG as possible, so that they provide a steady stream of bottle purchases, and hence cash flow to the bottler. The increased income from higher bottle throughput offsets the cost of providing credit facilities.

Box 2.1: The Deepam Scheme in Andhra Pradesh, India

The Government of India has attempted to encourage fuel switching from biomass to cleaner commercial fuels by providing large universal price subsidies to kerosene, sold through the Public Distribution System, and LPG sold in 14.2kg cylinders by dealers belonging to state-owned oil companies. A scheme providing price subsidies, however, does not address one of the barriers to household fuel switching to LPG: the high up-front cost associated with the start-up of LPG service. For example, a new LPG user in the state of Andhra Pradesh must (i) pay Indian Rupees (Rs.) 1,000 (about YR4,050) for an "LPG connection" in order to receive an LPG cylinder and (ii) purchase an LPG stove and associated accessories for a further Rs1,000 (YR4,050) or so. The combined cost of LPG connection and stove purchase makes it difficult for many poorer households to start using LPG as a cooking fuel.

In order to help overcome this barrier, the Government of Andhra Pradesh launched the so-called Deepam scheme in July 1999 whereby the connection fee was paid by the Government for below-poverty-line (BPL) households possessing white ration cards. Those who do not possess white ration cards are also eligible provided that their self-help groups pass a resolution attesting to their BPL status. Deepam recipients still had to purchase their own stove, and were only given the LPG cylinder.

The policy objectives of the Deepam scheme include (i) reducing drudgery among women and children from wood collection and cooking; (ii) improving the health of household members by reducing ambient concentrations of smoke and other harmful pollutants; and (iii) protecting forests from further degradation. The scheme was originally designed to cover one million rural and 0.5 million urban households.

Only members of self-help groups satisfying certain criteria may participate in the scheme. There are more than 373,000 self-help groups in Andhra Pradesh with a total of more than five million members. About 150,000 of these self-help groups are in rural areas. As of February 2002, more than 1.5 million LPG connections had been released through the Deepam Scheme, including 1.2 million in rural areas. The majority of recipients were members of groups under the Development of Women and Children in Rural (or Urban) Areas (DWCRA and DWCUA, respectively).

Source: S. Rajakutty and M. Kojima, *Promoting Clean Household Fuels Among the Poor: Evaluation of the Deepam Scheme in Andhra Pradesh.* World Bank, March 2002.

2.31 Even if one could make a case for Government to provide a subsidy of this type to poor families, two questions need answers before such a scheme could be made effective:

- How are the poor to be identified?
- Would the recipients in fact use LPG if given a free cylinder and cooking stove?

2.32 The international experience is relevant to Yemen, for such schemes have been tried elsewhere. The Deepam scheme in India (see Box 2.1) had a reasonably effective mechanism for identifying poor households through registered women's self-help schemes and providing free LPG cylinders to these households. However, in rural areas where free or cheap biomass is available, LPG was used by the recipients only very sparingly. The average cost of a cylinder refill was 270 rupees for a 14.3kg cylinder (or about YR845/11kg cylinder). Yet the maximum monthly household incomes of the recipients is 265 rupees in rural areas, and 457 rupees in urban areas (YR1,060 and YR1,860, respectively). Thus a cylinder refill in rural areas covered by the Deepam scheme amounts to one month's income – clearly a very significant outlay.

2.33 Private LPG dealers selling to better-off customers report that the average household consumes about half a cylinder per month, or 7kg/HH/month (a rate that is less than half that observed in Yemen). Deepam recipients used only 2.6kg/month in rural areas, and 4.8 kg/month in urban areas.[9]

2.34 It is thus unclear that such schemes are sustainable, even when, as in the case of the Deepam scheme, qualified beneficiaries could be identified with reasonable certainty. Therefore the first task in Yemen, were such a scheme to be considered by Government, would be to develop a mechanism for identifying beneficiaries. In discussions held in September 2004, both Government officials and non-government organizations (NGOs) expressed skepticism that the SWF could effectively do so in the more remote rural areas where the need is greatest.

Diesel

2.35 Total diesel consumption in 2003 was 2,475 million liters, of which the 2003 HES suggests only 486 million liters were purchased by households – the bulk of which was used by upper income deciles for agricultural use. PEC consumes 334 million liters/year. A major uncertainty is the extent of diesel smuggling (see below). However, the bulk of diesel is used by non-household sectors, including transport and industry. The main impact of diesel price increases on households would be indirect – higher prices for food (irrigated by diesel pumps, and transported by diesel lorries), and water (groundwater pumped by diesel pumps, and distributed by diesel bowsers).

[9] Many recipients of the free cylinder sold them (or even used them as part of dowries). A survey showed that the high cost of LPG was the main reason for discontinuing LPG use.

Diesel Smuggling

2.36 It is widely reported that considerable quantities of diesel (and LPG) are smuggled to neighboring countries across the Red Sea, motivated by the sharp difference between the domestic price in Yemen and the international price. Estimates range as high as 30% of total diesel consumption as being smuggled, and commentators note “significant economic losses”. As shown in Table 2.6, Yemen diesel prices are substantially below those of neighboring countries, so there is substantial incentive for smuggling. However, while the economics of petty smuggling suggest significant incentives (c.f. Box A4.2, Volume 2), it is difficult to see how this could amount to 30%, which, given 2003 consumption of 2,260 million liters of diesel, implies some 700 million liters, or 670,000 tons.

Table 2.6: Diesel Price Comparison (US cents/liter)

	1998	*2000*	*2002*
Yemen	**7**	**6**	**10**
Eritrea	23	33	25
Somalia(a)			
Djibouti	40	53	54
Saudi Arabia	10	10	10
UAE	18	26	30
Oman	29	29	26

Source: *World Bank Development Indicators, 2002; GTZ*

(a) No official information; according to press reports, diesel prices in Mogadishu are around 30 US cents/liter, but supply is erratic (mainly by tanker from UAE to the port at El-Ma’an, and often reach 80 US cents to $1/liter). Smuggling is also reported from Djibouti (where retail prices are high) into northern areas of Somalia. It is a reasonable assumption that Somali is a substantial market for smuggled fuels.

2.37 It has been suggested by other commentators that high growth rates of diesel consumption in Yemen are substantially in excess of the growth rate in GDP, which supports the proposition of large quantities of diesel smuggling.

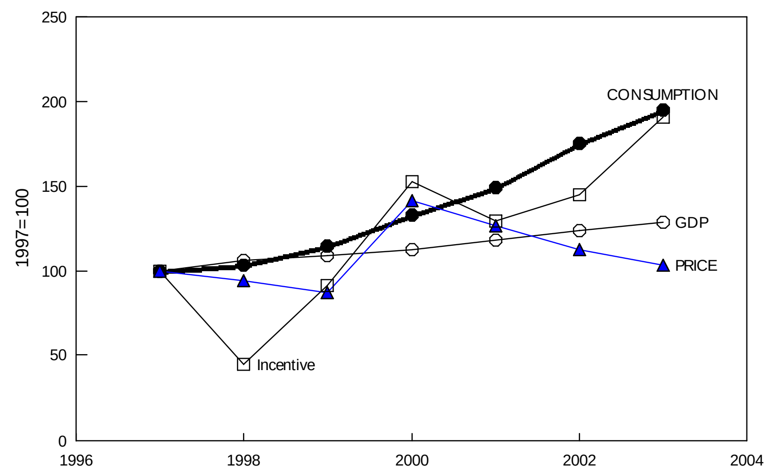
2.38 However this may not be a correct conclusion. First, one of the main reasons why diesel consumption has increased sharply over the past few years is increased consumption by PEC for electricity generation (as well as diesel purchases by industries and households for self-generation). As shown in Table 2.7, when PEC consumption is subtracted out, the 2002 increase in diesel consumption is 16%.

Table 2.7: Diesel Consumption, GDP and Price Differential

		1997	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*
Total diesel consumption	[10^6 liters]	1271	1310	1458	1689	1891	2222	2474
growth rate			3%	11%	16%	12%	18%	11%
PEC consumption	[10^6 liters]			60	127	203	257	334
Non-PEC consumption	[10^6 liters]	1271	1310	1398	1562	1688	1965	2140
growth rate			3%	7%	12%	8%	16%	9%
Differential (economic price-actual price)	[YR/liter]	11.9	5.4	10.9	18.2	15.4	17.3	22.8
Change	[YR/liter]		-6.6	5.6	7.3	-2.8	1.9	5.5
As % change			-55%	104%	67%	-15%	12%	32%
Non-oil real GDP growth rate		6.2%	5.8%	2.7%	3.5%	5.2%	4.6%	4.0%

2.39 A second reason is that many countries at Yemen's stage of economic development (and particularly rapid growth in road traffic) exhibit high income elasticities for diesel consumption, and one would *expect* that diesel consumption grows faster than GDP growth. While it is true that a large price differential between border price and domestic price is an incentive for diesel smuggling, a falling real (domestic) diesel price can also induce additional diesel consumption. Indeed, when real price and price differential are used as shown in Figure 2.7, a very different picture emerges: the falling real price of diesel has driven diesel consumption just as much as increasing price differential.

Figure 2.7: Diesel Consumption v. GDP and Diesel Prices



2.40 With so short a time series one may be reluctant to read too much into a simple regression model. Nevertheless, when one estimates the model

$$\delta Diesel = k\ \delta GDP^{a}\ \ \delta PRICE^{b}\ \ \delta PX^{c}$$

the income elasticity calculates as 2.4, the own-price elasticity as –0.2, and the elasticity with respect to the price differential as 0.1 (all statistically significant, signs and magnitudes of elasticities very much as expected, overall R^2=0.99). Based on this (admittedly simplistic) model, when one sets δPX=0, i.e. if the border and retail price were equal and thus no longer an incentive for smuggling, then the 2003 consumption reduces from 2,474 million liters to 2,300 million liters, a reduction of 7%. This reduction of 173 million liters calculates to 1 million bbls/year, or 145,000 tons per year.

Electricity

2.41 After unification in 1990, the two electricity corporations of North and South Yemen were amalgamated to form the PEC which today is the sole public utility with a mandate for the generation, transmission, distribution and sale of electricity in the country. In 2002 the General Authority for Rural Electrification and Water Supply (GAREWS) was dismantled and the rural electrification activities of GAREWS were merged with PEC. PEC's supply activities are concentrated around the three main systems of Sana'a, Aden and Hadramawt. Table 2.8 shows the growth in electricity consumption from PEC supply from 1992 to 2003. Households that are distant from PEC's network may obtain electricity service from PEC isolated systems, diesel gensets (their own or neighbor's) or from private and cooperative minigrids.

Table 2.8: Electricity Consumption from PEC Supply: 1992-2003

	PEC Grid Electricity	
	Sales [GWh]	All customers [1000]
1992	1498	492
1993	1601	512
1994	1480	531
1995	1572	547
1996	1565	583
1997	1734	629
1998	1854	684
1999	1935	758
2000	2079	809
2001	2244	868
2002	2477	928
2003	2736	996
Annual average growth rates, 92-03	6.3%	6.5%

2.42 Table 2.9 shows access to electricity. While 91% of urban households report access to electricity (of which 79.3% are served by PEC), only 42% of rural households are electrified, and, of these, only 23% are served by PEC's national grid.

Table 2.9: Electricity Access

	Urban		*Rural*		*All*	
	[#HH]	*[%]*	*[#HH]*	*[%]*	*[#HH]*	*[%]*
PEC national grid	402,747	79.3%	400,724	23.0%	803,471	35.7%
PEC isolated system	0	0.0%	56,988	3.3%	56,988	2.5%
Cooperative	21,118	4.2%	31,927	1.8%	53,045	2.4%
Private	0	0.0%	2,328	0.1%	2,328	0.1%
Village/community	22,603	4.4%	157,414	9.0%	180,017	8.0%
Relative/neighbor	12,642	2.5%	26,771	1.5%	39,413	1.8%
Family-owned	6,311	1.2%	52,484	3.0%	58,795	2.6%
Other	0	0.0%	6,724	0.4%	6,724	0.3%
Total non-grid	62,674	12.3%	334,636	19.2%	397,310	17.7%
total with electricity	**465,421**	**91.6%**	**735,359**	**42.2%**	**1,200,781**	**53.4%**
HH with no access	42,665	8.4%	1,005,727	57.8%	1,048,392	46.6%
Total HH	508,086	100.0%	1,741,087	100.0%	2,249,173	100.0%

2.43 Other notable features of access patterns include:

- widespread interconnection of family-owned systems to neighbors. Of 58,795 family-owned self generation systems, 67% also serve neighboring households.

- there are very few households served by privately owned systems; by far the largest number of rural households who do not have grid access are served by village/community-based systems.
- of the total households that do not have access (1,048,392), 96% (1,005,727) are in rural areas. As expected, lack of access to electricity is a rural issue.

2.44 The connection fees for electricity are YR10,000 in rural areas and YR25,000 in urban areas. Most poor and very poor households in urban and rural areas alike regard the initial cost of electricity connections as a significant obstacle to access. The PRA reported that to avoid paying high connection fees, some poor households in urban areas connect illegally to a neighbor's line and pay them YR700-900 per month. In some cases, households make illegal direct connections to the power lines. In part, those who connect illegally do so to avoid paying the connection charges. Respondents suggested smoothing payments throughout the year to lower the costs.

> *"If access fees to electricity were smaller and payable in installments, poverty would be reduced."* PRA Focus Group in village of Hawk with well-off women

2.45 Only three of the twelve localities in the research sample of the PRA were connected to grid electricity. Respondents in a poor urban neighborhood in the Western Coast claimed that in attempting to obtain PEC grid service they were faced with numerous obstacles. It was not clear to them who should submit a request on their behalf, should it be the *aqil*, the governor or the district council? There was confusion over who had the right to authorize the budget for the grid extension: the local council, the governor or the PEC in Sana'a?

2.46 Households with good negotiating skills or personal connections are able to make arrangements for installment payments during the more expensive peak consumption periods, although this is not a standard PEC practice. Different types of payment arrangements are based on the relationship between a PEC officer and the client.

2.47 PEC suffers from a range of financial and institutional problems, whose resolution is outside the scope of this report. The concern of this report is to identify the issues from the perspective of household electricity consumers.

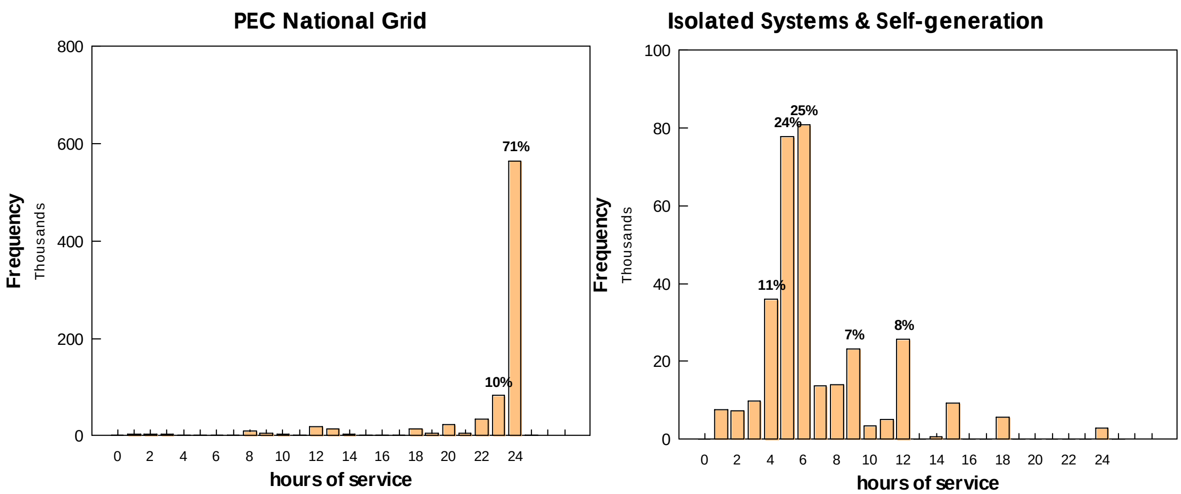
Service Reliability

2.48 As expected, there are significant differences in service quality between grid connected customers, and those connected to isolated systems and self-generation sets. The survey asked households to report average hours of service per day and the results are shown in Table 2.10. 83% of grid connected customers reported 23-24 hours of service per day, whereas the bulk of self-generation and mini-grid customers reported service for 4-6 hours per day. Surprisingly, there are few differences between PEC's urban and rural customers.

Table 2.10: Hours of Service

	PEC grid			*Isolated systems*					*All*
Hours of service	***Urban areas***	***Rural areas***	***Total***	***PEC***	***Coops***	***private***	***Village***	***Neighbor***	***Isolated systems***
1	1%		1%	10%	5%				2%
2		1%		8%	6%			1%	2%
3		1%		7%			3%	1%	3%
4		1%			3%		17%	12%	11%
5				1%	12%		29%	49%	24%
6				34%	21%	100%	23%	23%	25%
7				1%			7%		4%
8	2%		1%	14%	5%		1%	5%	4%
9	1%		1%		30%		5%		7%
10				2%	1%		1%	1%	1%
11				7%	1%			2%	2%
12	2%	3%	2%	5%			13%		8%
13	4%		2%						
14		1%						1%	
15					16%			4%	3%
16									
17									
18	1%	3%	2%	11%					2%
19		1%	1%						
20	1%	5%	3%						
21	1%	1%	1%		1%				
22	2%	6%	4%						
23	6%	14%	10%						
24	77%	64%	71%				1%		1%

Figure 2.8: Hours of Service, All Isolated Systems & Self-generation Sets



3

Patterns of Household Energy Use

3.1 Although Yemen has done much to improve access to energy services over the past decade, inadequacies in access, quality and efficiency remain, and these are most acute in rural areas. Since poverty in Yemen is also largely a rural phenomenon, it is the poor who experience these problems most acutely. The lower income deciles report the lowest access rates to LPG and electricity, and even with access, consume significantly lower amounts. Rural areas also experience far higher prices. Social infrastructure in rural areas does not have adequate energy service to ensure efficient operation. For example, clinics, schools and local government offices lack adequate energy services.

3.2 Table 3.1 summarizes the data on household access to electricity and fuels. Households typically use more than one fuel. For example, while 93% of urban households use LPG, 46% also use kerosene and 24% use fuelwood indicating that many households use a range of fuels for cooking and also for lighting. Even households in the highest income deciles purchase some wood for cooking and continue to use kerosene and LPG for lighting even though they have electricity grid access. Poor families use combinations of collected fuelwood, crop residue, dung, and kerosene (probably as a starter fuel) and LPG. In major urban areas (Sana'a and Aden) almost all households (even the poorest) use some LPG. Thus it appears that households use a range of fuels (i.e. they manage a portfolio of fuels) for cooking and lighting to cope with supply disruptions and shortages, variations in prices and because wood is a preferred fuel for preparation of some foods for reasons of taste. Only 4% of all rural households and only 3% of the poorest households use diesel for pumping or in generators or for any other direct use.

Table 3.1: Percentage of Households Reporting Use of Each Fuel

	Urban	*Rural*	***Total***	***Lowest decile***	***Highest decile***
Electricity	92	42	53	22	82
PEC grid	80	23	36	11	62
Non-grid, incl. self-generation	12	19	18	9	19
No access to electricity	8	58	47	78	18
LPG	93	74	78	49	93
Diesel	4	13	11	3	34
Kerosene	46	83	75	92	57
Fuelwood	36	85	74	80	66
of which purchased	24	24	24	13	36
Charcoal	43	11	18	9	31
Crop residue	3	26	23	24	20
of which purchased	<0.5	1	1	<0.3	2

Cooking

3.3 Table 3.2 summarizes appliance ownership and patterns of cooking and lighting. Poor and very poor households limit their cooking to once a day (usually lunch) and prepare foods that require less energy in their preparation such as tea, coffee and porridge. Foods that require more energy and slow cooking, such as meat, tend to be cooked using wood. Those that require less energy, such as fish stews may be cooked over LPG. Poor and very poor households consume little meat and when they do, it is *daka* (minced meat) which lends the dish a meat flavor and requires less fuel to cook. The better off social categories use the *tanoor* that requires the more costly and higher quality wood but which is more energy efficient. It also allows for simultaneously baking bread and cooking meat.

Table 3.2: Household Cooking Patterns

	*Well-Off**	*Poor**	*Very Poor**
Main cooking energy source	LPG for stews	Kerosene for stews	Wood for stews
Secondary cooking energy source	Wood for meat & bread	Wood for rice & tea	Wood for tea
Time spent cooking main meal	30 minutes	60 minutes	90 minutes
1. Meals cooked per day	Three full meals	Two meals and snack	One meal
2. Cooking appliances	LPG stove, *tanoor*, kerosene stove	Kerosene stove, *tanoor*	*Massad & mawqad*
Lighting fuel	Generator LPG Kerosene	Kerosene	Kerosene
Lighting appliances Equipment	Pressurized kerosene storm lantern, 1Liter LPG lantern	Pressurized kerosene storm lantern, ½ L	Wick dipped in tin receptacle

The social categories of the PRA are not the same as the income deciles of the HES 2003. See Volume 2, Annex 2 for definition of the PRA social categories.

Photo 3.1

Massad

Mawqad

3.4 Very poor households in rural areas are most dependent on wood for cooking all meals (rice, stews, tea) and cook on a "three stone" open fire, *massad*, or a half-enclosed home-made stove, *mawqad* (Photo 3.1). Both the *mawqad* and the *massad* are less efficient than the *tanoor* and only one item can be cooked at a time on them. In the highlands, where sub-zero temperatures are not uncommon during the cold season, households also use wood to heat the kitchen area where family members congregate. Urban households use significantly less wood than rural families. But even there, well-off households purchase it to grill meat on special occasions. Very poor urban households rely on wood to cook their main daily meal (stews, tea, rice, etc.) using kerosene as a starter fuel. The poorer the household, the fewer the number of meals they will consume and the smaller the portions of energy consumed.

HES Findings

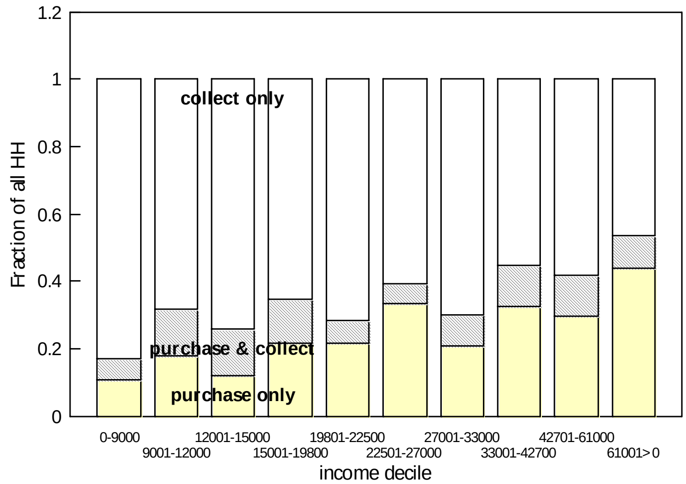
3.5 Four types of biomass fuel were examined in the HES: fuelwood, charcoal, crop residues, and dung. Despite the large-scale uptake of LPG, a surprising 74% of all households report use of firewood (Table 3.3). The rate of decline with increasing income is modest: while 80% of households in the lowest income decile report fuelwood use, this declines only to around 70% in the middle deciles, and 66% in the top decile.

Table 3.3: Percentage of Households Using Biomass Fuels

Decile	*Fuelwood*	*Charcoal*	*Crop residue*	*Dung*
1	80	8	24	12
2	82	12	24	19
3	84	11	31	27
4	82	15	30	22
5	70	11	22	19
6	71	18	18	13
7	70	24	19	15
8	71	19	22	18
9	59	20	19	18
10	66	30	20	21
All deciles	74	17	23	18

3.6 As expected, the extent to which fuelwood is purchased is strongly dependent upon income (Figure 3.1). In the bottom decile, only 17% purchase fuel wood, as opposed to 54% in the top decile.

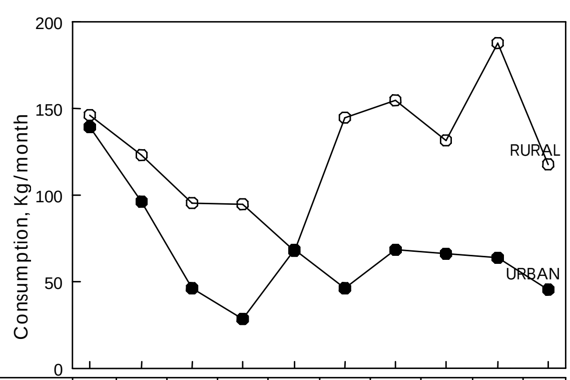
Figure 3.1: Method of Obtaining Fuelwood



3.7 The patterns of fuelwood consumption per decile are noteworthy: the poorest deciles consume larger quantities (much of it collected) than the middle deciles; consumption increases again in the upper deciles of rural areas (Figure 3.2). Evidently there is a cultural preference for wood, which higher income households manage by purchase (rather than spending time for collection).

3.8 Thus households use a number of different combinations of fuels for cooking, including all forms of biomass (crop residues, charcoal, fuelwood and dung) as well as kerosene and LPG. The permutation of combinations prevents display in the same form as for lighting. Figure 3.3 shows the fraction of rural households reporting use of each fuel: because of multiple fuel use, the sum is greater than 100%.

Figure 3.2: Consumption of Fuelwood by Decile, kg/HH/month



	d[1]	d[2]	d[3]	d[4]	d[5]	d[6]	d[7]	d[8]	d[9]	d[10]
● URBAN	139	96	46	28	69	46	68	66	64	46
⊖ RURAL	146	123	96	95	68	145	155	131	188	117

3.9 Households usually do not rely on just one means of cooking. Many households use simple three stone fires for cooking. In rural areas 47% of households in the lowest income decile have such a fire and although their use falls off with increasing income, 16% of households in the highest income decile still use simple stone fires. Consistent with LPG consumption patterns, ownership of LPG stoves is quite high in the lower income deciles (42% in the lowest) rising to 93% in the highest in rural areas. Kerosene stoves, firewood stoves and firewood *tanoors* are used in all income groups and in rural and urban areas. Experience from other countries suggests that smoke inhalation from simple stone fires contributes to the burden of respiratory disease in Yemen.

Table 3.4: Ownership of Selected Cooking Appliances as % of Total Households

A. Rural Households

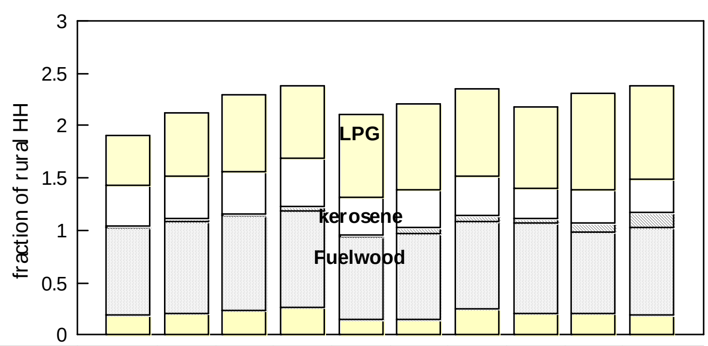
	[1]	*d[2]*	*d[3]*	*d[4]*	*d [5]*	*d [6]*	*d [7]*	*d [8]*	*d [9]*	*d [10]*
Simple 3-stone *Massad*	47%	33%	35%	39%	24%	23%	14%	28%	23%	16%
Firewood stove	58%	63%	81%	81%	61%	69%	69%	77%	70%	78%
Tanoor-firewood	34%	31%	39%	50%	36%	37%	44%	41%	39%	34%
Kerosene stove	22%	23%	22%	23%	17%	14%	20%	14%	12%	6%
LPG stove	42%	63%	72%	70%	79%	82%	84%	81%	91%	93%

B. Urban Households

	d[1]	*d[2]*	*d[3]*	*d[4]*	*d [5]*	*d [6]*	*d [7]*	*d [8]*	*d [9]*	*d [10]*
Simple 3-stone Massad	20%	17%	8%	8%	8%	10%	7%	2%	6%	1%
Firewood stove	31%	27%	24%	29%	23%	24%	29%	29%	17%	24%
Tanoor-firewood	24%	31%	16%	21%	26%	18%	17%	16%	12%	15%
Kerosene stove	29%	33%	7%	16%	17%	14%	20%	14%	12%	6%
LPG stove	72%	62%	69%	64%	77%	78%	82%	77%	88%	90%

Note: These data are for all households in each income decile.

Figure 3.3: Cooking Fuels, Rural Households

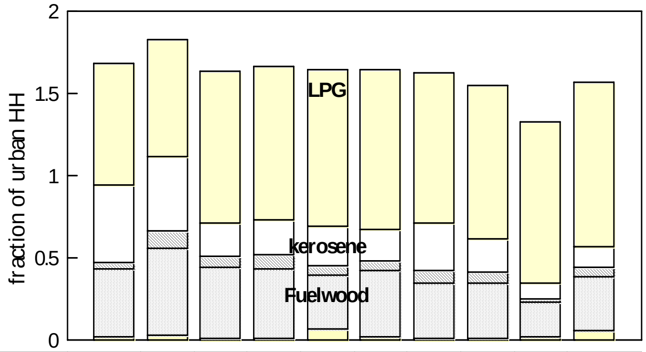


income decile	d[1]	d[2]	d[3]	d[4]	d[5]	d[6]	d[7]	d[8]	d[9]	d[10]
Crop residue	19%	21%	24%	27%	15%	16%	24%	21%	21%	19%
Fuelwood	84%	88%	91%	93%	78%	82%	85%	86%	77%	83%
charcoal	1%	3%	1%	4%	3%	5%	5%	4%	8%	15%
kerosene	39%	40%	40%	46%	35%	36%	37%	29%	32%	31%
LPG	47%	60%	73%	68%	79%	82%	84%	78%	92%	90%

Note: The data in Figure 3.3 represent the percentages of households in each income decile that use the stated fuel.

3.10 Figure 3.4 shows the corresponding patterns in urban areas: here crop residue and dung are hardly used (as expected).

Figure 3.4: Cooking Fuels, Urban Households



income decile	d[1]	d[2]	d[3]	d[4]	d[5]	d[6]	d[7]	d[8]	d[9]	d[10]
Crop residue	2%	3%	1%	2%	7%	2%	1%	1%	2%	7%
Fuelwood	41%	53%	43%	42%	33%	40%	34%	34%	21%	32%
charcoal	3%	10%	7%	8%	5%	5%	8%	7%	2%	6%
kerosene	48%	46%	21%	21%	24%	20%	29%	20%	9%	12%
LPG	74%	70%	92%	94%	95%	96%	91%	93%	98%	100%

Note: The data in Figure 3.4 represent the percentages of households in each income decile that use the stated fuel.

3.11 These results show that differences between urban and rural households are greater than the differences across the income deciles. This is explained by the availability of significant quantities of biomass in the rural areas.

Recommendations for Sustainable Fuelwood Supply and Use

3.12 A recommendation of the study is that measures to ensure sustainable fuelwood supply and use needs to be part of the Government's household energy strategy, as a proportion of poor households will continue to be dependent on fuelwood for cooking and heating and even well-off households will continue to use it. Improvement in stoves (raising energy efficiency to 20-30% compared to about 10-15% or less for the traditional design of stoves in use today – the three-stone fire (*massad*) and the enclosed *mawqad*) can substantially reduce the quantity of firewood required for cooking and heating. Improving the design of the stoves in use today and/or adopting modern biomass stoves can not only reduce cash outlays for fuel, it can also reduce the time spent collecting firewood, improve indoor air quality (with positive impacts on the health of women and children) and relieve local pressure on wood resources.

3.13 Although in the very long term, all Yemeni households may well switch to cooking with LPG, natural gas or electricity, in the medium term, many households will continue to use fuelwood and fuelwood stoves. However not all of these people can or should be reached with improved stove programs. Some would be better encouraged to move up the energy ladder to more modern fuels. Others may not be subjected to fuel shortages or high indoor smoke levels. In designing an improved stove program in any particular locality in Yemen, it will be necessary first to evaluate if the potential economic, social, and environmental benefits are sufficient to be worth pursuing.

3.14 It is likely that the right conditions exist in many localities in Yemen so that the social, economic, and environmental benefits of promoting improved stoves will be realized. A program should be targeted at localities where people are using crop residues because fuelwood is not available and at localities where people already paying high prices for fuelwood and/or are walking long distances to collect fuelwood. A feature of successful programs in other countries has been the intensive interaction between designers, producers and users of stoves and the recognition that successful programs call for a multidisciplinary approach which embraces the technical, social, economic, environmental and health issues that are involved.

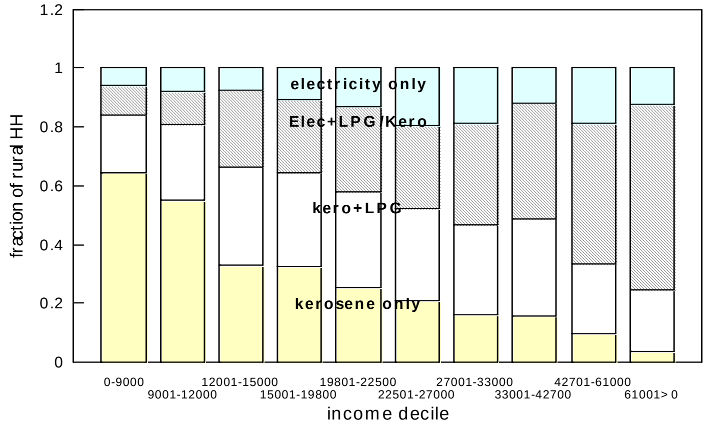
3.15 Yet, despite the apparent benefits of improved stoves, many developing-country households have failed to adopt them. Elements of an improved cooking stove program may include criteria for approving stove projects, credit facilities for stove makers and promotional support. Monitoring and evaluation would cover the acceptance and adoption of improved cook stoves and changes in fuelwood use, indoor air quality and exposure of household members to harmful emissions from cooking stoves. The design and implementation of an improved stove program that meets all the criteria of a successful program is a considerable challenge.

Lighting

3.16 Figure 3.5 shows the use of different fuels used for lighting in rural households, as a function of income. In all cases LPG is used as a lighting fuel either in conjunction with electricity or kerosene. However, the dependence on kerosene as the *sole* lighting fuel drops sharply with increasing income – from over 60% in the bottom income decile to less than 4% in the top decile. One may conclude that households move away from kerosene as soon as income permits the use of LPG and/or electricity for lighting areas where lighting quality is valued – but that kerosene is still used as a supplementary lighting source because of low cost.

3.17 Indeed, even in the richest decile, where 75% have access to electricity, only 12% of households use electricity exclusively for lighting – a reflection of the high cost of rural electricity noted in Section 4 (and/or of the very low cost of kerosene and LPG). Thus electricity tends to be used for applications where there is no substitute (TVs, fans, fridges, etc), or where the substitute (such as dry cells) is extremely expensive.

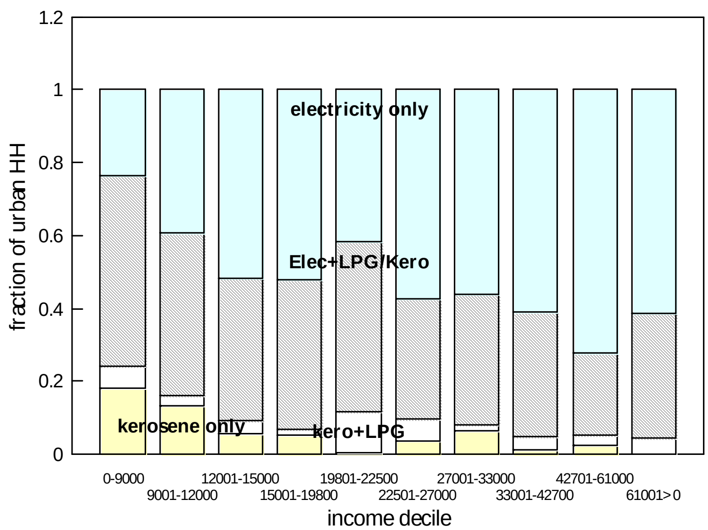
Figure 3.5: Fuel Substitution for Lighting, Rural Households



Note: The data in Figure 3.5 are for all households in each income decile

3.18 The situation in urban areas is quite different (though again there are no households that use *only* LPG for lighting). With even 75.8% of the poorest decile having access to electricity (see Fig 3.10 below), very few households use kerosene only for lighting. In the poorest 10% (see Figure 3.6), the predominant pattern among electrified households is to continue to use kerosene for lighting – a reflection of the high perceived cost of electricity. In the top income decile close to 60% of all households use electricity exclusively for lighting, though even here, 34% of households also use some kerosene.

Figure 3.6: Fuel Substitution for Lighting, Urban Households



Note: The data in Figure 3.6 are for all households in each income decile

Energy Consumption and Preferences

Kerosene

3.19 Kerosene is available year round, but prices vary seasonally in rural areas, especially in areas without all-weather roads. Very poor and poor households cope by traveling to locations where they can purchase kerosene more cheaply, by borrowing small amounts from neighbors and by either collecting or buying more wood.

3.20 In the PRA, women expressed a strong dislike for cooking with kerosene, explaining that its bad smell affects the taste of food and causes headaches. Respondents throughout the study area also described kerosene as a safety risk. Both men and women also dislike the poor quality of kerosene light, which they say is insufficient for doing any type of work at night. Parents complained that children are unable to study or do their homework with a kerosene lamp. Very poor households use a simple tin receptacle with a wick dipped in kerosene (Photo 3.2) that is not much brighter than a candle. Respondents explained that the lack of indoor lighting forces the household to gather in a single room.

Photo 3.2: Simple Kerosene Lamp

Table 3.5: Kerosene Use by Social Category and Purpose

Location		*Well-off(a)*	*Poor(a)*	*Very poor(a)*
Rural urban	Lighting	A supplement to generator power or LPG	Main source of light	Sole source of lighting
		Own a 1 liter pressurized kerosene storm lantern	Own a ½ liter pressurized kerosene storm lantern	Own a small can dipped in a simple wick
Urban	Cooking	Use it to ignite wood for cooking	Primary source of energy	Use it in combination with wood
	Lighting	Not used	In combination with electricity	Sole source

Note: (a) The social categories of the PRA are not the same as the income deciles of the HES 2003. See Annex 2 for definition of the PRA social categories.

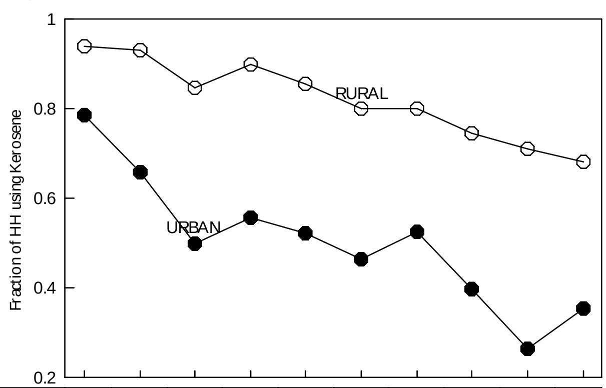
3.21 However the expectation that kerosene is used primarily by the poor is **not** confirmed by the survey. 92% of the poorest households report kerosene use, but 57% of the richest decile also reports kerosene use. Indeed, as shown in Table 3.6, monthly consumption of households using kerosene varies very little across income deciles (between 15 and 19 liters/month).

Table 3.6: Kerosene Use by Income Decile

Income by decile (YR/month)	***%HH reporting use***			***Consumption,*** *[liters/month]*			***Consumption,[10^6 liters/year]***		
	Urban	Rural	All	Urban	Rural	All	Urban	Rural	All
1 0-9000	79%	94%	92%	8	10	10	1	17	18
2 9001-12000	66%	93%	89%	10	11	11	2	16	18
3 12001-15000	50%	85%	80%	10	11	11	2	16	17
4 15001-19800	56%	90%	83%	6	11	11	1	12	13
5 19801-22500	52%	86%	79%	6	9	8	1	11	12
6 22501-27000	46%	80%	71%	7	10	9	1	11	12
7 27001-33000	52%	80%	72%	9	11	11	2	12	14
8 33001-42700	40%	74%	64%	8	11	10	1	10	11
9 42701-61000	27%	71%	57%	7	11	10	1	9	10
10 61001>0	35%	68%	57%	7	11	10	1	9	10
average	46%	83%	75%	8	10	10	14	121	135

Note: The consumption data in Table 3.6 represent the average consumption for households in each income decile that do consume kerosene (i.e. not averaged across all households in the income decile, for which the average consumption would be lower).

Figure 3.7: Kerosene Use by Income Decile



	d[1]	d[2]	d[3]	d[4]	d[5]	d[6]	d[7]	d[8]	d[9]	d[10]
● URBAN	79%	66%	50%	56%	52%	46%	52%	40%	27%	35%
⊖ RURAL	94%	93%	85%	90%	86%	80%	80%	74%	71%	68%

3.22 In the case of kerosene use, what varies by income decile is not the quantity of kerosene used, but the percentage of households using kerosene. Thus, for example, 40% of households in the bottom decile use kerosene for cooking, but only 13% of households do so in the top decile. But for those households using kerosene for this purpose, monthly consumption increases only from 11 liters/HH/month in the bottom decile, to 13 liters/ household/month in the top decile.

LPG

3.23 LPG lanterns are a status symbol in rural areas without electricity and are considered to have a high aesthetic value. The intensity of LPG-supplied light is high enough for nighttime tasks, although the high running cost makes LPG lanterns too expensive for regular use. They tend to be used when entertaining guests or as a substitute for generator light during power outages. LPG is not, therefore, used as a primary source for lighting.

3.24 Table 3.7 shows LPG usage by social category.

Table 3.7: Uses of LPG by Social Category

	Well-Off	*Poor*	*Very Poor*
Frequency of cooking with LPG and types of meals prepared	Several meals a day: stews, rice, fish, meat and bread.	Main meal of the day, lunch stews in combination with Kerosene or wood.	Rarely use LPG. When they do, it is for cooking Friday meals.
Quantities consumed	2 cylinders (11 kilo cylinder) per month in combination with wood	1 cylinder per month in combination with wood and kerosene	
LPG related equipment for cooking – All areas	4 burner stove	Two burner stove	Two burner stove
LPG related equipment in rural areas	LPG tanoor	---	---

Table 3.8: Cost of LPG Related Equipment

LPG Related Equipment in Bajil(a)	***Cost in rials***
11 kilo cylinder	2,500-3,000
2 burner stove (Chinese made or locally made)	1,200-1,600
3 burner stove	2,000-2,200
4 burner stove with oven	10,000-15,000
LPG tanoor (bread oven)	5,000-9,000

Note: (a) Village located on the western coast, with very poor road accessibility

3.25 The PRA found that storekeepers are unlikely to extend credit for the purchase of LPG (in contrast to kerosene), especially for the poor and very poor. In some instances, well-off households can obtain credit for a few days to purchase LPG refills. In some instances, village development associations provide credit for the purchase of LPG cylinders and related equipment (see Table 3.8 for prices). This type of credit is rare and is realized through the support of external aid agencies in villages with a high degree of social solidarity. An example is the village of Khamis Bani Sa'd in Al Mahwit governorate. There villagers also spoke of the LPG credit initiative as part of the association's effort to help women participate more in productive activity.

> *"If I use too much LPG to cook, it means that my children will have less to eat. So, I ration how much I use."*
> *Poor woman from Nuba.*

3.26 The PRA found that households in rural areas run a greater risk of purchasing faulty or deficient cylinders, since distributors try to "dump" those rejected by urban dwellers, especially when they are in short supply. Damage to cylinders is also caused by the way in which they are transported. In rural areas, LPG cylinders are rolled along pathways over several kilometers where they can easily be dented or damaged.

3.27 Table 3.9 shows the results of the survey for LPG. LPG use by income decile ranges from 50% in the poorest decile, to 94% in the top decile (or 78% of all households).

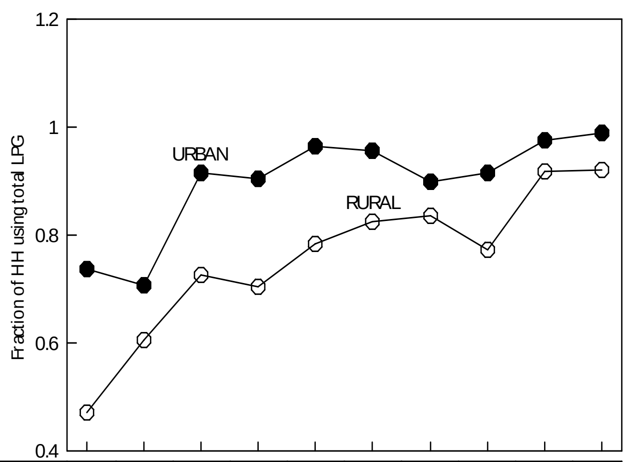
Table 3.9: LPG Use by Income Decile

		%HH reporting use			*Consumption (Kg/month)*			*Consumption (1000 tons/year)*		
Decile	*YR*	*Urban*	*Rural*	*All*	*Urban*	*Rural*	*All*	*Urban*	*Rural*	*All*
1	0-9000	74%	47%	50%	21	20	20	4	24	28
2	9001-12000	71%	60%	62%	24	22	22	7	31	39
3	12001-15000	91%	73%	75%	23	22	22	9	41	51
4	15001-19800	90%	70%	74%	21	23	22	9	28	37
5	19801-22500	96%	78%	82%	23	24	24	12	43	55
6	22501-27000	96%	82%	86%	23	24	24	15	41	56
7	27001-33000	90%	83%	85%	24	30	28	17	48	65
8	33001-42700	91%	77%	81%	24	27	26	18	41	58
9	42701-61000	97%	92%	94%	24	32	29	20	54	75
10	61001>0	99%	92%	94%	31	38	36	27	63	91
	average	92%	74%	78%	25	26	26	139	415	555

Note: The consumption data of Table 3.9 represent the average consumption for households in each income decile that consume LPG (i.e. not averaged across all households in the income decile, for which the average consumption would be lower).

3.28 Across all income deciles, urban access is greater then rural access (Figure 3.8).

Figure 3.8: Urban Versus Rural Access to LPG



	d[1]	d[2]	d[3]	d[4]	d[5]	d[6]	d[7]	d[8]	d[9]	d[10]
● URBAN	74%	71%	91%	90%	96%	96%	90%	91%	97%	99%
⊖ RURAL	47%	60%	73%	70%	78%	82%	83%	77%	92%	92%

3.29 In the major urban areas (such as Sana'a and Aden), LPG is used by more than 97% of households, even in the poorest income groups. In most, LPG use increases with income as expected: on average just 50% of households in the poorest income decile use LPG, rising to close to 100% in the top decile. Al Hodeiah has the greatest variation across income deciles, with only 4% of the lowest income decile using LPG.

Photo 3.3: LPG Delivery in Sana'a

Diesel

3.30 Remote areas suffer supply interruptions which can last three to six days a month due to difficulty in transporting diesel from the nearest retail outlet or because of unavailability due to religious holidays. In areas where there are no filling stations, village shops sell diesel in small quantities. In areas without grid electricity, well-off households that own generators may provide electricity to their neighbors for a fee that ranges up to about YR500 a month. The fees are based on the estimated amount of electricity consumed, which depends on equipment in the household (e.g. TV and number of light bulbs). Diesel consumption for generator use varies from 2.8 to 5 liters per day for a maximum of four to six hours of use. In areas that are accessible by road, the cost of operating a generator for a single household is about YR1,600 per month. A similar household in a more remote, difficult-to-access area would pay YR1,900.

3.31 Table 3.10 shows the results of the HES survey for diesel. Direct use of diesel by income decile ranges from 3% in the poorest decile, to 34% in the top decile.

Table 3.10: Diesel Use by Income Decile

	%HH reporting use			*Consumption (liter/month)*			*Consumption (10^6 liters/year)*		
	Urban	Rural	All	Urban	Rural	All	Urban	Rural	All
1 0-9000	4%	3%	3%	172	35	55	2	3	5
2 9001-12000	0%	3%	2%	274	40	43	0	2	3
3 12001-15000	3%	7%	6%	3	119	111	0	21	21
4 15001-19800	1%	11%	9%	71	96	95	0	18	18
5 19801-22500	3%	10%	9%	26	130	124	0	29	29
6 22501-27000	4%	6%	6%	86	98	96	2	13	15
7 27001-33000	2%	17%	13%	45	169	163	1	56	57
8 33001-42700	5%	15%	12%	115	203	196	5	57	62
9 42701-61000	6%	23%	18%	184	175	176	10	74	84
10 61001>0	10%	45%	34%	185	217	214	16	176	192
average	4%	13%	11%	139	167	164	38	448	486

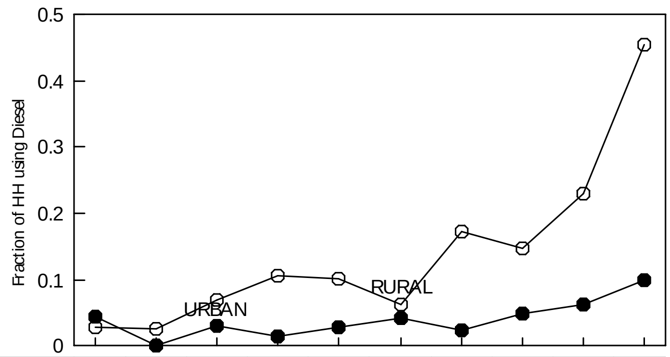
3.32 Table 3.11 also shows the proportion of households reporting diesel consumption in the survey, broken down by categories. 6.9% of all households report diesel use for agriculture, but only 2.8 for self-generation. Note the strong relationship to income decile: 34% of households in the top decile report diesel use, as opposed to 3% in the bottom decile. The largest reported use of diesel is for agriculture: 22.1 million liters of the total of 45 million liters per month is reported as used for this purpose. Diesel for self-generation is the second largest use, accounting for 14 million liters/month.

Table 3.11: Proportion of Households Reporting Diesel Use

Decile	*YR/month*	*Transport-tation*	*Water pumping*	*Agriculture*	*Business*	*Other*	*Self-generation*	*Any diesel use*
1	0-9000	0.1%	0.0%	1.6%	0.0%	1.0%	0.4%	3.0%
2	9001-12000	0.0%	0.1%	1.7%	0.0%	0.3%	0.0%	2.1%
3	12001-15000	0.6%	0.1%	3.5%	0.0%	2.9%	1.8%	6.4%
4	15001-19800	0.0%	0.2%	6.5%	0.5%	1.6%	1.4%	8.7%
5	19801-22500	0.5%	0.2%	5.0%	0.5%	2.3%	2.9%	8.7%
6	22501-27000	0.9%	0.1%	4.2%	0.3%	0.7%	0.6%	5.8%
7	27001-33000	1.5%	0.9%	7.0%	0.1%	1.2%	4.1%	12.9%
8	33001-42700	2.0%	1.2%	6.6%	0.0%	1.4%	5.0%	11.9%
9	42701-61000	3.1%	1.5%	12.2%	0.3%	1.9%	3.0%	17.6%
10	61001>0	9.4%	2.6%	21.8%	3.0%	5.6%	8.9%	33.6%
	Average	1.8%	0.7%	6.9%	0.5%	1.9%	2.8%	11.0%

3.33 Given the predominance of irrigation pumping in the use of diesel, there are sharp differences between urban and rural households. 45% of rural households in the top decile use diesel, as opposed to only 10% in urban areas (Figure 3.9).

Figure 3.9: Proportion of Households Using Diesel



	d[1]	d[2]	d[3]	d[4]	d[5]	d[6]	d[7]	d[8]	d[9]	d[10]
● URBAN	4%	0%	3%	1%	3%	4%	2%	5%	6%	10%
⊖ RURAL	3%	3%	7%	11%	10%	6%	17%	15%	23%	45%

Other

3.34 *Car batteries.* In rural areas, mostly well-off households use both standard wet cell car and heavy truck batteries for operating TVs. Car batteries are seen as a luxury good because they are very expensive. Depending on size, a second- hand battery costs between YR2,000-4,000 and a brand new one costs YR6,000-8,000. The recharge costs between YR50 and 200. The batteries are often recharged in car repair shops.

3.35 *Dry cell batteries.* These are infrequently used, primarily for flashlights in rural areas and for radios which, women complained, tend to be monopolized by men. Dry cell batteries are available in neighborhood shops and, like kerosene, can easily be obtained on credit. Nearly all social categories prefer buying the lower cost alkaline batteries which are of poorer quality.

Gender Issues in Energy Use

Findings of the PRA

3.36 The PRA found that women and girls are more involved than men and boys in wood and other biomass collection. In rural areas, regardless of social category, women and especially girls of 10 years and older are responsible for collecting wood. They go out in small groups of five or six from neighboring households and collect fallen branches, twigs and leaves, or snap off dead wood, thus preserving the life of the tree. A child carries roughly 10kg on her head and a grown woman can carry 15-20kg. Used exclusively for this purpose, 15-20kg of wood can cook about four meals for an average household of seven.

3.37 Respondents pointed out that collection poses a risk of injury in hilly terrain. Respondents consistently pointed out that fuelwood collection contributes to low school enrolment among girls. Many women throughout the research areas pointed out that concerns about safety where there is no public lighting constrains their ability to move about freely in their communities. The field teams observed that women and girls invariably tend cooking fires and are exposed to indoor smoke.

3.38 However, the results of the survey are somewhat different to the PRA findings in terms of the time spent collecting biomass by household members. As shown in Table 3.12, adult males spend slightly more time than women on fuelwood collection, though girls spend more time than boys. The apparent discrepancy between the PRA and HES findings on participation by male members of households is thought to arise from the phenomena that fuelwood collection is now taking place at ever greater distances from villages, requiring male family members to accompany females. While fuelwood collection is thought of as a woman's and a girl's chore, the reality is that men and boys also participate, though they may perform different tasks during collections (such as cutting fuelwood but not carrying it).

Table 3.12: Fuelwood Collection

	Hours per collection				*Collections /month*
Decile	*adult male*	*adult female*	*girl*	*boy*	
1	3.2	3.4	3.9	2.6	2.0
2	3.1	3.6	3.8	5.9	3.7
3	6.4	4.9	7.3	4.9	2.2
4	6.5	3.7	3.3	4.2	3.9
5	4.6	3.4	4.3	3.3	3.8
6	2.1	3.8	4.9	2.4	3.8
7	7.6	4.2	3.1	2.6	2.8
8	4.7	2.9	2.8	1.6	5.2
9	2.3	3.9	5.2	7.3	3.0
10	5.5	4.5	5.0	4.9	2.1
Average	4.6	3.8	4.4	4.0	3.3

Electricity

Findings of the PRA

3.39 *Uses of electricity*: Primary uses of electricity are for lighting, television and some refrigeration by both well-off and poor households. In the lowlands and coastal areas, electricity is also important for cooling (ventilation or air conditioning) during the hot seasons (Table 3.13). The very poor use electricity primarily for lighting. When refrigeration is available in neighborhood stores, it also extends the benefit indirectly to the very poor as it increases the variety of consumable goods available for purchase.

Table 3.13: Electricity (where available): Use by Social Category and Purpose

Location	*Well-off*	*Poor*	*Very poor*
Rural highland	Main source of lighting Television Refrigeration	Main source of light Television	Not connected
Rural lowland	Main source of lighting Television Refrigeration Fans	3. Main source of light Television	Not connected
Urban	Main source of lighting Television Refrigeration Fans/AC	Main source of light Television	Some households connected, used for lighting

3.40 Rural and urban households both aspired to have access to electricity and insisted that it improved the quality of life, especially through better lighting and the ability to watch TV. Parents also stressed that electricity was an investment in the future as it allowed children to study in the evenings. In areas without electricity, respondents also highlighted that it could generate employment for youths, for example as mechanics repairing cars and charging batteries in mechanized repair shops, or as technicians repairing television sets, generators, or x-ray equipment in health centers.

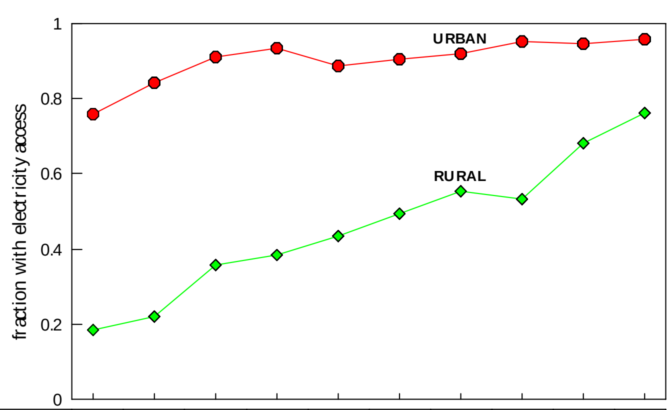
> *"Our area is poor. Our only solution is to attract investors. Access to electricity will create new job opportunities. I will open an ice cream shop."*
> Sheik of Mousseimeer

> *"Watching TV (with electricity) is the defining characteristic of the well-being we hope for."*
> Focus Group well-off women, Hawk

Findings of the HES

3.41 Access to electricity is strongly dependent on income and on the urban/rural divide (Figure 3.10). In the poorest decile, 76% of urban, but only 18.6% of rural households have electricity. However, in the top decile, the difference between urban and rural is much smaller (95% versus 76%).

Figure 3.10: Access to Electricity by Income Decile



Income decile	1	2	3	4	5	6	7	8	9	10
Urban	75.8%	84.2%	90.9%	93.3%	88.5%	90.4%	92.0%	95.3%	94.7%	95.6%
Rural	18.6%	22.0%	35.8%	38.5%	43.5%	49.5%	55.3%	53.3%	68.1%	76.0%

3.42 Indeed, access to electricity is strongly correlated to income. Table 3.14 shows monthly household income by type of access. The average monthly income of those with electricity access, some 41,000 YR/month, is almost double that of households without access.

Table 3.14: Electricity Access and Income

	Electricity access		*Total HH income*
	[HH]	*[%HH]*	*[YR/month]*
PEC national grid	803471	35.7%	43950
In urban areas	402747	17.9%	44573
In rural areas	400724	17.8%	43323
PEC isolated system	56988	2.5%	36428
Coop	53045	2.4%	34684
Private	2328	0.1%	38727
total grid/minigrid access	**915832**	**40.7%**	**42932**
Village/community genset	180017	8.0%	29379
Relative/neighbor genset	39413	1.8%	27880
Family genset	58795	2.6%	50025
Other	6724	0.3%	47817
Total with electricity access	**1200781**	**53.4%**	**40781**
No electricity access	1048392	46.6%	**22282**
Total	2249173	100.0%	

Energy Use in Social Infrastructure

Findings of the PRA

3.43 Throughout the research areas of the PRA it was found that lack of energy services in social institutions affects all households. All inhabitants, regardless of income, complained that they receive inferior services from schools, health centers, mosques and private businesses because these institutions have difficulty accessing modern sources of energy. It was found that the truck battery is the most common form of electricity supply in schools, health centers and mosques throughout the research areas.

> The health unit in the village of Utmah is not operational in part because it has no energy services. A few kilometers outside the village is an old hallowed out tree called the "Tree of Delivery" where many women have given birth on their way to the health center in the district capital. Sometimes the cars run out of petrol on the way to the district and there are no petrol stations on the way. According to one woman of the village, *"If electricity were available, the health unit will become operational again and qualified people would want to work there, saving us time, money and danger; there would be mechanics and petrol stations if cars were to break down on the way to the district health center."*

3.44 Fully equipped health units in three of the PRA research localities had virtually closed down because there was no electricity; one clinic had a generator but was abandoned once the generator or essential appliances and equipments such as refrigerators or x-ray equipment had broken down. Women throughout the research areas stressed the need for lighting in health units to enable midwives to attend to women giving birth. The operating hours of health units are restricted to daytime because of the lack of light.

> *"If there were electricity, the health unit could become operational which will attract good doctors to come here and we could also store drugs in the refrigerators until it's needed*." Poor woman in Mouthkehira

3.45 Several of the schools in PRA research rural localities had no classrooms. Some lessons were held under trees. One was held under the staircase of the local Sheik's house. None of the rural schools had lighting. The bigger school districts have a morning and afternoon shift but classes must end by 4:45 p.m. due to lack of light. Schools and mosques use car batteries to power their microphones. In the few institutions that have grid electricity, PEC has difficulty collecting payments. The costs of charging car batteries are collected from the school students. Mosques use kerosene for lighting and funds are collected from charitable individuals.

> "*It is very very difficult for a woman to leave her house after sunset because the streets are dark,"* said one woman from a poor urban neighborhood.

3.46 Table 3.15 summarizes energy services available in the PRA research areas.

Table 3.15: Summary of Institutional Usage of Energy Services

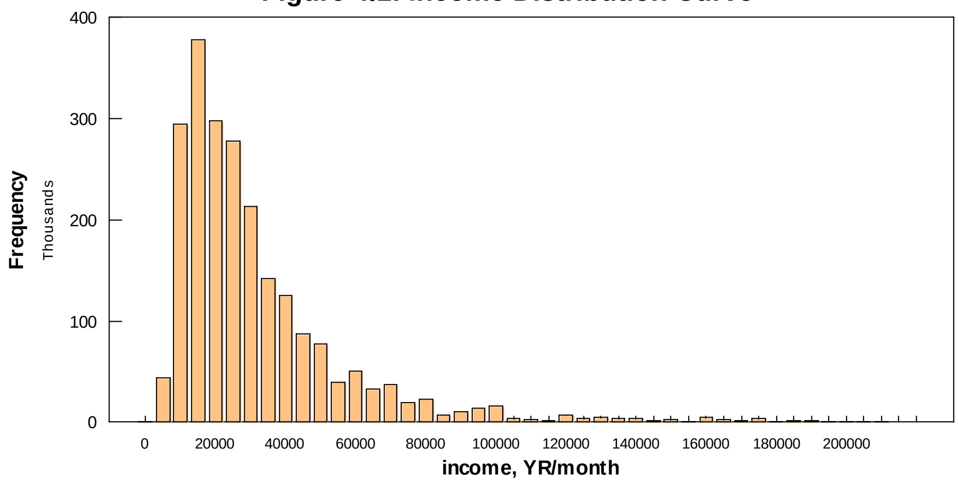
Type of institution	*Number in sample*	*Type of energy source*	*Type of equipment*	*Uses*
Schools without electricity	10	Truck/car battery	Microphone and amplifier	Announcements
Schools with electricity	2	Grid electricity	Fans Bulbs Cassette player microphone	Cooling Lighting Media Announcements
Health center without electricity	7	Truck battery	12 volt fans light bulb	Cooling lighting
Health centers with generator	1	Generator	Fan Bulbs Mobile phone	Cooling Lighting Communications
Health centers with grid electricity	2	Grid Electricity	Bulbs Electric kettle Fans X-ray	Lighting Disinfection Cooling
Mosque		Truck/car battery	Microphone & amplifier	Calls to prayer
		Kerosene	Lamp	Lighting

4

Household Energy Prices and Expenditures

4.1 The 2003 HES was designed to assess energy access, consumption and expenditure in the context of patterns of household expenditure and as a function of relative income. The survey therefore included questions on income and expenditure. Income deciles were defined on the basis of reported income of each surveyed household. Figure 4.1 shows the overall income distribution curve based on household income as reported in the survey.

Figure 4.1: Income Distribution Curve

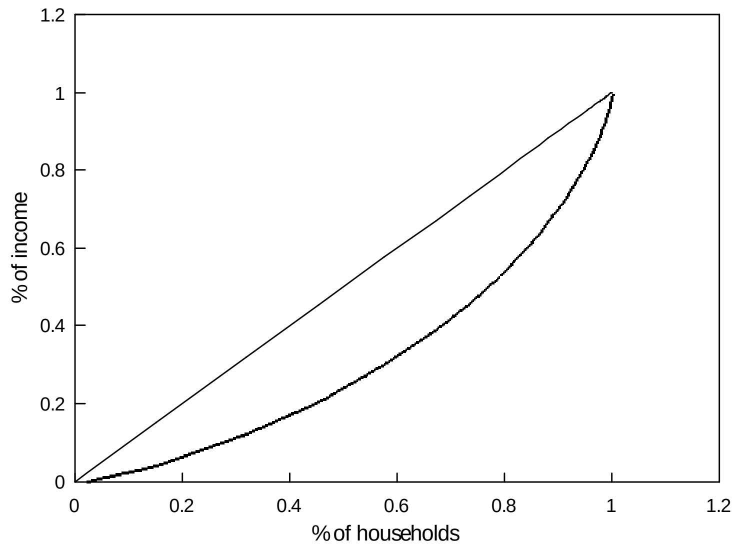


4.2 The corresponding Lorenz curve, which plots cumulative % of income against cumulative % of households is shown in Figure 4.2. The calculated Gini coefficient[10] is 0.382, comparable to the value of 0.33 reported in the 2003 HDR (that is likely based on the 1998 Household Budget Survey).[11]

[10] A coefficient of 0 indicates perfect equality, a value of 1 perfect inequality.

[11] The Gini coefficient for historically equalitarian countries of Eastern Europe is between 0.2 and 0.3 (e.g. Poland 0.27, Hungary 0.279) to 0.5-0.6 for Central and South American countries (Guatemala 0.59, Brazil 0.6). Cuba's Gini index fell from 0.55 in 1953 to 0.2 by the mid-1980s. On the other hand, inequality has grown in the US, rising from 0.35 in the 1970s to around 0.4 presently.

Figure 4.2: The Lorenz Curve for Yemen



The Petroleum Product Pricing System

4.3 Petroleum products are subject to an administered pricing system that determines the price at the distribution plant gate. Table 4.1 shows the present structure.

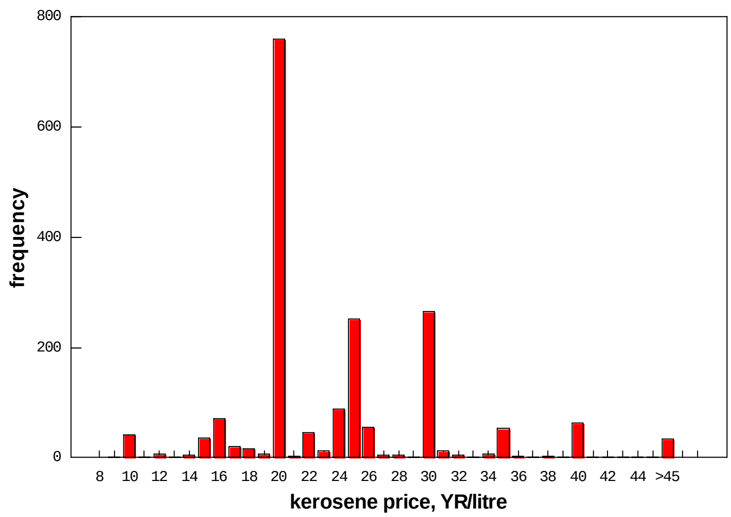
Table 4.1: Retail Price Structure for Petroleum Products

	LPG			*Gasoline*	*Kerosene*	*Diesel*	*Fueloil*
	YR/11kg.Cyl	*YR/kg*	*YR/liter*	*YR/liter*	*YR/liter*	*YR/liter*	*YR/liter*
Ex-refinery Price (a)	0.00		0.00	0.00	0.00	0.00	26.11
Ministry of Finance	99.00	9.00	4.95	28.27	12.82	12.49	
Petroleum products							
Distribution margin				2.10	0.90	1.02	
YPC (administration and profit)				2.10	0.90	0.92	2.28
Average transportation cost				1.08	1.08	1.08	2.00
Rounding in favor of YPC							0.24
LPG							
Primary transportation (average)	41.50	3.77	2.06				
Cylinder maintenance (YGC)	3.00	0.27	0.15				
YGC costs	6.00	0.55	0.30				
Filling station investment return	25.00	2.27	1.24				
Bottle shop and secondary transport	24.00	2.18	1.19				
Taxes							
Local authority	1.50	0.14	0.07				
Local tax	5.00	0.45	0.25				
Vehicle Tax Authority				0.25		0.15	
Consumption tax (2%)				0.70	0.30	0.34	0.37
Road and bridge maintenance fund				0.50			
Fish and agriculture fund						1.00	
Retail price	205.00	18.64	10.20	35.00	16.00	17.00	31.00

Petroleum Product Prices Paid by Households

4.4 While Table 4.1 shows the official prices, actual prices paid by households are considerably higher. For example, in the case of kerosene, the PRA reports retail kerosene prices ranging from 20 YR/liter in urban areas and in rural areas with easy access (paved road, close to district capital) to 25-35 YR/liter in less accessible rural areas with poor roads or far from a district capital, to 30-35 YR/liter in rural areas during the rainy season. The overall national average retail price reported in the 2003 HES is 23 YR/liter, some YR7 more than the nominal ex-YPC price of 16 YR/liter. The most common price is 20 YR/liter (Figure 4.3).

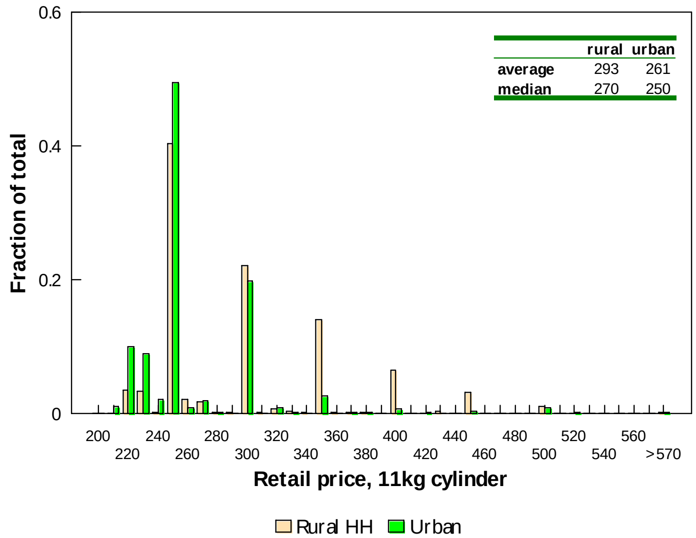
Figure 4.3: Frequency Distribution of Reported Retail Kerosene Prices



4.5 The 2003 HES data reveal no significant difference in retail price paid across the income deciles, which ranges from 22 to 24 YR/liter. However, regional differences are more pronounced, as discussed in more detail in Annex 3 Volume 2: Sana'a has the highest average price at 31 YR/liter, and Shabwah the lowest at 20 YR/liter.

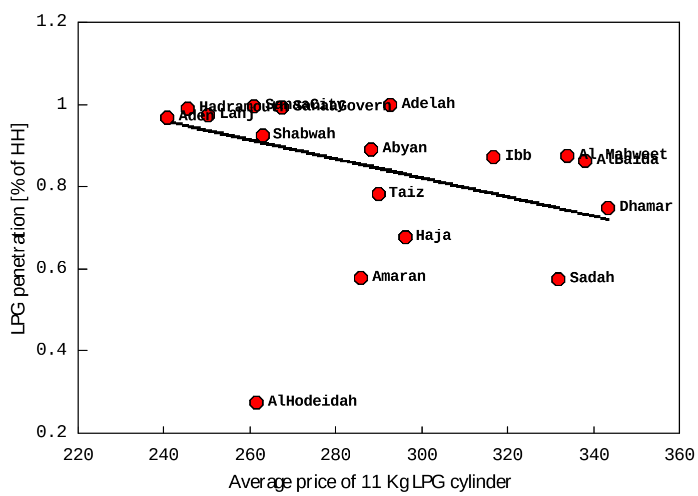
4.6 LPG prices show similar variations. Compared to the official price of YR205 per 11kg cylinder, the survey shows that the most common price actually paid by the consumer for an 11kg cylinder is YR250, with YR300 and YR350 being other common prices (Figure 4.4). As expected, there are significant differences between rural and urban prices: the overwhelming majority of bottles priced more than YR350 are in rural areas. The price differential reflects tertiary distribution costs. YGC is responsible for monitoring and enforcement of the official price at the LPG bottle shop, which it does by random inspections throughout the country.

Figure 4.4: Distribution of Reported Consumer LPG Prices



4.7 There is some evidence that price variations affect LPG penetration, as shown in Figure 4.5 for the case of urban households: higher prices result in lower penetration rates. Annex Figure A6.15 shows a similar relationship for rural households. The simple linear least squares fit have a statistically significant R^2 of 33% (if one excludes Al Hodeida as an outlier).[12]

Figure 4.5: LPG Penetration v. Average Price



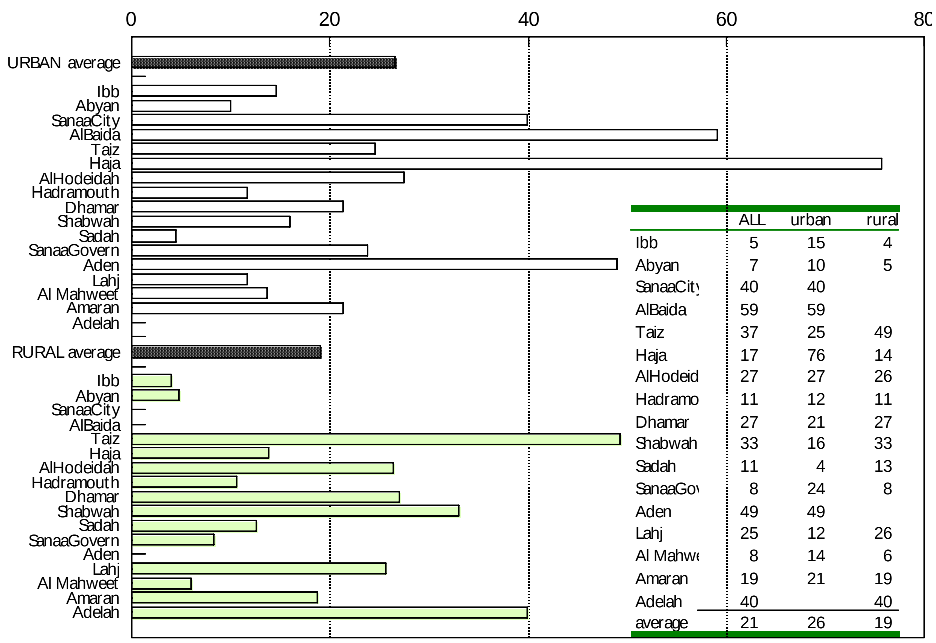
4.8 With a wide network of filling stations where diesel is sold at the official price of 17 YR/liter throughout the country, reported retail diesel prices vary little: 70% of respondents report a price of between 17 and 20 YR/liter. Where there are no gas stations, diesel is sold in village shops in small quantities and at higher prices.

[12] The low rate of LPG consumption in Hodeida has been known to YGC for some time. YGC has been trying to overcome local resistance to the use of LPG in the rural areas of this Governorate, which is apparently grounded in fears about safety.

Biomass Fuels

4.9 As expected, urban fuelwood prices are higher than in rural areas (Figure 4.6). However, these differences are far smaller than the variation across.

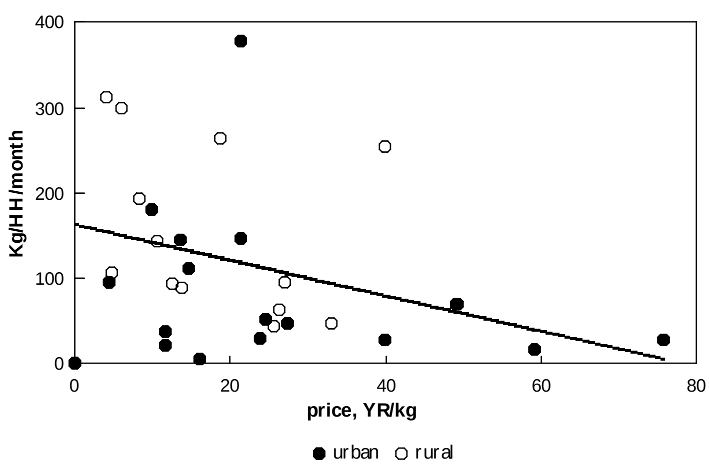
Figure 4.6: Fuelwood Prices, YR/kg



	ALL	urban	rural
Ibb	5	15	4
Abyan	7	10	5
SanaaCity	40	40	
AlBaida	59	59	
Taiz	37	25	49
Haja	17	76	14
AlHodeid	27	27	26
Hadramo	11	12	11
Dhamar	27	21	27
Shabwah	33	16	33
Sadah	11	4	13
SanaaGov	8	24	8
Aden	49	49	
Lahj	25	12	26
Al Mahwe	8	14	6
Amaran	19	21	19
Adelah	40		40
average	21	26	19

4.10 These price variations have the expected impact on consumption rates, as shown in Figure 4.7: the higher the price, the lower the monthly consumption per household. However, price explains only about 15% of the total variation in consumption rate across,[13] suggesting that the dominant determinant of consumption rate is resource availability.

Figure 4.7: Fuelwood Consumption v. Price



[13] As captured by the R^2 in a simple linear model. Addition of second and third order polynomial terms, or a log form, did not significantly improve the explanatory power.

4.11 In the case of charcoal, prices vary more, ranging from 37 YR/kg in rural areas to 61 YR/kg in urban areas. The bulk of charcoal is used in urban areas and the national average price is 51 YR/kg. As shown in Volume 2, Figure A9.19, there is also considerable variation in price by governorate, with a low of 10 YR/kg in Abyan to 146 YR/kg in Amaran. Crop residues and dung are used only by very small numbers of rural households, and are almost entirely collected rather than purchased.

Electricity

4.12 PEC has two domestic tariffs: one for its grid connected customers, and one for its "rural" customers, which in fact does not mean rural in its normal administrative or practical definition, but customers in its isolated systems. Therefore, of PEC's total number of customers (see Table 2.9), only 56,000, or 7%, pay the rural tariff (see Volume 2, Annex 8 for further details of PEC's tariff).

4.13 The existing tariff structure raises several questions:

- to what extent does the tariff recovers PEC's costs?
- to what extent does the first least-cost tariff block serve as an effective "lifeline" rate for the poor?
- to what extent do the differences in rural and grid tariffs reflect differences in actual economic costs of the two types of service?
- to what extent does the high connection charge discourage formal connections?

Cost Recovery

4.14 PEC does not cover its present costs, notwithstanding the subsidy on diesel fuel. At this point it is not possible to make recommendations on the structure of the tariff because this requires, as a first step, an understanding of the actual economic costs of supply at different voltage levels, properly reflecting the economic costs of generation, transmission and distribution. It is recommended that such a study be undertaken as soon as possible.

Lifeline Rate

4.15 As shown in Table 4.2, the first block in the PEC tariff, whose purpose is to provide a first tranche of low cost power to poor households, is set at 200 YR/kWh. This is substantially higher than in other countries, and there is no evidence that it effectively serves this role.

Table 4.2: International Comparisons of the First Tariff Block

	kWh
Indonesia	20
India (Gujrat, GSEB)	20
India (Ahmedabad, Kolkata)	25
Egypt	50
Pakistan	50
Laos	50
India (Bombay, BSES)	100
Bangladesh (BPDB/DESA)	100
Yemen: Isolated systems	100
National grid	200

Source: World Bank (2002a)

4.16 Yet as shown in Table 4.3, the average monthly consumption in rural areas is 101 kWh, and even the top decile consumes only 137 kWh. The average consumption of the bottom decile is 94 kWh, which would argue for a first block of no more than 100 kWh, and certainly not 200 kWh as at present.

Table 4.3: Monthly Consumption, PEC Grid Customers

		% HH reporting use			*Consumption, [kWh/month]*		
Decile	YR	Urban	Rural	All	Urban	Rural	All
1	0-9000	51%	8%	12%	157	58	94
2	9001-12000	74%	8%	19%	228	64	174
3	12001-15000	79%	16%	25%	188	65	123
4	15001-19800	74%	16%	28%	258	94	182
5	19801-22500	72%	19%	29%	228	77	144
6	22501-27000	81%	25%	39%	264	95	181
7	27001-33000	82%	28%	43%	275	106	191
8	33001-42700	81%	24%	41%	283	81	171
9	42701-61000	90%	46%	60%	291	114	196
10	61001>0	83%	52%	63%	388	137	237
	average	79%	23%	36%	273	101	183

Note: Rural refers to HH in rural areas, not HH paying the REC rural tariff!

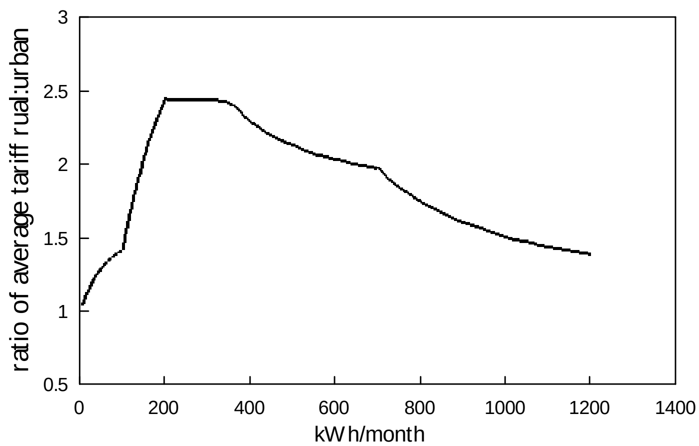
4.17 In the absence of a cost study, it is difficult to make specific suggestions for a residential tariff structure. However the HES data do suggest that the present structure requires revision, and that (as with petroleum product subsidies) the first block results in poor targeting of the implied subsidy.

PEC Rural Tariff (for Isolated Systems)

4.18 As in the case of the PEC grid system, the extent of subsidy to customers of the isolated systems is not transparent and again the economic costs of service to isolated systems need to be clearly established. The available data suggest very high connection costs for these systems. Although many isolated systems appear to have benefited from grant aid, the value of this assistance is not included in the PEC database: this should be corrected in any proper assessment of economic costs.

4.19 Figure 4.8 shows the ratio of monthly household bills of the rural (isolated system) and normal PEC tariffs, as a function of the kWh consumed. The rationale for the very different relative block structure is quite unclear, reaching a peak of 2.5 times the normal tariff for consumption between 200 and 350 kWh/month.

Figure 4.8: Ratio of Monthly Bills, Rural to Urban, as a Function of kWh



Policy Options for Rural Electrification

4.20 PEC alone will not be able to shoulder the challenge of rural electrification in Yemen. Cooperatives and private suppliers which today play a limited role can in the future play a much bigger role. The Government will need to draw on international experience of different institutional forms of rural electrification when designing a model for Yemen. Some considerations in the design of a rural electrification strategy based on international experience include:

- A strategic vision needs to be articulated that defines realistic goals grounded in the resources that can reasonably be deployed by the public and private sectors. It needs to also be based on realistic assessments of growth in household incomes in rural areas. In this context, the goal of rural household electrification is a limited one, because a strategic vision should also embrace targets for the electrification of social institutions and establishing reliability and competition in the supply of energy services in rural areas. Electricity for productive uses is critical and cuts across farm and non-farm activity, including home businesses. Thus, achieving the goals of rural electrification will require improved coordination between electrification programs and other sector programs focused on rural development.

- An appropriate institutional body should be established. Experience from other countries that have successfully scaled up rural electrification indicates that a well resourced and well functioning, high-level public institution is critical. The role of this high-level public institution is first and foremost that of market enabler – to create a competitive environment for commercial or cooperative electricity provision.

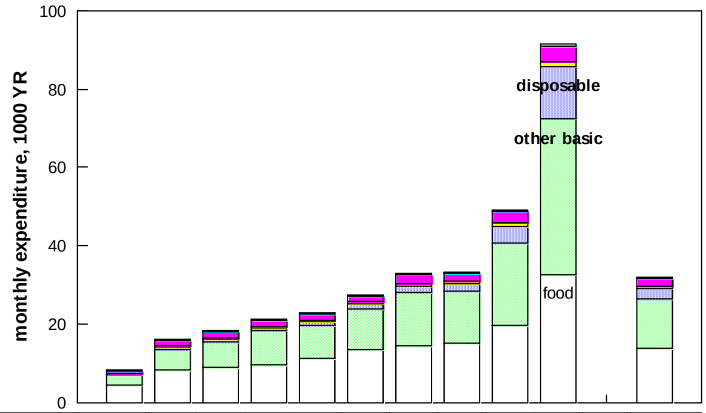
- The regulatory regime – the rules under which concession areas may be granted to cooperatives and private companies and under which they will operate – is important. In this context, retail electricity tariffs should reflect the actual cost of the service and should vary by service area. Costs should be minimized by using a least cost combination of grid extensions, isolated grid and off-grid approaches to electricity supply. Low cost grid reticulation methods should be used to minimize grid extension costs. Least cost generation and supply options should be considered, including diesel generators, grid extension from provincial load centers, cross border supplies, wind/hybrid systems, solar photovoltaics and rechargeable batteries.
- Given that Government resources are scarce, ensuring financial sustainability must be of paramount importance. Where Government resources can be justified, they should be for connections and not for electricity consumption and furthermore should be somehow competitively given. It will be questioned why subsidies are being made available for electricity connection and not for other un-met basic needs of the poor. If cash transfers to the poor can be well targeted, this will enable the poor to decide for themselves which basic needs they wish to satisfy with their scarce cash resources.

Household Energy Expenditures

4.21 Figure 4.9 shows energy expenditures in the context of *all* household expenditures. The category "other basic" is the sum of expenditure for housing, medicine, water, clothes etc.[14] "Disposable" (expenditure from disposable income) is that recorded by the survey as "other expenditure". "Fuel" includes all non electricity expenditures except biomass (including, for example, battery charging and dry cells, in addition to petroleum fuels such as LPG, kerosene and diesel). Note the sharp increases in food, other basic and disposable expenditure in the 9th and 10th income decile (whereas energy expenditures increase only slightly in the two upper deciles).

[14] The question of definition of expenditure categories is discussed further in Volume 2, Annex 10.

Figure 4.9: Overall Expenditure Patterns (All Households)

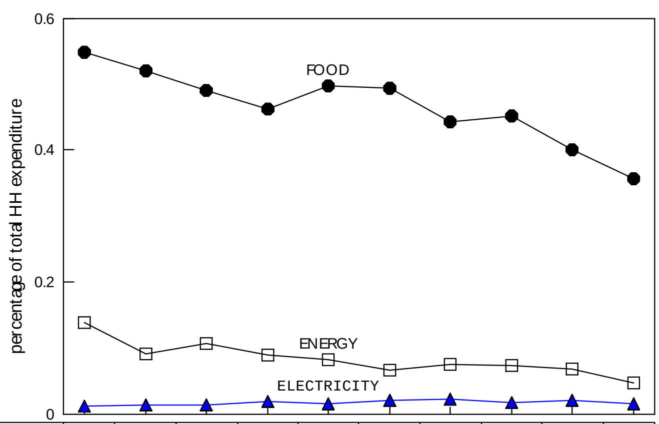


	d[1]	d[2]	d[3]	d[4]	d[5]	d[6]	d[7]	d[8]	d[9]	d[10]		average
food	4650	8342	9025	9879	11456	13650	14583	15061	19739	32641		13843
other basic	2423	5148	6502	8471	8114	10187	13491	13338	20875	39654		12728
disposable	133	845	643	705	1177	1357	1584	1911	4280	13459		2595
GridElectricity	92	223	240	400	346	575	736	577	985	1375		550
Fuel	927	1136	1698	1615	1677	1461	2163	2085	3051	3787		1935
Biomass	255	326	280	295	221	361	310	354	317	553		327

Note: The expenditure data in Figure 4.9 are averaged across *all* households in each income decile

4.22 Figure 4.10 shows the fraction of household income spent on food, energy (including purchased biomass) and electricity as a function of income decile. Both food and energy shares decline with increasing income, as one would expect, but electricity as a share of income is remarkably constant. On average, 7.1% of household income is spent on fuels for lighting and cooking, and 1.5% on electricity.

Figure 4.10: Food and Energy Expenditures as a Function of Income Decile



	d[1]		d[3]		d[5]		d[7]		d[9]	
FOOD	54.8%	52.1%	49.1%	46.2%	49.8%	49.5%	44.4%	45.2%	40.1%	35.7%
FUEL	13.9%	9.1%	10.8%	8.9%	8.3%	6.6%	7.5%	7.3%	6.8%	4.7%
ELECTRICITY	1.1%	1.4%	1.3%	1.9%	1.5%	2.1%	2.2%	1.7%	2.0%	1.5%

Note: The data in Figure 4.10 are averaged across *all* households in each income decile

4.23 Table 4.4 compares the Yemen budget shares with those reported in other household surveys: the urban share is lower than the average reported elsewhere, but the rural share is by far the highest. This may be explained by the fact that LPG has very high penetration rates (due to a highly subsidized price) and that most of the other countries have much higher collected (rather than purchased) rural biomass shares.

Table 4.4: Budget Share of Cash Energy (Purchased Cooking Fuels and Lighting)

	Urban	*Rural*	*Total*
Yemen	**3.9**	**8.4**	**7.1**
Brazil	3.4	3.2	3.4
Nicaragua	4.8	2.5	3.8
South Africa	3.7	5.9	4.7
Vietnam	5.6	2.9	3.5
Guatemala	6.7	6.2	6.4
Ghana	5.0	3.1	3.8
Nepal	6.0	2.1	2.4
India	7.5	4.1	5.0

Source: ESMAP (2003), Table 6.1.

4.24 There are significant differences between urban and rural households. Table 4.5 shows the detailed breakdown of energy expenditures in rural households by income decile. As expected:

- Kerosene expenditure (and consumption) declines with income (from 369 YR/month in the bottom to 267 YR/month in the top decile)
- Electricity expenditure (and consumption) increases sharply with income (from 50 YR/month in the bottom to 1,018 YR/month in the top decile)
- LPG expenditure (and consumption) increases with income (though the increase is much smaller than for electricity, as one might expect) (from 319 YR/month in the bottom to 1,149 YR/month in the top decile)
- Diesel expenditure increases sharply with income (from 19 YR/month in the lowest to 1,708 YR/month in the top decile). This is a reflection of significant diesel use by wealthy farmers for raising cash crops

Table 4.5: Average Energy Expenditures, Rural Households, YR/month

	d[1]	*d[2]*	*d[3]*	*d[4]*	*d[5]*	*d[6]*	*d[7]*	*d[8]*	*d[9]*	*d[10]*	*average*
Electricity, Grid	50	56	126	189	187	318	425	288	679	1018	306
Battery charging	13	11	15	8	26	13	26	27	37	41	21
Dry Cell	127	193	233	252	219	220	324	285	369	388	253
LPG lighting	33	63	103	129	103	121	162	132	139	186	112
LPG fridge	0	0	1	1	11	7	1	17	3	4	4
LPG: cooking	286	418	483	479	554	604	734	560	823	959	571
Total LPG	*319*	*481*	*587*	*609*	*669*	*732*	*897*	*709*	*966*	*1149*	*688*
Candles	22	21	65	37	52	41	62	64	77	149	56
Self-gen fuel	0	0	25	79	100	9	243	277	841	311	169
Self-gen maintenace	0	0	82	59	51	3	217	108	418	417	123
Repairs [annual/12]	0	0	34	1	44	16	17	91	73	211	45
Total self-gen	*0*	*0*	*141*	*139*	*195*	*29*	*478*	*476*	*1333*	*939*	*337*
Purchased self-gen	44	35	256	116	110	82	130	166	90	153	118
Kero: lighting	232	237	186	206	163	177	203	182	122	131	187
Kero: cooking	137	171	180	220	150	140	129	127	145	136	154
Total kerosene	*369*	*408*	*366*	*426*	*313*	*317*	*332*	*309*	*266*	*267*	*340*
Fuelwood	238	273	233	252	150	332	221	309	249	415	263
Charcoal	16	35	14	43	38	39	62	50	85	164	51
Crop residue	1	22	18	28	11	0	4	2	24	45	15
Dung	0	2	3	2	3	1	0	1	1	0	1
Total biomass	*256*	*332*	*268*	*326*	*202*	*373*	*288*	*361*	*359*	*625*	*331*
Diesel	19	30	140	178	215	117	377	357	790	1708	355
Total energy	1217	1566	2197	2280	2187	2242	3339	3042	4964	6437	2805
Total	8320	15565	18157	18930	22654	27596	33146	32967	48985	90407	29743
Energy as % of total	14.6%	10.1%	12.1%	12.0%	9.7%	8.1%	10.1%	9.2%	10.1%	7.1%	9.4%

Note: The expenditure data in Table 4.5 are averaged across *all* households in each income decile, (and are therefore *lower* than the corresponding average expenditures for those households that do use the stated fuel).

4.25 Less expected, perhaps, is that biomass expenditure is relatively flat across the deciles, reflecting the preference for wood *tanoors* even among the top income deciles who also consume LPG.

4.26 The corresponding data for urban households are shown in Table 4.6. The following differences are noted:

- Much lower expenditure on diesel in the top deciles than in the rural areas; average diesel expenditure in urban areas is YR103, as opposed to YR355 in rural areas. This is primarily a reflection of irrigation use in the top rural deciles.
- Much lower expenditure on self-generation (47 YR/HH on average in urban areas, v. 337 YR/HH in rural areas)
- Correspondingly higher expenditure on electricity (1,379 YR/month v. 309 YR/month in rural areas – a consequence of the greater penetration of the grid in urban areas.
- Note that the data reported in this section are averaged across all households in the respective income deciles. For example, the average monthly expenditure for grid-supplied electricity in rural households is 306 YR/month. However, on average, only 26.6% of rural households have

access; therefore the average expenditure of households actually connected to the grid is 1,154 YR/month. (The corresponding figure for urban grid-connected households is 1,754 YR/month, based on access of 78.6%).

4.27 Much of the difference can also be explained by the distribution of poverty, which is largely a rural phenomenon: 91% of households in the bottom income decile are in rural areas, as opposed to an overall average of 77% of all households being in rural areas. Similarly, 33% of the households in the top decile are in urban areas, as against 23% of all households.

Table 4.6: Average Energy Expenditures, Urban Households, YR/month

	d[1]	***d[2]***	***d[3]***	***d[4]***	***d[5]***	***d[6]***	***d[7]***	***D[8]***	***d[9]***	***d[10]***	***average***
Grid Electricity	499	1076	910	1224	1007	1332	1501	1286	1627	2096	1379
Battery charging	0	3	0	10	6	10	5	11	10	19	9
Dry Cell	96	82	100	116	129	127	78	133	115	133	114
LPG lighting	17	31	22	33	81	48	21	44	29	42	38
LPG fridge	0	0	0	0	0	0	3	0	0	16	3
LPG: cooking	447	482	644	562	600	648	619	614	655	842	637
Total LPG	*463*	*513*	*665*	*595*	*681*	*697*	*643*	*659*	*683*	*901*	*678*
Candles	29	52	51	43	79	43	62	77	59	65	59
Self-gen fuel	154	5	0	2	5	2	0	82	61	38	32
Self-gen maintenace	52	1	0	3	1	2	0	26	19	11	11
Repairs [annual/12]	0	4	0	0	0	0	0	10	16	0	4
Total self-gen	*206*	*10*	*0*	*5*	*7*	*4*	*0*	*118*	*96*	*49*	*47*
Purchased self-gen	50	14	111	86	118	82	29	115	34	147	81
Kerosene: lighting	97	94	108	45	59	47	78	20	30	52	57
Kerosene: cooking	119	148	49	85	81	74	110	96	31	55	80
Total kerosene	*215*	*242*	*157*	*130*	*140*	*120*	*189*	*116*	*61*	*107*	*136*
Firewood	160	187	219	98	141	185	168	186	158	193	172
Charcoal	85	110	131	74	121	139	196	148	70	199	135
Crop residue	0	1	0	0	33	1	0	0	1	7	4
Dung	0	0	0	0	4	2	1	0	1	9	2
Total biomass	*245*	*299*	*349*	*172*	*300*	*326*	*365*	*334*	*230*	*407*	*313*
Diesel	12	5	2	42	12	112	18	100	159	331	103
Total energy	1,815	2,295	2,345	2,422	2,479	2,853	2,890	2,948	3,075	4,256	2,917
Total	10,028	18,344	19,745	30,900	24,386	27,577	32,181	34,208	49,798	93,613	40,831
Energy as % of total	18.1%	12.5%	11.9%	7.8%	10.2%	10.3%	9.0%	8.6%	6.2%	4.5%	7.1%

Note: The data in Table 4.6 are averaged across *all* households in each income decile (and are therefore *lower* than the corresponding average expenditures for those households that do use the stated fuel).

4.28 The corresponding calculation for all households is shown in Table 4.7.

Table 4.7: Average Energy Expenditures, All Households (Urban and Rural), YR/month

	d[1]	*d[2]*	*d[3]*	*d[4]*	*d[5]*	*d[6]*	*d[7]*	*d[8]*	*d[9]*	*d[10]*	*average*
GridElectricity	92	223	240	400	346	575	736	577	985	1375	550
Battery charging	11	10	13	8	22	13	20	22	28	34	18
Dry Cell	124	175	214	224	201	196	253	241	287	304	221
LPG lighting	31	58	91	109	99	103	122	106	104	138	95
LPG fridge	0	0	1	1	9	5	1	12	2	8	4
LPGcooking	301	429	507	496	563	615	701	575	769	920	586
Total LPG	333	486	598	606	671	723	824	694	874	1067	685
Candles	22	26	63	38	57	41	62	68	71	121	57
Self-gen fuel	14	1	21	63	82	7	173	221	589	220	138
Self-gen maintenace	5	0	70	48	41	3	154	84	289	283	97
Repairs [annual/12]	0	1	29	1	36	12	12	68	55	141	36
Total self-gen	19	2	120	112	158	23	340	373	933	644	271
Purchased self-gen	44	32	235	110	111	82	101	151	72	151	110
Kero: lighting	219	214	175	173	143	144	167	135	92	105	157
Kero: cooking	135	167	161	193	137	123	123	118	108	110	137
Total kerosene	354	381	335	366	280	267	291	253	200	214	294
Fuelwood	231	259	231	221	148	295	206	273	220	341	243
Charcoal	23	47	31	49	54	64	101	78	80	176	70
Cropres	1	18	16	22	15	0	3	1	17	33	13
Dung	0	2	3	2	3	2	0	1	1	3	2
Total biomass	255	326	280	295	221	361	310	354	317	553	327
Diesel	18	26	120	150	176	116	273	283	586	1252	298
Total energy	1274	1686	2218	2309	2243	2397	3209	3015	4354	5715	2830
Total	8481	16021	18389	21365	22990	27591	32867	33326	49248	91469	31997
Energy as % of total	15.0%	10.5%	12.1%	10.8%	9.8%	8.7%	9.8%	9.0%	8.8%	6.2%	8.8%

Note: The data in Table 4.6 are averaged across *all* households in each income decile, and are therefore *lower* than the corresponding average expenditures for those households that do use the stated fuel.

Willingness to Pay for Electricity

4.29 Benefit-cost analysis of rural electrification clearly requires a measure of the benefits of electrification. If a demand curve were available, then the total economic benefits of some level of consumption follow as the area under the demand curve (i.e. the total willingness to pay), and the net benefits as the consumer surplus. The methodology for such calculations is discussed in Volume 2, Annex 8. This approach works best in longitudinal surveys, where information is available from a household before and after electrification, and has been used in a number of recent World Bank studies.[15]

4.30 In the case of the Yemen energy survey, the derivation of such demand curves is not possible. However valuable insights into household behavior and preferences may still be drawn. Table 4.8 shows spending on fuels that are in theory substitutes for electricity – LPG and kerosene for lighting, candles, dry cells and battery charging. For example, the table shows that households connected to the PEC grid,

[15] E.g. Vietnam (for electrification by mini-hydro), the Philippines (for electrification by diesel mini-grids), and Sri Lanka and Indonesia (for electrification of rural households in remote areas by solar systems). The method is easiest to apply for solar systems, because the quantity of electricity provided is small, and therefore gets used just for lighting and TV-viewing, for which deriving demand curves is tractable.

that use kerosene for lighting, spend 134 YR/month on kerosene; but households with no access to electricity spend 332 YR/month for kerosene. Overall, households with access to electricity spend 418 YR/month on items (that could be replaced by electricity), as opposed to 779 YR/month in households that have no access.

Table 4.8: Spending on Electricity Substitutes

	total	kerosene		batterycharging		dryCell		LPG lighting		LPGfridge		candles	
	[YR/m]	[YR/m]	[%HH]	[YR/m]	[%HH]	[YR/m]	[%HH]	[YR/m]	[%HH]	[YR/m]	[%HH]	[YR/m]	[%HH]
PEC national grid	307	134	36%	212	1%	224	53%	204	18%	594	0%	119	58%
at PEC urban tariff													
at PEC rural tariff													
PEC isolated system	499	149	64%	353	1%	304	71%	265	48%		0%	84	28%
Coop	407	191	66%	314	1%	257	58%	244	19%	484	6%	98	19%
Private	1043	162	91%		0%	607	100%	198	100%		0%	141	64%
total grid/minigrid acces	**328**	**141**	**40%**	**226**	**1%**	**234**	**54%**	**215**	**20%**	**512**	**0%**	**117**	**54%**
village/community gense	488	156	57%	314	4%	308	68%	247	31%	1159	1%	149	33%
relative/neighbor gense	575	257	41%	277	12%	372	66%	245	35%	1250	1%	185	25%
family genset	1365	306	43%	332	20%	716	80%	421	52%	918	2%	760	30%
other													
total with electricity acce	**418**	**160**	**42%**	**309**	**3%**	**287**	**58%**	**245**	**24%**	**703**	**1%**	**141**	**49%**
no access	**779**	**332**	**78%**	**354**	**8%**	**439**	**64%**	**401**	**34%**	**492**	**0%**	**197**	**22%**

Note: The data in Table 4.8 are averaged across all households in each income decile

4.31 This shows that households with access to electricity still use substantial quantities of the alternative fuels, presumably because the cost of kerosene (and LPG) is so cheap that electricity is used sparingly for lighting (because of the perception of high cost): electricity is used for services for which there are no (or no cost-effective) substitutes – such as TVs, fans and other appliances.

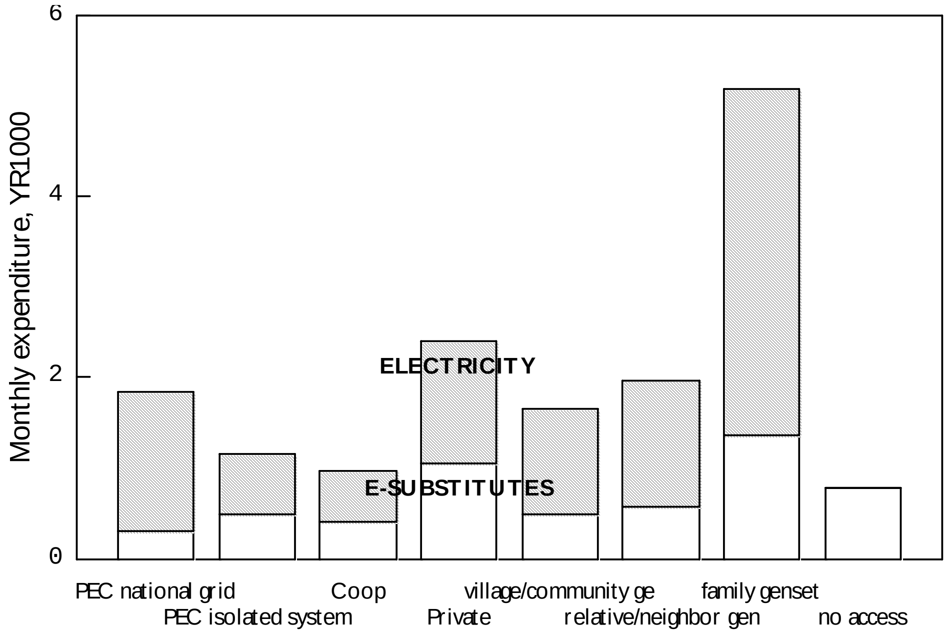
4.32 Table 4.9 shows the incremental expenditures. Column [1] shows electricity expenditure, and column [2] expenditure on substitutes; column [3] is the total expenditure (=[1]+[2]). The incremental expenditure for electricity in column [4] is relative to households with no access: for example, in households connected to the PEC national grid, the incremental expenditure (for electricity) is 1,072 YR/month.

Table 4.9: Incremental Expenditure

	Electricity expenditure	*Non- electricity expenditure*	*Total expenditure*	*Incremental expenditure*
	[1]	[2]	[3]	[4]
PEC national grid	1543	307	1850	1072
PEC isolated system	663	499	1162	383
Coop	570	407	977	198
Private	1355	1043	2397	1618
Village/community genset	1166	488	1654	875
Relative/neighbor genset	1386	575	1962	1183
Family genset	3822	1365	5187	4409
No access	0	779	779	

4.33 The most interesting finding of these data is highlighted in Figure 4.11: households with the highest expenditure for electricity are those connected to private mini-grids or with their own gensets – but these households spend *more* on electricity substitutes than those with no access at all and more than those connected to the PEC grid. Evidently these households place great value not just on electricity, but on the entire bundle of energy services.

Figure 4.11: Expenditure on Electricity and Electricity Substitutes, By Type of Electricity Access



How to Deliver Rural Electrification

4.34 The GOY's targets for electricity access by 2005 are for 40.3% of all households (98.2% of urban households and 22.2% of rural households) to have access to the national grid. The Government is presently working on the National Development Plan for Poverty Reduction to be completed by June 2005, which is to be based on the MDGs. Experience from other countries demonstrates that goals for increased rates of energy access and rural electrification must be premised on cost recovery to ensure that energy service providers are financially healthy. Although the economic cost of supply in different areas of the country is not known, it is undoubtedly the case that the costs of grid expansion in rural areas will be high, given the nature of Yemen's topography and the small and dispersed electricity loads in rural areas that are concentrated in the evening for household lighting demand.

4.35 Although the cost of rural electrification can be reduced by employing technologies and technical standards appropriate to the low level of demand, the costs of off-grid systems are likely to be less than that of grid extension. Furthermore, affordability is likely to continue to be a constraint for poorer households who, even as their incomes increase, will sometimes exercise choice not to spend the little cash that they have on electricity. Similarly in the case of access to clean cooking fuels, a proportion of poor households will continue to depend on biomass fuels for reasons of its affordability. Development of fuelwood markets and deployment of more efficient cooking stoves needs to be part of the Government's strategy.

4.36 Poor people benefit from rural electrification even when they do not have a household connection. They benefit from the improved services when post offices, local government offices, clinics and trading centers are electrified. They will also have more employment opportunities. Yemen needs to improve coordination between electrification programs and other sector programs focused on rural development so that delivery of electricity services is part of a package of complementary rural services.

4.37 Taking account of these considerations may lead the Government to broaden the currently formulated energy access goals in the present PRSP to ones that embrace sustainable cooking fuel use and electrification of social institutions.

4.38 PEC alone will not be able to shoulder the challenge of rural electrification in Yemen. Cooperatives and private suppliers, which today play a limited role, can in the future play a much bigger role. The Government will need to draw on international experience of different institutional forms of rural electrification when designing a model for Yemen. Equity goals will likely continue to justify subsidized electricity connections for target households. In consideration of this, Government subsidies to the electricity sector should shift from operating subsidies to a capital subsidy for the cost of connection.

Conclusions on Energy Prices and Expenditures

4.39 Overall, the survey confirms the classic pattern: as income rises, energy as a share of total household expenditure declines (e.g. in the case of fuels, from 14% in the bottom decile to 5% in the top decile).

4.40 There is some evidence that expenditures (and incomes) in the 2003 HES are underreported. However, the overall distribution of expenditure among categories also conforms to the classic pattern: the bottom decile reports 55% of its total expenditure is devoted to food, as against only 36% in the top decile.

4.41 The main determinant of petroleum product price differentials is geographic location. While official prices are well maintained at the officially regulated outlets (pumps at filling stations for diesel, LPG bottling plants), tertiary distribution costs add significantly to the price, particularly in remote rural areas during inclement weather.

5

Petroleum Product Subsidies

5.1 Petroleum products price subsidies in Yemen are among the highest in the world, with the result that household energy consumption patterns are very strongly influenced by them. Subsidies have encouraged wasteful consumption of fossil fuels and have created an unsustainable burden on Government finances. This chapter reviews the pricing system of petroleum products and the magnitude of the subsidies involved.

5.2 Table 5.1 shows official retail prices for petroleum products since 1997.[16] Diesel prices were last adjusted in 2001; kerosene in 1999 and gasoline in 1998.

Table 5.1: Official Retail Prices of Petroleum Products

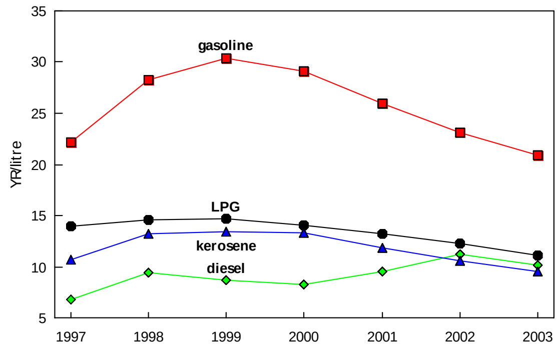
	1997	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*
CPI (Nov99=100)	86.84	92.03	100	104.59	117.05	131.37	145.6	161.5 [(a)]
Nominal price								
Gasoline	22.1	30.0	35.0	35.0	35.0	35.0	35.0	35.0
Diesel	6.8	10.0	10.0	10.0	12.9	17.0	17.0	17.0
Kerosene	10.8	14.0	15.5	16.0	16.0	16.0	16.0	16.0
LPG	153.8	170.1	186.4	186.4	195.7	205.0	205.0	205.0
Price in constant 1997 YR								
Gasoline	22.1	28.3	30.4	29.1	26.0	23.1	20.9	18.8
Diesel	6.8	9.4	8.7	8.3	9.6	11.2	10.1	9.1
Kerosene	10.8	13.2	13.5	13.3	11.9	10.6	9.5	8.6
LPG [per kg]	14.0	14.6	14.7	14.1	13.2	12.3	11.1	10.0

(a) average for first six months of 2004

5.3 In real terms, retail petroleum product prices have declined over recent years, as shown in Figure 5.1. Diesel prices increased between 2000 and 2002 following the price increase in 2001.

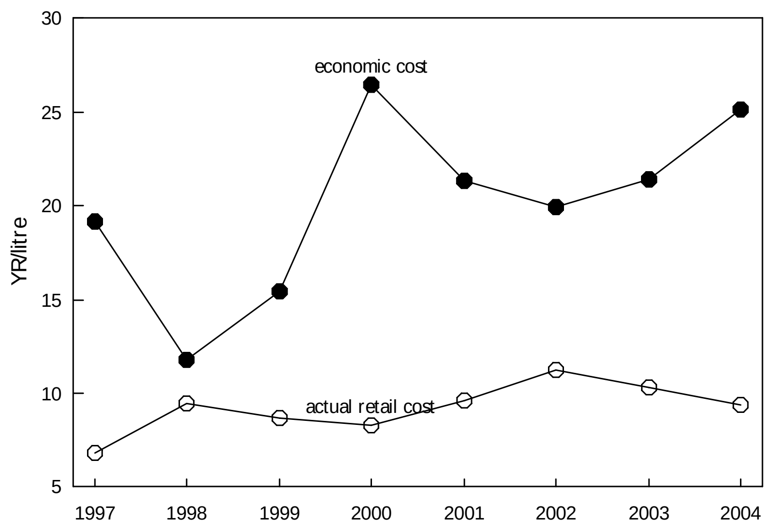
[16] As noted below, actual retail prices are slightly higher to account for local bottle shop and retail distribution margins.

Figure 5.1: Retail Prices, in Constant 1997 YR



5.4 However, the border price of diesel has increased substantially since 1998. As shown in Figure 5.2 and Table 5.2, the differential between the economic price and the actual retail price in Yemen has steadily increased since the all-time low of oil prices in late 1998 (when Brent Crude traded at $10/bbl, and Gulf gas oil at $11.50/bbl): as of June 2004, the differential is 28.7 YR/liter (15.8 YR/liter at constant 1997 prices).

Figure 5.2: Diesel Prices in Yemen



5.5 Many of the findings of this report can be explained (at least in part) by these trends. Even though one would expect energy expenditure as a percentage of total household expenditure to fall over time with increasing real incomes, with falling real prices there is little incentive for efficient energy use. Moreover, sudden *ad hoc* price increases make it more difficult for households to adjust (as in the case of kerosene in 1999, when the price almost doubled).

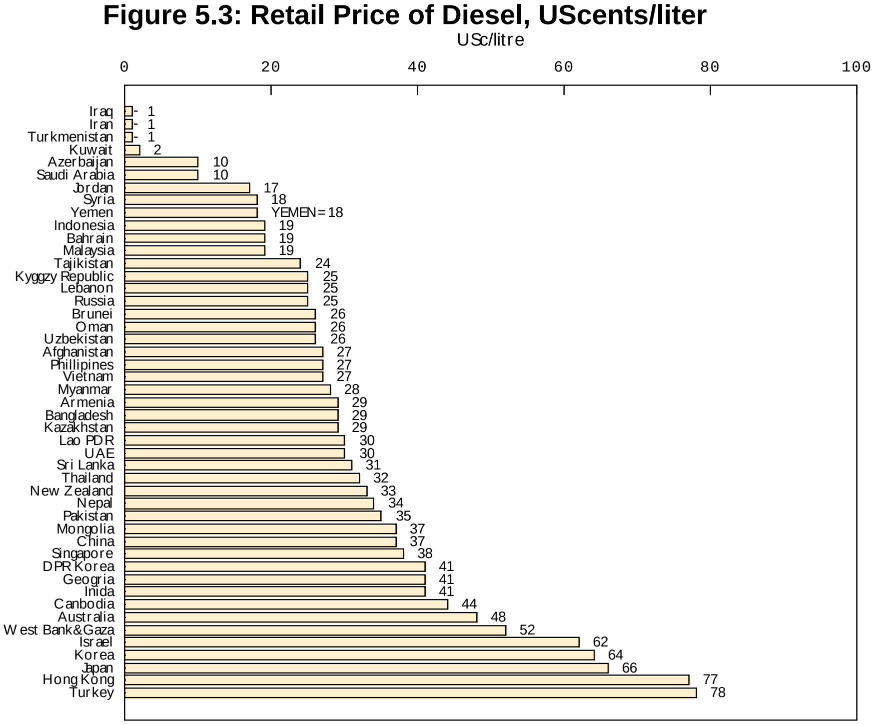
5.6 Thus the prices of petroleum products are heavily distorted. Diesel, gasoline, kerosene and LPG are far below their international price. In addition to large fiscal costs to the Government, the implicit subsidies distort choices and result in high and inefficient consumption. Examples from other countries illustrate the unintended consequences of subsidy policy: Box 5.1 illustrates the distortions and inefficiencies in the Indian electricity sector that resulted from the diesel subsidy policy of the 1990s.

Table 5.2: Economic and Actual Prices of Diesel

		1997	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*
Platts' Gulf gas oil	[$/bbl]	22.6	13.5	17.1	30.4	25.4	25.8	29	38.8
Freight	[$/bbl]	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Landed cost	[$/bbl]	23.8	14.7	18.3	31.6	26.6	27	30.2	40
Exchange rate	[YR/$]	129	136	156	162	173	179	187	183
Landed cost	[YR/bbl]	3072	1992	2844	5104	4595	4826	5640	7313
	[YR/liter]	19.2	12.5	17.8	31.9	28.7	30.2	35.2	45.7
Transport&distribution	[YR/liter]	2.7	2.9	3.2	3.3	3.7	4.1	4.5	5
Economic price	[YR/liter]	21.9	15.4	20.9	35.2	32.4	34.3	39.8	50.7
Retail price	[YR/liter]	6.8	10	10	10	12.9	17	17	17
Difference=subsidy	[YR/liter]	15.1	5.4	10.9	25.2	19.5	17.3	22.8	33.7
In constant 1997 prices									
Economic cost	[YR/liter]	19.2	11.7	15.4	26.5	21.3	19.9	21.4	25.2
Retail price	[YR/liter]	6.8	9.4	8.7	8.3	9.6	11.2	10.3	9.4
Difference=subsidy	[YR/liter]	12.4	2.3	6.8	18.2	11.7	8.7	11.1	15.8

5.7 Yemen prices for petroleum products, as shown in Figure 5.3 for diesel prices, are low compared to most other countries. Gasoline prices show a similar pattern.

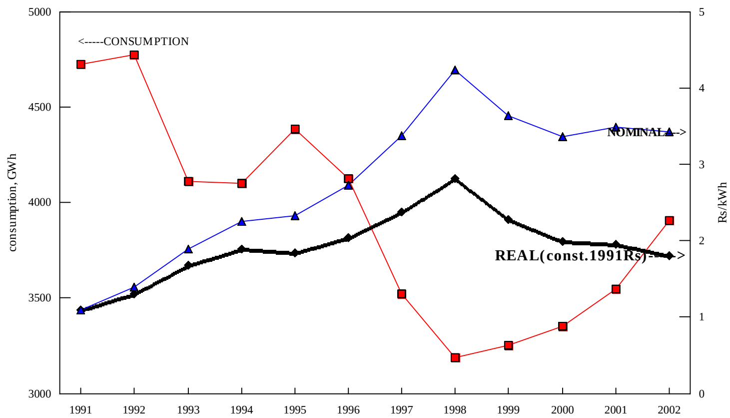
Figure 5.3: Retail Price of Diesel, UScents/liter



Source*: GTZ, International Fuel Prices, 2003.*

Box 5.1: The Consequences of Diesel Subsides: Lessons from India

The relationship between industrial load growth, the industrial electricity tariff and diesel price subsidies, is well illustrated by the experience of India. Until the late 1990s, diesel fuel was highly subsidized in India, costing around Rs11/liter. At the same time, Indian State Electricity boards, under great financial stress because of the widespread practice of providing free (or almost free) power to agriculture, raised electricity prices to the industrial sector. The figure shows the rise of the industrial tariff in the State of Karnataka, rising from 1 Rs/kWh to over 4 Rs/kWh (nominal) by 1998.



Because of the diesel price subsidy, self-generation was widely adopted by industry, and thus, not surprisingly, industrial consumption *declined* (with industrial consumption falling from 56% of total sales to only 18%). Falling revenues to the Karnataka Electricity Board resulted in inadequate investment, further increases in transmission and distribution losses, and sharp deterioration in quality of supply, that reinforced the trend toward self-generation. Eventually, extensive reform and restructuring was the only choice available to the essentially bankrupt electric utilities in India.

Two changes occurred in 1999-2000. First, the central government abandoned the diesel subsidy, resulting in a doubling of the diesel price to around 22 Rs/liter, making self-generation more expensive than the industrial tariff. Second, the futility of increasing industrial tariffs to unreasonable levels was recognized, and industrial tariffs were allowed to decline under the watchful eye of the new independent regulators that were introduced as part of electricity reform. The result in Karnataka was dramatic: as shown in the figure, industrial sales have risen sharply since 1998.

Two main conclusions are relevant to Yemen. First, cross-subsidies often have poor outcomes. Free power to farmers financed by very high industrial tariffs not only drove industrial customers off the grid, but resulted in such deterioration in service quality that many pump motors were burnt out. Second, energy policy needs to be comprehensive: the diesel subsidy allowed widespread industrial self-generation (with significant consequences to the environment: health damages from ground level emissions of diesel sets in densely populated areas are two orders of magnitude greater than from grid-power stations located in remote areas).

Box 5.2: The Economic Impact of Subsidies: Basic Concepts

Subsidies are advocated on grounds that the poor should be protected from bearing the full cost of important items in the household budget. Leaving aside (for the moment) the question of whether subsidies do in fact reach the intended groups (discussed in Volume 2 of this report for each fuel), it is important to understand some basic characteristics of subsidies (which are also important in understanding the impacts when subsidies are removed).

There is widespread public misunderstanding about diesel subsidies. Since Yemen exports oil, holds one view, why should Yemeni citizens not benefit from cheap oil? Why should a farmer pay the world price for diesel (based on world price for crude oil which in mid-2004 is 45$/bbl), when Yemen's actual production cost is $5/bbl?

There are several reasons. First, every liter of oil consumed in Yemen means one liter of oil that cannot be exported. The export value is the true value to Yemen of its oil, because every liter that is sold at $5/bbl means the Government gets $40/bbl less in revenue in 2004. Of course, farmers may argue that it is better that they benefit from the 40$/bbl than the Government. Yet why should nature's bounty of a nation's oil resource accrue to those few who happen to use oil, rather than to society as a whole?

Indeed, if the farmer only pays $5/bbl, he will likely have little incentive for its efficient use – so, for example, crop choice will be influenced by the low cost of pumping groundwater. Thus more groundwater will be pumped for irrigation purposes than is justified by the real cost of energy. The cost of farm produce may therefore be less, but households will need to spend more on the cost of water because groundwater tables have fallen to a lower level than they would otherwise be. Thus a subsidy distorts choices in the economy (or, as economists would put it, resources are misallocated).

Subsidies are what economists term "transfer payments". That is, they represent payments from one group of society to another group – in the case of diesel subsidies, from Government (or taxpayers in general) to users of diesel. If diesel subsidies are eliminated, these same funds will be available to the Government and can be spent by it on cash income support for the poor, or in subsidizing other goods, or spent in development projects such as training teachers and health workers and building schools and clinics. In other words, always assuming that the funds would be used for development purposes, it is very unlikely that eliminating the diesel subsidy will have significant adverse macroeconomic effects.

Note that this is entirely different to the impacts of a domestic price increase that occurs in an oil-importing country following an increase in the world oil price. When the oil price increases from 30 to 40$/bbl, this represents a real shift of resources from the consumers in the importing country to the oil exporting countries. This would not be the case were Yemen to reduce the diesel subsidy since the resources (i.e. the money paid by consumers) stay inside Yemen.

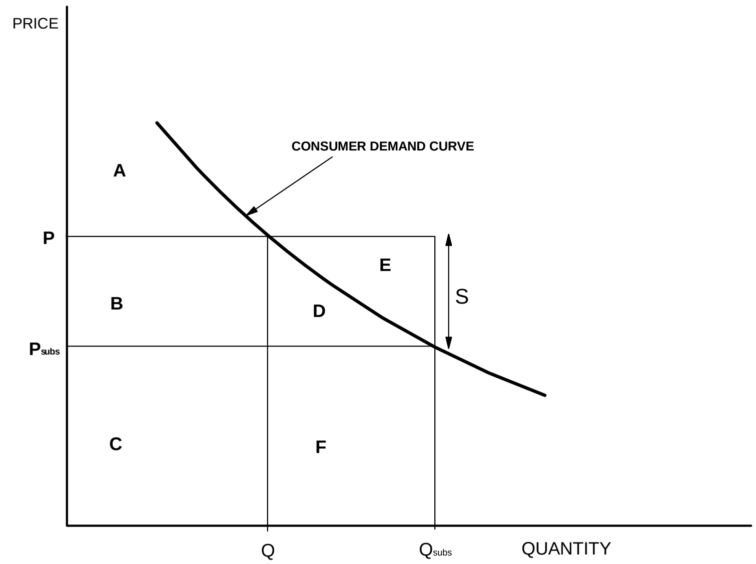
However, there is a real cost to society as a whole that results from a subsidy, a cost that economists call "deadweight losses." This loss to the economy – Yemeni society as a whole – occurs because the incremental cost of the subsidy to Government exceeds the incremental benefit to the consumer.

In summary, subsidies on energy or other commodities, even if they do reach the intended beneficiaries, have undesirable economic effects. When, as shown below, most of the subsidy does not even reach the poor, the reasons for removing subsidies become even more compelling.

Note that this is not necessarily an argument against subsidies *per se*, but against subsidies *on energy*. It is far better that subsidies be paid directly to the poor in cash (or cash equivalents), because then, at least, resource allocation decisions in the economy as a whole are not distorted.

Box 5.2 continued

The figure demonstrates why this should be so. The downward sloping curve represents the consumer's demand curve: the higher the price, the less he consumes. Now suppose the world oil price is ***P***, at which price the quantity ***Q*** is consumed. The total benefit to the consumer is the area under the demand curve, i.e. the area ***A + B + C***.[(1)] But the consumer pays ***P x Q***, or the area ***B + C***, so the net benefit to the consumer, called "*consumer surplus*" is the area ***A***.



Now suppose the Government decides to subsidize the fuel in the amount ***S***, and sets the domestic retail price at P_{subs}. At this lower price, the consumer increases his consumption to Q_{subs}. Therefore the cost to government is the subsidy times the quantity consumed, $S \times Q_{subs}$, equal to the areas ***B + D + E***.

This cost is offset by an increased benefit to the consumer. At the price P_{subs} he consumes Q_{subs}, so his cost is $P_{subs} \times Q_{subs} = C + F$. The total area under the demand curve (to Q_{subs}) is ***A + B + C + D + F***, and therefore his net benefit is the difference, namely the area ***A + B + D***. Previously his surplus was ***A***, so the result of the subsidy is an increase in benefit of ***B + D***. Thus the incremental cost to Government is ***B + D + E***, while the incremental benefit to the consumer is ***B + D***, so the net result is a loss equal to the area ***E***. This is the cost to the economy of the subsidy. Thus any subsidy necessarily involves a trade-off between economic efficiency and equity.

(1) Since the axes of the graph represent price (YR per liter) and quantity (liters), an area in this graph represents an amount of money given by the product of these two, namely YR/liter x liters = YR

5.8 In addition to these distortions in the economy, petroleum product subsidies (in common with all other subsidies) result in a real cost to society, that economists call "deadweight losses". This loss to the economy (Yemeni society as a whole) occurs because the incremental cost of the subsidy to Government exceeds the incremental benefit to consumers. This was estimated to be in the order of 13% of the subsidy, i.e. YR13 billion in 2003. (see Box 5.3).

Box 5.3: Calculation of Deadweight Losses

As explained in Box 5.2 the deadweight loss represents the difference between the cost of a subsidy to Government, and the benefit of that subsidy to the consumer.

To calculate the deadweight loss an appropriate functional form for the consumer demand curve is needed, for which a simple (and widely used) representation is that of constant elasticity β, namely

$$Q_p = Q_o\left(\frac{P_p}{P_o}\right)^{\beta}$$

The area D+F is then given by the definite integral of this function, namely

$$\frac{P_o}{Q_o^{1/\beta}}\int_{Qo}^{Qp} Q^{1/\beta}\,dQ = \frac{P_o}{Q_o^{1/\beta}}\left|_{Q_o}^{Qp}\frac{Q^{1/(1+\beta)}}{1+1/\beta}\right.$$

Thus the calculation of deadweight losses, assuming a price elasticity of –0.3, is as follows

			LPG	*gasoline*	*kerosene*	*diesel*	*fueloil*	*total*
Q_{econ}			822	1343	102	1918	984	
Q_{subs}			1158	1414	135	2475	1001	
P_{econ}			32	42	40	40	33	
P_{subs}			10	35	16	17	31	
Elasticity			-0.3	-0.3	-0.3	-0.3	-0.3	
Constant		x10^-6	165555	1110621	202	3486312	311035	
Definate integral	Q @ Q_{econ}	x10^6	-0.0677	-0.0215	-8.7565	-0.0094	-0.0445	
	Q @ Q_{subs}	x10^6	-0.0304	-0.0191	-4.5840	-0.0052	-0.0428	
hence area ***D+F***			6163	2722	843	14649	548	
Area ***D+E+F=dq P***			10671	2966	1319	22134	564	
hence deadweight loss = ***E***			**4508**	**244**	**476**	**7485**	**16**	**12729**
as % of subsidy			18%	3%	15%	13%	1%	13%

Previous Estimates of Subsidies

5.9 The 2002 Energy Sector Assessment estimated total 2001 petroleum product subsidies at $370 million (YR63.4 billion).[17]

[17] World Bank/ ESMAP, *Energy Sector Performance Improvement And Future Development: The Way Forward*, Washington, DC, 2002.

Table 5.3: Energy Sector Assessment Estimate of Subsidies for 2001

Products	*Cons-umption*	*Import parity price*			*Retail prices*			*Subsidy (Million)*	
	[1000 t]	[$/ton]	[$/l]	[YR/l]	[YR/liter]	[$/liter]	[$/ton]	[YR]	[$]
LPG (a)	506	205			YR 205/ 12.5 kg.		98.88	(9)	(54)
Gasoline	982	320	0.229	39	35	0.205	287.2	(5,557)	(33)
Kerosene	220	220	0.17	28.9	16	0.094	119.7	(3,733)	(22)
Diesel	1,600	287	0.24	40.8	17	0.10	120	(45,476)	(267)
HSFO(3.5% S)	1,056	153	0.145	24.65	25	0.147	155.7	459	3
Total								**(63,435)**	**(373)**

(a) In 2001, the Aden Refinery Company (ARC) produced about 70,000 tons of LPG from its refining process. The import parity price was about US$ 205/ton in 2001. The LPG retail price is YR 205/12.5 kg bottle, which is equivalent to YR 16810/ton or US$ 98.9/ton. Prices of other products are the average of the ARC's import parity prices for these products during 2001.

Source: *World Bank/ ESMAP, Energy Sector Performance Improvement And Future Development: The Way Forward, Washington, DC, 2002: Table 2.2.*

5.10 In December 2003, the IMF estimated petroleum product subsidies at "3-6% of GDP".[18] The total amount for "petroleum product subsidies" for 2003 was estimated at YR 100 billion.

5.11 In early 2004, the World Bank[19] estimated total petroleum product subsidies in 2002 (excluding LPG) at YR38.5 billion, or 2.19% of GDP (Table 5.4). The bulk of this subsidy is for diesel (YR33.1 billion).

Table 5.4: Petroleum Product Subsidies for 2002

		Gasoline	*Diesel*	*Kerosene*	*Fuel-oil*	*Total*
Retail price	[YR/liter]	35	17	16	31	
Retail price based on border price (b)	[YR/liter]	39.6	37.3	36.8	28.7	
Rate of economic subsidy	[% of border price]	13.2	119.5	129.7	-7.4	
Sales at current price	[million liters]	1,414	2,222	139	1,078	
Sales at current retail price	[billion YR]	49.49	37.77	2.22	33.42	
Sales at international price (a)	[million liters]	1379	1898	127.9	1086	
Value of sales at international price	[billion YR]	54.7	70.9	4.7	31.2	
Economic subsidy	[billion YR]	5.2	33.1	2.5	-2.2	**38.5**
Subsidy as % of GDP	[%]	0.3	1.89	0.14	-0.13	**2.19**

(a) Based on the following price elasticity of demand: gasoline –0.2; diesel –0.2; kerosene –0.1, and fueloil –0.1.
(b) Based on Platts Gulf, December 2003, plus freight of 8.66$/ton (except fueloil at 6.71$/ton)

5.12 The main reason why these estimates are significantly lower than those of Table 5.3 is the adjustment for price elasticity – if petroleum products were priced at their economic price, the magnitude of the subsidy is not just the difference between the economic cost and the previous subsidized price (as in the calculation of Table

[18] IMF, *Republic of Yemen-Selected Issues*, December 5, 2003.
[19] *Yemen: Prices of Petroleum Products*, mimeo World Bank, 24 February 2003.

5.4) but a somewhat smaller amount that takes into account the smaller quantity consumed at the higher economic price. The World Bank estimate is thus the *economic* subsidy, while the IMF and the Ministry of Oil and Minerals' (MOM) estimates are accounting subsidies, i.e. the net difference between actual and border prices actually paid to YPC by the MoF.

5.13 The MOM estimates annual (accounting) subsidies paid to the two refineries as shown in Table 5.5. For 2002, the estimate of YR54.2 billion is substantially higher than that of Table 5.4. For 2003, this increases further to YR95 billion. Clearly this level of subsidy is unsustainable. In 2003 and 2004, the sharp increase in subsidies will have been offset to some extent by the increase in the value of crude oil exports as world oil prices have climbed to the 40-50$/bbl range. However, the GOY recognizes that using these increased oil revenues for subsidizing domestic oil consumption is not economically efficient, and reduces the available funds for social programs.

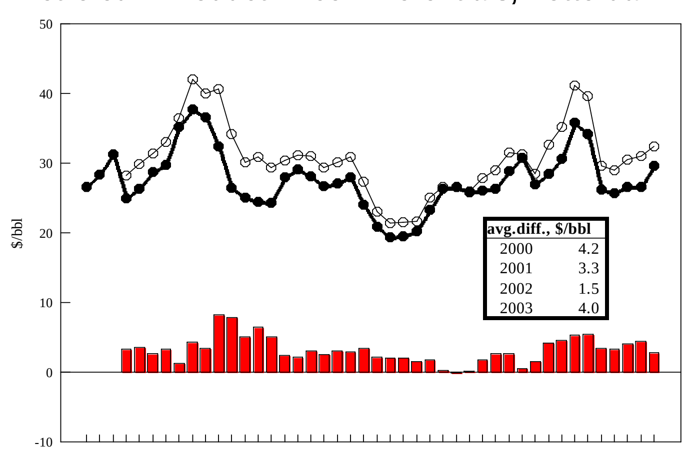
Table 5.5: Subsidies on Petroleum Products as Estimated by Ministry of Oil and Minerals (YR million)

	Aden	*Marib*	*Total*
2000	71,704	6,604	78,308
2001	50,328	3,783	54,111
2002	50,495	3,721	54,216
2003	88,740	6,820	95,560

Calculation of the Border Price for Petroleum Products

5.14 The first issue in calculating subsidies concerns the basis for calculating border prices for petroleum products. The present practice is to use Platts Rotterdam plus $17/ton freight as the basis – the rationale for which is unclear, since in fact the source of imported products would be the Gulf. Therefore, Platts Gulf is a more appropriate basis for calculating the economic price. The differential between Platts Gulf gas oil and Platts Rotterdam has varied in the past few years from around 1.5 to 4 $/bbl (Figure 5.4), averaging $3.25/bbl over the four-year period.

Figure 5.4: Petroleum Product Price Differentials, Rotterdam v Gulf Gas Oil



source: Platts

5.15 The estimates of subsidy made by the MoF, and the MOM are based on the differential between the ex-refinery price and the domestic price, less margins and distribution/transportation costs, as enumerated in Table 4.1. However, as noted earlier, the international prices used for this calculation do not reflect the actual international price, cif Aden, which is surely Platts Gulf plus freight from Gulf? Instead, the international price basis for the subsidy calculation is Platts Rotterdam or Mediterranean, which are significantly higher than Platts Gulf. Moreover, the notional transportation cost from Europe/ Mediterranean to Aden is $17/ton, as opposed to actual average bulk cargo cost from Gulf to Aden of around $7/ton.[20]

5.16 Table 5.6 shows average annual differentials between Platts Gulf and Rotterdam, and between Platts Gulf and Italy. Rotterdam is in fact the price basis used for the last few years. It may be noted that Rotterdam is actually fob barges (for onward transportation into Germany and other Inland European markets): it therefore generally has the highest prices among the various widely quoted (and significantly traded) European price basis options.

5.17 The differentials in the case of fueloil are *negative* – in other words, the cost of 3.5% sulfur fueloil in Europe is less than the published Gulf quotation for 180 cst fueloil. This is simply a reflection of supply and demand: because of environmental regulations in Europe, there is little demand for high sulfur fueloil. Much higher volumes in Europe are for low sulfur (1%S) fueloil, for which there is a substantial premium.

Table 5.6: Differentials v Gulf, $/bbl

		Rotterdam		*Italy*	
	Gulf	*fob*	*Differential to Gulf*	*fob*	*Differential to Gulf*
Kerosene					
2000	32.4	38.1	*5.7*	36.0	3.6
2001	26.5	30.7	*4.3*	26.7	0.3
2002	26.4	29.1	*2.7*	23.7	-2.8
2003	30.7	35.7	*5.0*		
2004 (a)	38.5	42.7	*4.2*		
Gasoline (b)					
2000	27.7	36.1	*8.4*	36.3	8.6
2001	24.0	29.3	*5.3*	28.6	4.6
2002	24.5	28.5	*4.0*	27.0	2.6
2003	28.8	35.1	*6.3*	33.0	4.2
2004	36.4	43.8	*7.3*	42.9	6.4
Diesel					
2000	30.4	35.1	*4.7*	34.9	4.5
2001	25.4	28.8	*3.3*	28.4	3.0
2002	25.8	27.3	*1.5*	26.6	0.9
2003	29.0	33.5	*4.4*	32.6	3.6
2004	37.2	38.6	*1.4*	38.2	1.0
Fueloil (c)					
2000	21.2	20.5	*-0.6*	19.2	-2.0
2001	17.8	17.1	*-0.7*	15.4	-2.4
2002	20.3	19.8	*-0.6*	18.3	-2.1

[20] This $17/ton reportedly also includes storage, handling and delivery costs at Aden, but these cannot account for more than 2-3$/ton. e

2003	22.9	22.4	*-0.5*	21.0	-1.9
2004	23.4	22.3	*-1.1*	20.8	-2.6

Source: Platts
(a) 2004 is first six months only
(b) Gasoline is premium unleaded 95
(c) 3.5%S

5.18 These are substantial differentials which have a significant effect on the calculations of subsidies. Table 5.7 shows the impact on the subsidy calculation based on differentials to Rotterdam, Table 5.8 on differentials to Italy.

Table 5.7: Impact of the Price Basis Assumption on Subsidy Calculations: Rotterdam Differentials for 2003

		Total	*Gasoline*	*Kerosene*	*Diesel*	*Fueloil*
Differential to Platts Gulf	[$/bbl]		6.3	5	4.4	-0.5
Transportation differential (a)	[$/bbl]		1.3	1.3	1.3	1.3
Total	[$/bbl]		7.6	6.3	5.7	0.8
$/liter	[$/liter]		0.048	0.040	0.036	0.005
Subsidy to refinery	[YR/liter]		8.37	6.94	6.28	0.89
Volume	[million liters]		1,497	136	2,474	1,001
Subsidy	[YR million]	29,908	12,534	944	15,540	889

(a) $17/ton notional freight from Rotterdam less $7/ton Gulf-Aden actual 2003 bulk cargoes divided by 7.65 bbls/ton = 1.3 $/bbl.

Table 5.8: Impact of the Price Basis Assumption on Subsidy Calculations: Mediterranean Differentials for 2003

		Total	*Gasoline*	*Kerosene*	*Diesel*	*Fueloil*
Differential to Platts Gulf	[$/bbl]		4.2	1.2	3.6	-1.9
Transportation differential	[$/bbl]		1.3	1.3	1.3	1.3
Total	[$/bbl]		5.5	2.5	4.9	-0.6
$/liter	[$/liter]		0.035	0.016	0.031	-0.004
Subsidy to refinery	[YR/liter]		6.06	2.76	5.40	-0.65
Volume	[million liters]		1,497	136	2,474	1,001
Subsidy	[YRmillion]	22,158	9,074	375	13,362	-653

5.19 It follows that of the total YR95 billion subsidy reported as having been paid, given Rotterdam as the pricing basis, YR30 billion is purely notional. The *actual* 2003 subsidy that arises purely from the difference between domestic price and the economic price, when a reasonable basis is employed, is therefore YR65 billion.

Subsidizing the Refinery

5.20 A detailed examination of the economics of the Aden Refinery lies outside the scope of this report. However, because it appears from available information that a significant portion of the subsidy on petroleum products is not a transfer to households but to the refinery, the subject is of great importance to the policy debate. Several points may be noted at the outset.

- Marib crude is of exceptional quality (API 49-51); export prices are therefore close to Brent.[21]
- In 2002, according to the MOM, 28 million bbl of Marib crude were "lifted" by the Aden refinery (from the Government's share of oil production), while 65 million bbls were exported.
- The Aden refinery is old and lacks secondary processing capability: the product slate poorly matches the domestic requirement (which is biased towards middle distillates). Large quantities of naphtha are exported (3.1 million bbls in 2002).
- The transactions that actually occur are not clear. It is reported that the refinery's allocation (of the Government share of crude) is swapped for a heavier crude (better suited to the domestic product mix); such a crude swap would certainly be logical, but the details were not available.
- If indeed crude is swapped, the economics and refining margins of operating old hydroskimming refineries such as Aden running typical Gulf crude oils are very unlikely to be favorable, compared to simply importing a product slate exactly matched to the domestic market.

Price Elasticity of Petroleum Products

5.21 The third issue concerns the values for price elasticities necessary to estimate the actual impact on Government revenue, should subsidies be reduced. For example, in the case of LPG, the subsidy is implicit since there is no flow of money from the MoF to YGC. However, were the subsidy reduced and prices increased, consumption would doubtless fall (by an amount determined by the price elasticicities). Consequently the actual revenue gain to Government may be somewhat less than suggested by the present quantities consumed.

5.22 However there exist no reliable studies of petroleum product and electricity price elasticities for Yemen.[22] But even in the absence of such Yemen-specific estimates, the least reasonable would be to assume inelastic consumer behavior (equivalent to the assumption of zero price elasticity). Based on experience

[21] In 2002, the average differential for Marib light was 0.21$/bbl less than Brent. (MoOM, *Annual Bulletin #2*).

[22] Some evidence may be drawn from the cross-sectional household survey data, but a number of issues constrain more rigorous econometric study:

- There are no time-series data of consumption (except possibly for electricity, which could in principle be extracted from PEC records, but the only recent computerization would make construction of a 15-20 year time series practically very difficult).
- For petroleum products, because price increases have been infrequent, even with time-series data it is hard to reliably separate out income and price effects.

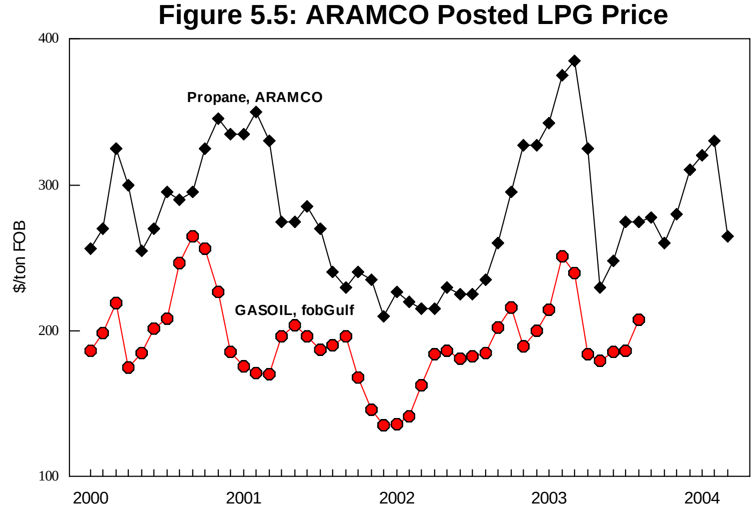
elsewhere, values of -0.1 for diesel,[23] -0.2 for kerosene, and -0.3 for LPG are assumed in the calculations below.[24]

Estimated Border Prices and Accounting Subsidies for 2003

5.23 Estimating border prices, cif Aden, is straight-forward, based on Platts Gulf plus freight of $8.66/ton (except $6.71/ton for fueloil). To this are added the various margins and taxes identified in Table 4.1.

5.24 Estimating the economic price of LPG is more difficult, and can be considered in two ways. Since LPG is recovered from the associated gas at Marib, the opportunity cost (i.e. if exported rather than consumed domestically) would be ARAMCO posted price *less* transportation from Marib to the Yemen coast. Since there are many potential export customers in South Asia (such as Sri Lanka), for whom the ocean transportation cost would be roughly the same from ARAMCO/Gulf or Aden, the fob price Yemen could obtain would likely be the ARAMCO price (or slightly less). The 2003 average ARAMCO LPG price was $300/ton, and the transportation cost Marib-Coast can be taken at the same rate as the present average primary transportation cost ex Marib (in large tanker-trucks), namely YR3.77/kg., so the economic price computes to 300*175/1000-3.77 = YR48.7 /kg.[25]

Figure 5.5: ARAMCO Posted LPG Price



5.25 On the other hand, once production at Marib no longer meets domestic demand growth, as seems likely at some point in the future, then the relevant price is ARAMCO *plus* Ocean freight to Aden. Assuming ocean transport in 5,000-tonne pressurized vessels at 25$/ton, the economic cost CIF Aden would therefore be (300+25) *175 /1000 = YR 56.9/kg. The result is shown in Table 5.9.

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[23] Household purchases of diesel are mainly for agriculture (cash crops), water pumping and self generation - uses likely to be relatively inelastic.

[24] With the retail price at only 30% of the economic price, LPG is used very inefficiently (compared to other countries where LPG prices are relatively higher). There is substantial scope for more efficient use in response to price changes.

[25] Data on actual export prices of LPG produced at the Aden refinery, which would be the better indicator than the above estimate, were not available to the mission.

Table 5.9: 2003 Border Prices and Accounting Subsidies

		LPG	*Gasoline*	*Kerosene (b)*	*Diesel*	*Fueloil*
Platts Gulf, annual average	[$/bbl]		28.80	30.70	29.00	22.90
Freight Gulf-Aden	[$/ton]		8.66	8.66	8.66	6.71
	[$/bbl]		1.03	1.09	1.15	1.01
Aramco LPG (see text)	[YR/kg.]	48.7				
cif price	[$/bbl]		29.83	31.79	30.15	23.91
	[YR/bbl]		5578	5945	5639	4472
	[YR/liter]	26.54	34.9	37.2	35.2	27.9
Economic costs [distribution] (a)	[YR/liter]	4.93	5.28	2.88	3.02	4.52
Economic price	[YR/liter]	**31.5**	**40.1**	**40.0**	**38.3**	**32.5**
Taxes	[YR/liter]	0.3	1.5	0.3	1.5	0.4
Economic price (plus taxes)	[YR/liter]	31.8	41.6	40.3	39.8	32.8
Actual retail price (incl.taxes) (a)	[YR/liter]	10.2	35.0	16.0	17.0	31.0
Net subsidy	[YR/liter]	**21.6**	**6.6**	**24.3**	**22.8**	**1.8**
2003 consumption	[million liters]	1158	1414	135	2475	1001
Accounting subsidy	[billion YR]	25.1	9.3	3.3	56.3	1.8
% of total subsidy	[%]	26%	10%	3%	59%	2%
% of import parity price	[%]	32%	84%	40%	43%	94%
% of 2003 Govt expenditure	[%]	3%	1%	0%	8%	0%
% of non-oil GDP	[%]	2%	1%	0%	4%	0%
% of 2003 development spending	[%]	16%	6%	2%	37%	1%

(a) from Table 4.1
(b) excluding Jet fuel sold at international prices.

5.26 Therefore, in this report the estimate of total subsidies (accounting subsidy) for petroleum products, including LPG, is YR96 billion. Excluding LPG, the total is YR70.7 billion, which is substantially below the YR95.5 billion shown in the MOM statistics that apply only to products distributed by YPC (Table 5.5). There are two reasons for this: first, the MOM statistics use Rotterdam +$17/ton as the pricing basis, which overestimates the true border price (except for fueloil). Second, as noted earlier, a significant part of the MOM estimate is a subsidy to the refinery, rather than to the consumer.

Do the Subsidies Reach the Poor?

5.27 However, the critical question for the household energy sector, and one of the main subjects of this report, is the extent to which these subsidies actually reach the poor.

LPG

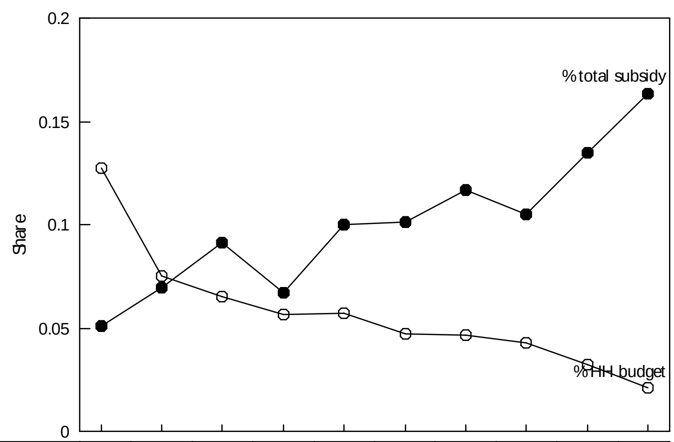
5.28 As noted in the introduction, LPG is the most highly subsidized of all petroleum products: in 2003, the domestic price was only 23% of the import parity price. The LPG subsidy is not included in many of the estimates of petroleum product subsidies (such as that compiled by MOM in Table 5.5). Experience in other countries suggests that at the present level of subsidy, conversion of vehicles from gasoline to LPG will accelerate. Attempts to price domestic size bottles at a lower price than at filling stations will be unlikely to succeed, as again experience elsewhere shows that this simply leads to illicit conversion of vehicles to use domestic bottles.

5.29 Table 5.10 and Figure 5.6 show LPG subsidies by income decile. The top decile captures over three times the subsidy of the bottom decile (16% v. 4%). [26]

Table 5.10: LPG Subsidies by Income Decile

			Subsidy		*For HH reporting use*		
		consumption	total	captured by each decile	subsidy	total expenditure	subsidy
		[1000 tons/year]	[10^6 YR]	[%]	[YR/month]	[YR/month]	[% of total expenditure]
1	0-9000	28	1123	5%	1080	8481	12.7%
2	9001-12000	39	1537	7%	1209	16021	7.5%
3	12001-15000	51	2006	9%	1206	18389	6.6%
4	15001-19800	37	1474	7%	1213	21365	5.7%
5	19801-22500	55	2203	10%	1318	22990	5.7%
6	22501-27000	56	2227	10%	1309	27591	4.7%
7	27001-33000	65	2578	12%	1529	32867	4.7%
8	33001-42700	58	2315	11%	1422	33326	4.3%
9	42701-61000	75	2965	13%	1607	49248	3.3%
10	61001>0	91	3602	16%	1950	91469	2.1%
	Total	555	22029	100%	1415	31997	4.4%

Figure 5.6: Fraction of Total LPG Subsidy to Household, Captured by Each Income Decile



	d[1]	d[2]	d[3]	d[4]	d[5]	d[6]	d[7]	d[8]	d[9]	d[10]
%total subsidy	5%	7%	9%	7%	10%	10%	12%	11%	13%	16%
%HH budget	12.7%	7.5%	6.6%	5.7%	5.7%	4.7%	4.7%	4.3%	3.3%	2.1%

[26] Note that the subsidy shown here of YR30.3 billion relates only to the 88% of total LPG consumption by households, and is therefore correspondingly smaller than the total LPG subsidy shown in Table 5.10.

Kerosene

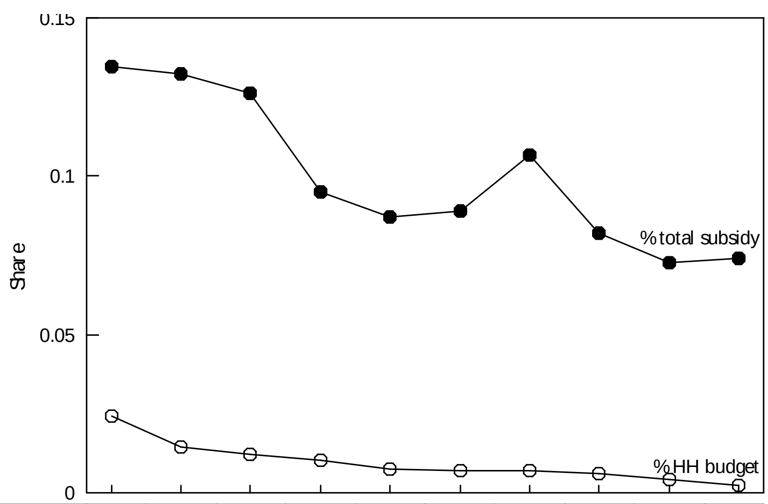
5.30 As shown in Table 5.11, as a percentage of household income, the subsidy is more important to the poorest decile (13% of income) than to the richest (7%). However, the variation across deciles is relatively small (unlike that for diesel, where 43% of the total is captured by the richest decile).

Table 5.11: Kerosene Subsidies by Income Decile (2003).

			Subsidy		*For HH reporting use*		
		consumption	total	% received by each decile	subsidy	total expenditure	subsidy
		[10^6 liters/year]	[10^6 YR]	[%]	[YR/month]	[YR/month]	[% of total expenditure]
1	0-9000	18	382	13%	208	8481	2.5%
2	9001-12000	18	377	13%	230	16021	1.4%
3	12001-15000	17	359	13%	224	18389	1.2%
4	15001-19800	13	270	9%	224	21365	1.0%
5	19801-22500	12	248	9%	178	22990	0.8%
6	22501-27000	12	253	9%	194	27591	0.7%
7	27001-33000	15	303	11%	230	32867	0.7%
8	33001-42700	11	233	8%	210	33326	0.6%
9	42701-61000	10	206	7%	209	49248	0.4%
10	61001>0	10	211	7%	206	91469	0.2%
	Total	137	2842	100%	212	31997	0.7%

5.31 The variation in the corresponding share of total household budget is much greater: the subsidy is equivalent to 4.3% of the total expenditure of the poorest decile, but only 0.4% of the top decile (Figure 5.7).

Figure 5.7: Fraction of Total Kerosene Subsidy to Household Captured by Each Income Decile



	d[1]	d[2]	d[3]	d[4]	d[5]	d[6]	d[7]	d[8]	d[9]	d[10]
%total subsidy	13%	13%	13%	9%	9%	9%	11%	8%	7%	7%
%HH budget	2.5%	1.4%	1.2%	1.0%	0.8%	0.7%	0.7%	0.6%	0.4%	0.2%

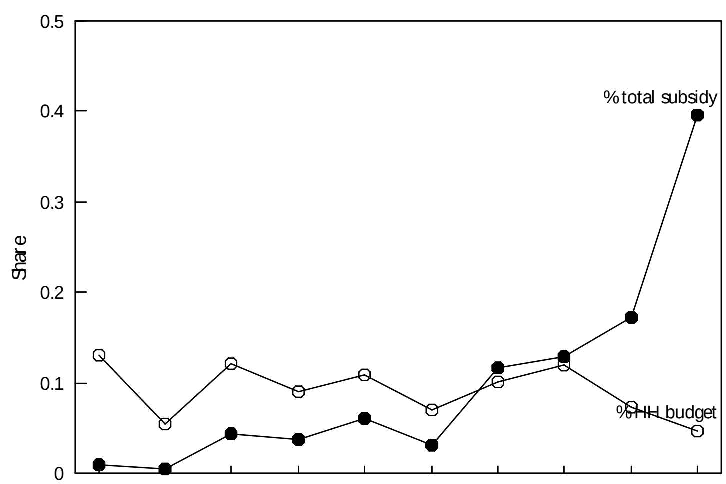
Diesel

5.32 Table 5.12 and Figure 5.8 show the incidence of diesel subsidies by income decile. 57% of the total subsidy (associated with direct use) is captured by the two top deciles: the bottom three deciles capture 6% of the total – a simple reflection of the low direct diesel use in the low deciles.

Table 5.12: Diesel Subsidies by Income Decile

			Subsidy		*For HH reporting use*		
		consumption	total	captured by each decile	subsidy	Total expenditure	subsidy
	Income decile	[10^6 liters/year]	[10^6 yr]	[%]	[YR/month]	[YR/month]	[% of total expenditure]
1	0-9000	5	93	1%	1114	8481	13.1%
2	9001-12000	3	52	1%	870	16021	5.4%
3	12001-15000	21	427	4%	2247	18389	12.2%
4	15001-19800	18	375	4%	1935	21365	9.1%
5	19801-22500	29	597	6%	2507	22990	10.9%
6	22501-27000	15	305	3%	1952	27591	7.1%
7	27001-33000	57	1147	12%	3304	32867	10.1%
8	33001-42700	62	1266	13%	3982	33326	11.9%
9	42701-61000	84	1699	17%	3581	49248	7.3%
10	61001>0	192	3899	40%	4335	91469	4.7%
	total	486	9861	100%	3331	31997	10.4%

Figure 5.8: Fraction of Total Diesel Subsidy to Household, Captured by Each Income Decile



	d[1]	d[2]	d[3]	d[4]	d[5]	d[6]	d[7]	d[8]	d[9]	d[10]
● %total subsidy	1%	1%	4%	4%	6%	3%	12%	13%	17%	40%
⊖ %HH budget	13.1%	5.4%	12.2%	9.1%	10.9%	7.1%	10.1%	11.9%	7.3%	4.7%

Summary of the Impacts of Petroleum Product Subsidies

5.33 Petroleum product subsidies in Yemen are among the highest in the world and have been growing over the past few years as domestic prices have stayed unchanged while international prices have increased sharply. In 2003, these subsidies amounted to some YR98 billion, and will be higher still in 2004. This level of subsidy is not sustainable.

5.34 Nor do the subsidies benefit the poor. Most (57%) of the direct subsidy on diesel that is directly used by households is captured by the two top deciles. The LPG subsidy is also poorly targeted: 5% is captured by the poorest decile, but 16% by the top income decile. The kerosene subsidy is the most targeted, with the bottom decile capturing some 13% as against 7% captured by the top decile. This reflects that fact that most kerosene is in fact used by the poor.

5.35 Table 5.13 illustrates the policy trade-offs associated with petroleum product subsidies, uniform pricing and *ad hoc* infrequent adjustments to prices. The impact of these policies on each of the four major objectives noted in the introduction is noted. Subsidizing petroleum products is rarely sound policy. Box 5.2 summarizes the economic impacts of subsidies, and sets out the reasons why removal of petroleum product subsidies is unlikely to have significant macroeconomic impacts.

Table 5.13 Impacts of Present (late 2004) Petroleum Product Pricing Policies

	Actual Impact			
Policy	*Economic efficiency*	*Cost recovery*	*Environment*	*Social equity*
	[1]	[2]	[3]	[4]
Petroleum product subsidies	Distorts choices (e.g. industry uses diesel self-generation rather than PEC grid)	High revenue industrial customers lost to PEC; worsens PEC financial situation	Even electrified households continue to use low-cost kerosene and LPG for lighting; kerosene has high health cost	Most of the subsidy is received by the well-off not by the poor
Uniform petroleum product pricing (e.g. single price for fueloil, unconnected to quality)		Poor fueloil quality imposes costs on PEC (high sulfur content corrodes equipment)	No incentive for refinery to produce low-sulfur fuels	
Ad hoc petroleum pricing policy (prices adjusted infrequently, typically only every five years)	Over time, differential between border price and domestic price grows, creating distortions in fuel use	Creates serious periodic imbalances in GOY budget		Poor exposed to sudden jumps in fuel prices (70% increase in diesel price in 1997; 70% in 2001)

Reduction of Petroleum Product Subsidies

5.36 When petroleum product subsidies are reduced and removed altogether, expenditures by households will be affected and there will be an impact on the cost of goods and on inflation generally. The likely magnitude of these effects is discussed in the following sections.

The Need for a Comprehensive Petroleum Pricing Strategy

5.37 International experience shows clearly the dangers of focusing only on a single fuel. In Chapter 4 it was noted that at present LPG has a 13% price advantage over diesel at the present diesel price. Therefore, if only diesel prices are adjusted, but prices of LPG and kerosene are left at their present level, the distortions will increase.

5.38 If, for example, diesel prices were brought to their economic level, but LPG and kerosene were left at their present prices, the relative price of LPG and kerosene would fall sharply: LPG would be 40% of the diesel price (rather than 87% as at present), and kerosene would be 45% of the diesel price (rather than 97% as at present), as shown in Table 5.14. Under such relative prices, one must expect large amounts of kerosene to be used to dilute diesel in transportation applications, and larger amounts of LPG diverted from household use into the sorts of new applications noted in Annex 6, Volume 2 (such as its use in diesel irrigation pumps).

Table 5.I4: Impact of Diesel Price Increases on Relative Prices

		LPG	***gasoline***	***kerosene***	***diesel***
Cost per liter	[YR/liter]	10.2	35.0	16.0	37.0
calorific value	[MJ/liter]	24.5	32.4	34.4	35.4
Cost per MJ	[YR/MJ]	0.42	1.08	0.47	1.05
Cost relative to diesel		40%	103%	45%	100%
Cost relative to diesel at present prices		87%	225%	97%	

Direct and Indirect Effects of Removing the Diesel Subsidy

5.39 There is widespread concern in Yemen that removing the diesel subsidy would have a significant impact on the cost of goods and on the CPI generally. Given that poor households make little direct purchase of diesel it is the indirect impact, notably on food prices (through the cost of transportation) and on water prices (because groundwater is extracted for both irrigation and drinking water) that is of greatest public concern.

5.40 If prices of all petroleum products were raised to their economic levels, the impact on the different income deciles is estimated as shown in Table 5.15. The *direct* impact of adjusting fuel prices on the various income groups can be calculated by applying the difference between the economic price and the actual prices paid for each of the various fuels to the consumption data for each income decile. Since almost all kerosene and LPG are purchased directly by households, the indirect impacts attributable to these fuels are minimal. Note that the impacts shown in Table

5.41 5.15 are averaged across all households in each income decile; i.e. it includes households who do not consume. For the impact on those households in each income decile which consume the fuels, see Tables 5.10, 5.11. and 5.12. Thus, the direct impact of diesel subsidy removal on the highest income decile is 1.6% (Table 5.15) for all households in the income decile and 4.7% (Table 5.12) for households in the highest income decile that consume diesel directly.

5.42 The *indirect* impact of diesel subsidy removal would be best estimated by application of an input-output model, an accounting framework that could be used to predict price changes in all goods consumed in Yemen as a result of changes in the diesel price. In the absence of such a model an *upper bound* of the increase in the cost of non-energy goods can be estimated by calculating how food prices would be impacted if all the diesel not consumed by PEC and in direct consumption by households were consumed in the production and transport of food. In this (hypothetical) case (diesel is also consumed in other sectors), since food accounts for 54% of household expenditure in the lowest decile and 36% in the highest decile, the poor would be affected disproportionately if food prices were to rise as consequence of higher diesel prices.

Table 5.15: Impact of Bringing Petroleum Products to their Economic Price as % of Present Household Expenditure

	d[1] lowest income decile	*d[2]*	*d[3]*	*d[4]*	*d[5]*	*d[6]*	*d[7]*	*d[8]*	*d[9]*	*d[10] highest income decile*
LPG	6.5%	4.8%	5.1%	4.3%	4.8%	4.2%	4.1%	3.5%	3.1%	2.0%
Kerosene	2.4%	1.3%	1.0%	0.9%	0.6%	0.5%	0.5%	0.5%	0.2%	0.1%
Diesel direct impact only	0.4%	0.1%	0.8%	0.8%	1.0%	0.4%	1.3%	1.4%	1.3%	1.6%
Diesel indirect impact only	5.0%	4.7%	4.4%	4.2%	4.5%	4.4%	4.0%	4.0%	3.6%	3.2%
Electricity (as a result of diesel subsidy removal)	0.2%	0.2%	0.2%	0.3%	0.2%	0.3%	0.3%	0.2%	0.3%	0.2%
Total	14.4%	11.1%	11.5%	10.4%	11.1%	9.8%	10.2%	9.7%	8.5%	7.1%

Note: The HES may have underestimated total household expenditure by as much as 30%. Applying this adjustment to the calculations in the table above would reduce the impacts by this same amount

5.43 Table 5.16 gives the impact of removing the subsidy on only those households who actually use the various fuels. Note that these cannot be added down the rows since the same households do not consume each of the fuels. The numbers for diesel show the biggest variations, since diesel is used by small fractions of households in the lower deciles.

Table 5.16: For Households Consuming Each Fuel; Impact of Bringing Petroleum Products to their Economic Price as % of Present Household Expenditure

	d[1] *lowest income decile*	*d[2]*	*d[3]*	*d[4]*	*d[5]*	*d[6]*	*d[7]*	*d[8]*	*d[9]*	*d[10]* *highest income decile*
LPG	12.7%	7.5%	6.6%	5.7%	5.7%	4.7%	4.7%	4.3%	3.3%	2.1%
Kerosene	2.5%	1.4%	1.2%	1.0%	0.8%	0.7%	0.7%	0.6%	0.4%	0.2%
Diesel	13.1%	5.4%	12.2%	9.1%	10.9%	7.1%	10.1%	11.9%	7.3%	4.7%

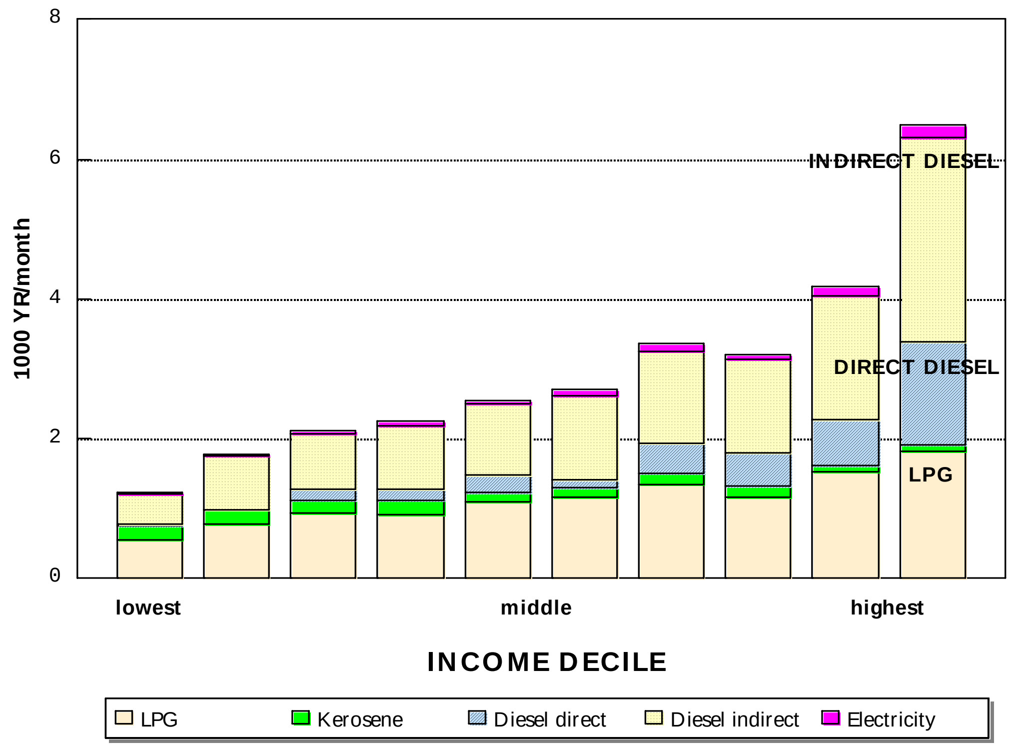
5.44 However, these effects do not take into account the price response of consumers. If the price of diesel were to increase, farmers would use diesel fuel more sparingly; there would be an incentive to improve efficiency of pumps, in the transport sector, trucks would be dispatched more carefully, and so on. PEC would use less diesel and more fueloil (which it could do at some of its more modern units) – all of which would tend to reduce the above impacts. More importantly, the indirect impacts are an upper bound: the actual impact would be considerably less (as suggested on previous occasions when the diesel price was increased by comparable amounts).

5.45 The aggregate affects of eliminating subsidies on each of the fuels are regressive – i.e. they have far greater impact on the poor than on the better off.

5.46 Figure 5.9 shows the impacts of eliminating petroleum product subsidies by decile. Figure 5.10 shows the relative importance of direct and indirect impacts of eliminating diesel subsidies by decile. For diesel, in the lowest decile, the indirect impact dominates, while in the top decile, the indirect impact accounts for only 60% of the total, with a much larger *direct* impact (much of which is diesel for self-generation and agricultural irrigation by rich farmers).

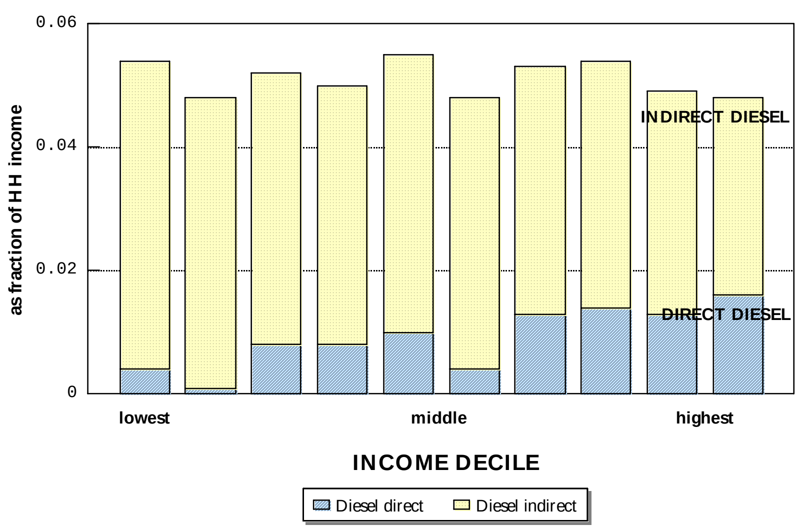
5.47 Sectors that make direct diesel purchases, such as transport and farming that uses pumped water, would be hard hit by removal of the diesel subsidy. So too would water sellers engaged in groundwater abstraction and distribution.

Figure 5.9: Impact of Bringing Petroleum Products to their Economic Price: Direct and Indirect Impacts



Note: percentage figure= total impact as percent of monthly HH expenditure

Figure 5.10: Impact of Bringing Diesel to its Economic Price (Direct and Indirect Impacts)



Impact on Water Prices

5.48 Only 32% of the population has access to drinking water from a public supply and therefore large sections of the population are dependent upon purchased water, which, in turn, is dependent upon diesel, both for groundwater extraction and for bulk transportation. The impact on purchased water prices will therefore be one of the critical issues in the political economy of reducing subsidies, and is discussed in detail in Annex 5 (Volume 2).

5.49 Elimination of the diesel subsidy would result in the cost of wholesale (bulk) water to increase 10-15%. But demand for bulk water is likely to be elastic: it is relatively easy to use 10-15% less for washing, bathing, etc. if one wants to adjust to higher prices by reducing consumption. The survey shows the average urban purchased water bill is 3,000 YR/HH/month, and thus the average household would therefore face an increase of 300-450 YR/month. However, the bulk water supply is consumed by the non poor: for example, the top urban income decile spends 6,750 YR/month on purchased water. But if these groups adjusted to higher prices by conservation, that could only be to the good of Yemen.

5.50 On the other hand, drinking water demand is inelastic and a basic human need. 79% of poor urban households buy water, spending 900 YR/month. If diesel increased to 20 YR/liter, their water costs would increase by 10-15% (assuming they access a bulk water supply), or 90-140 YR/month. This increase represents about 1% of their total household expenditure. Similarly, 35% of poor rural households buy water, spending 330 YR/month. If diesel increased to 20 YR/liter, their water costs would increase by 10-15%, or 33 to 66 YR/month. This increase represents 0.5% of their household expenditure.

5.51 Thus the impact of diesel price increases on (purchased) drinking water is small. The most significant impact is on the urban poor, because a much smaller proportion of the rural poor purchase water. However, even for the urban poor, the impact is about 1% of their monthly income.

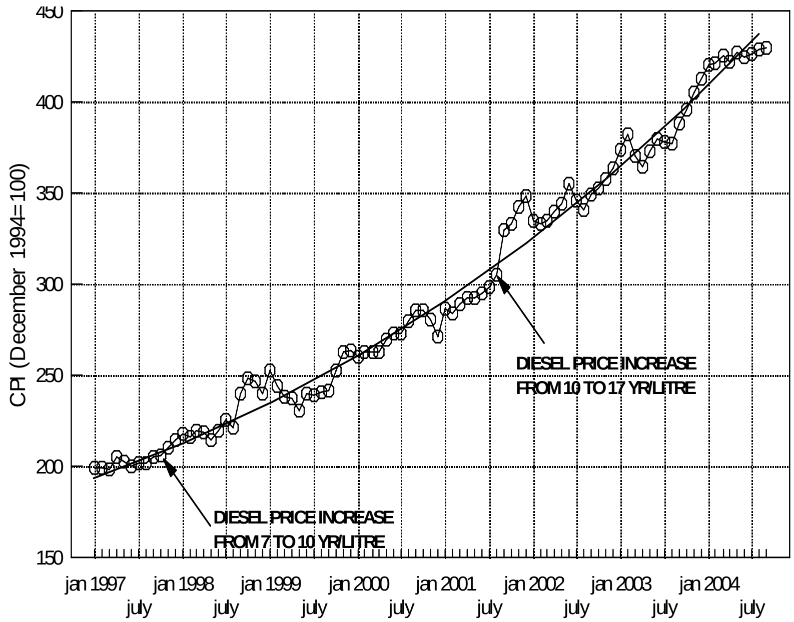
Past Experience of Diesel Price Increases

5.52 Some indication of the impact of petroleum price increases on household budgets can be gained by examination of the historical record. For example, diesel prices were last raised in mid-2001 (from 10 YR/liter to 17 YR/liter); the previous price increase occurred in late 1997, when the price was raised from 6 YR/liter. Can one discern any direct and indirect effects of these price increases (70% in both instances) on the CPI? In 2001, diesel consumption was 1,891 million liters: the increase of 7 YR/liter therefore represented a total increase of YR 11.8 billion. In 2001, private consumption (roughly equal to all household expenditures subject to the CPI) was YR1,050 billion; therefore, the diesel price increase was equivalent to 1% of household expenditure.

5.53 Over the longer term, the impact on CPI would be more than the 1% suggested by the above calculation. If higher diesel prices resulted in higher salaries and wages, then non-diesel input costs for consumer goods and services would also increase, increasing output costs, putting further pressure on salaries and wages, and so forth. A secondary effect can be represented by a multiplier which has typical values of between 1.2-1.8. Therefore the total effect of the 2001 diesel price increase on the CPI was likely to lie between 1 and 2%.

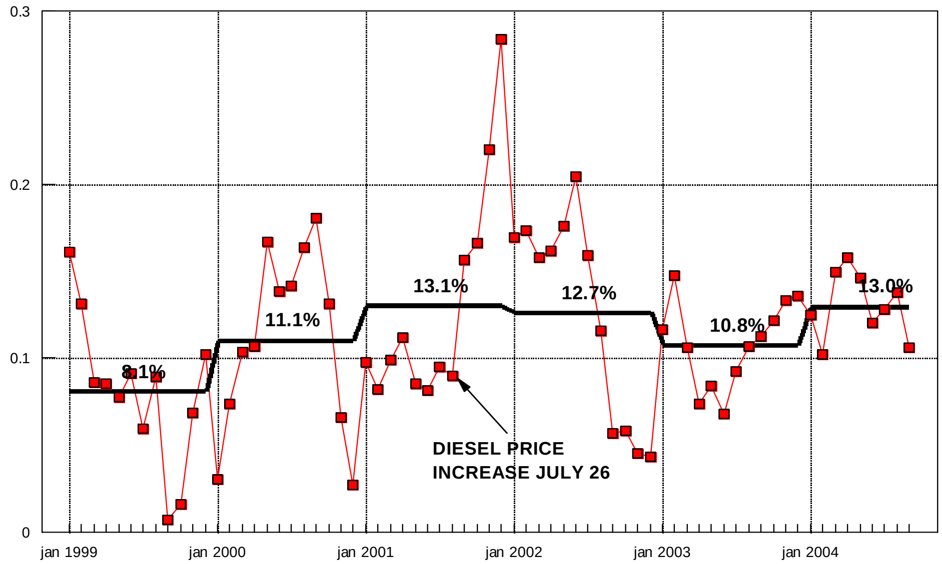
5.54 Figure 5.11 shows the diesel price superimposed on the monthly CPI. It does appear that in the months following the price increases, the inflation rate accelerated with respect to the average inflation trend.

Figure 5.11: CPI and Diesel Price Increases



5.55 The effect of normal seasonal effects can be factored out of the CPI by examining the year-on-year inflation rates (Figure 5.12). In 2000, the average inflation rate (in the CPI) was 11.1%, followed by 13.1% in 2001, the year of the diesel price increase, followed by 12.7% and 10.8% in 2002 and 2003, respectively. One does observe an inflation spike immediately following the diesel price increase of 2001, but this is followed by a period of declining rates of inflation, so the overall impact in the annual inflation rate is within the 2% suggested above. A more detailed analysis of quarterly inflation rates in Annex 4, Volume 2, confirms these results.

Figure 5.12: Year-on-year Inflation Rates in the CPI



Attributes of a Desirable Petroleum Product Pricing System

5.56 In addition to being based on true border costs, as discussed above, a pricing system for petroleum products should have two further attributes: the prices charged should be related to the quality of fuels delivered; and prices should be adjusted regularly to reflect world market trends – thereby avoiding the present situation where very large adjustments must be made after several years of constant domestic prices.

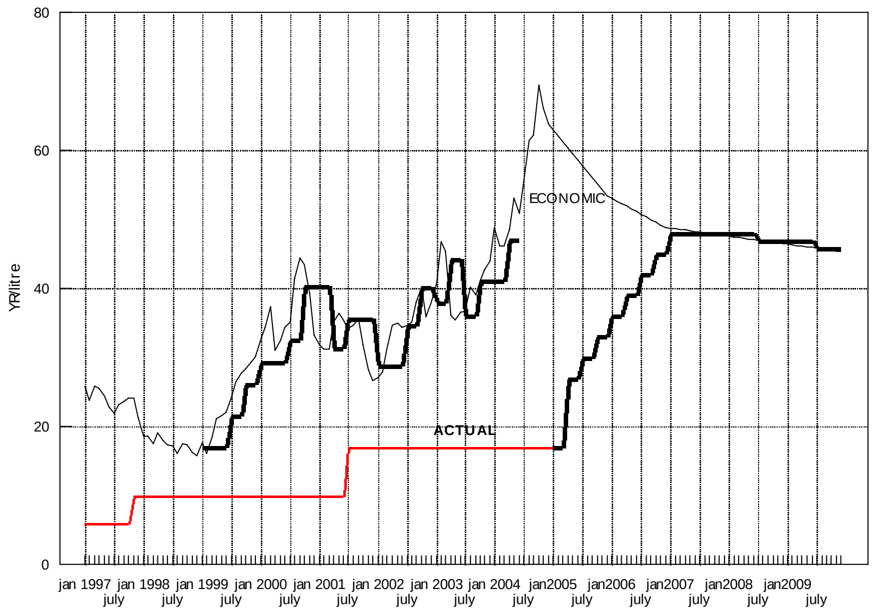
5.57 PEC in particular has encountered problems with the fueloil that it receives from YPC, since the high sulfur content of some deliveries corrodes equipment. A rational pricing system would price fueloil according to its sulfur content, in accordance with world market differentials.

Adjustment to changing conditions

5.58 The present system of *ad hoc* adjustments of retail prices has numerous disadvantages. Prices should signal to consumers the real economic costs of the energy they purchase; as world oil prices change, so should retail prices. Of course it is not necessary that retail prices should change every day, for the international oil markets are increasingly volatile. However, many countries have now instituted retail pricing systems in which retail prices are adjusted once a month (or once a quarter), based on average prices during the previous month. Box 5.4 describes the system introduced in 2002 for Sri Lanka.

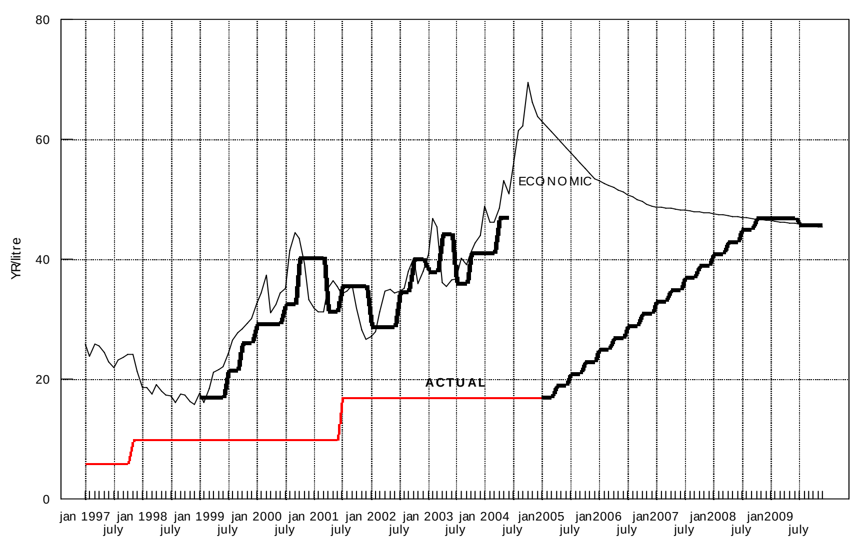
5.59 Figures 5.13 and 5.14 show a simulation of a pricing system that meets the attribute of adjusting prices according to market trends without needing to make adjustments for volatile price spikes of short duration. The simulations assume that prices are adjusted quarterly to reflect the average economic price of the previous quarter. This is calculated as Gulf gas oil plus freight plus the present YPC margins plus an additional margin to the refinery for transportation of fuels from the refinery to YPC's five main depots. Figure 5.13 simulates the price adjustment path if the diesel price is raised immediately by 10 YR/liter and thereafter by 2 YR/liter per quarter. Under this scenario the economic price would be reached in about two years. Fig 5.14 simulates the price adjustment path if there is no immediate step increase but only quarterly increases of 2 YR/liter.

Figure 5.13: Sample Simulation of New Pricing System. Immediate 10 YR/liter Increase. Thereafter Quarterly Increases of 2 YR/liter



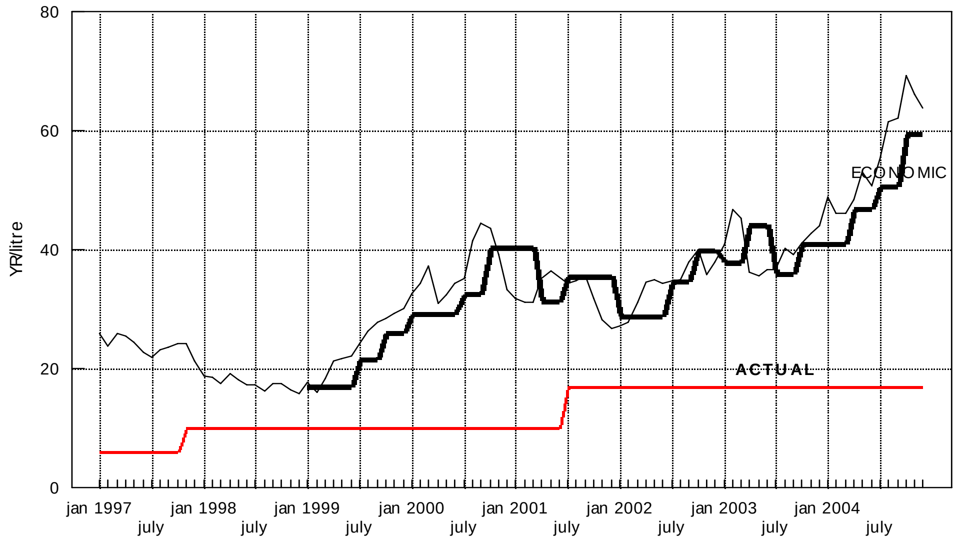
Notes: (1) World oil price assumption for this simulation is \$32/bbl by 2006 and \$32.00/bbl by 2010.
(2) Diesel price is adjusted every three months, set at the average of the previous quarter:
(3) Prices are changed only if the increment is greater than 1 YR/liter.

Figure 5.14: Sample Simulation of New Pricing System. No Immediate Price Adjustment. Quarterly Increases of 2YR/liter



5.60 Figure 5.15 demonstrates how automatic price adjustment would have worked in the past if (following the system in Sri Lanka) adjustments were only made when the difference between the economic price of the previous quarter and the retail price at the time is greater than 2 YR/liter. In some cases this would have resulted in six months of stable prices (e.g. during the last quarter of 2002-first quarter of 2003). The price dip in late 2003, and the price spike in February 2003 are seen to have been smoothed out. Under this system, the retail price in the second quarter of 2004 would have been 47 YR/liter. However, had the system been introduced in late 1998, when oil prices were at an all-time low, the main price rise to current levels would have been a series of price increases from 17 YR/liter in January 1999 to 35 YR/liter by late 2000 – i.e. the increase would have been spread over a 12-month period.

Figure 5.15: How Automatic Price Adjustment System Would Have Worked in the Past



Box 5.4: Petroleum Product Pricing System in Sri Lanka

Until 2001 the petroleum pricing system in Sri Lanka was much the same as in Yemen: price adjustments were made on an *ad hoc* basis, usually at the point at which subsidies had increased to unsustainable levels. But in 2002 a new system was introduced as part of a package of petroleum sector reforms. Prices are adjusted monthly, based on the previous month's average of daily Singapore Platts quotations. For pump prices to be revised, the increment must be at least 0.25 Sri Lanka Rupees (Rs.)/liter (0.5 YR/liter), and the adjustment is subject to a maximum monthly limit of 2.00 Rs/liter (4 YR/liter). The system is applied to kerosene, gasoline, diesel and fueloil. The table shows the details of a calculation for a world oil price of 35$/bbl.

		Petrol	***Diesel***	
World oil price	$/bbl	35	35	
fob Singapore [Platts]	$/bbl	46.22	44.2	average of the previous month
	bbls/ton	8.38	7.52	
Freight $/ton	$/ton	11	11	
Jetty pipeline charge	$/ton	3	3	
Freight & jetty	$/bbl	1.67	1.86	
cif, $/bbl	$/bbl	47.89	46.08	
Exchange rate	[Rs/$]	94.83	94.83	average of the previous month
cif, Rs/liter	Rs/liter	28.58	27.50	
Stamp duty	Rs/liter	0.34	0.33	
Landed cost	Rs/liter	28.92	27.83	
Excise duty	Rs/liter	30.00	6.50	fixed amount for 2002 and 2003
Customs duty	Rs/liter			
	Rs/liter	58.92	34.33	
National security levy	Rs/liter	2.32	2.23	
GST (since replaced by VAT)	Rs/liter			presently only on fueloil
Tax paid landed cost	Rs/liter	61.25	36.57	
CPC finance charge	Rs/liter	2.54	2.54	fixed amounts for 2002
CPC wholesale costs	Rs/liter	0.24	0.24	for 2002 only
CPC margin	Rs/liter			for 2002 zero on petrol and diesel
CPC wholesale cost	Rs/liter	64.03	39.35	
Marketing +distribution cost	Rs/liter	1.23	1.23	for 2002 only
Dealer discount	Rs/liter	0.46	0.26	
Consumer retail price	Rs/liter	65.72	40.84	

The Ceylon Petroleum Corporation (CPC) owns the refinery, and was previously responsible for product distribution – combining the functions of the Aden refinery and YPC. CPC is now being unbundled, and CPC has lost the import monopoly on oil products: The Indian National Oil Company (plus another party yet to be determined) provide competition in the oil sector.

Recommendations for Implementation of Removal of Petroleum Product Subsidies

5.61 In order to minimize the impact on households, it is therefore recommended that the elimination of subsidies be achieved through an immediate large one-time increase that significantly reduces the subsidy and that thereafter prices be adjusted quarterly over a period of two years through an automatic price-setting mechanism as outlined above. This phased approach, which would allow households a satisfactory period of time to adjust their expenditure patterns without large shocks, could be structured along the following lines:

- Subsidies should be eliminated on all petroleum products if even greater distortions are to be avoided. If diesel subsidies are removed and other fuels are left unadjusted, distortions of the present system will only be amplified. Since kerosene is easily substituted for diesel, if the price differential between the kerosene and diesel widens, kerosene will be used in place of diesel in transport and in stationary engines. Similarly, if the price differential between LPG and diesel widens, diesel LPG will be used in cars and stationary engines.

5.62 The main features of the petroleum pricing formula would be :

- Price-setting formula is transparent and should be published. The Government should announce a timetable for eliminating subsidies on all petroleum products and LPG, with prices to increase by a constant increment every quarter until such time as the retail price reaches its economic price.
- The retail price lags the world price by one quarter based on the assumption that the long-term international price will return to the 2003 level. The price should be set at the average of the previous quarter.
- The economic price for all products should be reached within a reasonable time period, say within two years. If world prices fall from the present level in early 2005, then the economic price would be reached sooner. If international prices rise, the resultant quarterly increase would continue until such time as the international price is reached. Prices should be adjusted only if the calculated increment is greater than 2 YR/liter.
- The pricing formula smoothes out large daily and monthly fluctuations on world oil markets, but follows the longer term trend, thereby giving proper signals to consumers.
- The price formula should be based on Platts Gulf plus freight (not Platts Rotterdam)

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Joint UNDP/World Bank

ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

LIST OF REPORTS ON COMPLETED ACTIVITIES

Region/Country	***Activity/Report Title***	***Date***	***Number***
	SUB-SAHARAN AFRICA (AFR)		
Africa Regional	Anglophone Africa Household Energy Workshop (English)	07/88	085/88
	Regional Power Seminar on Reducing Electric Power System Losses in Africa (English)	08/88	087/88
	Institutional Evaluation of EGL (English)	02/89	098/89
	Biomass Mapping Regional Workshops (English)	05/89	--
	Francophone Household Energy Workshop (French)	08/89	--
	Interafrican Electrical Engineering College: Proposals for Short- and Long-Term Development (English)	03/90	112/90
	Biomass Assessment and Mapping (English)	03/90	--
	Symposium on Power Sector Reform and Efficiency Improvement in Sub-Saharan Africa (English)	06/96	182/96
	Commercialization of Marginal Gas Fields (English)	12/97	201/97
	Commercilizing Natural Gas: Lessons from the Seminar in Nairobi for Sub-Saharan Africa and Beyond	01/00	225/00
	Africa Gas Initiative – Main Report: Volume I	02/01	240/01
	First World Bank Workshop on the Petroleum Products Sector in Sub-Saharan Africa	09/01	245/01
	Ministerial Workshop on Women in Energy	10/01	250/01
	Energy and Poverty Reduction: Proceedings from a Multi-Sector And Multi-Stakeholder Workshop Addis Ababa, Ethiopia, October 23-25, 2002.	03/03	266/03
	Opportunities for Power Trade in the Nile Basin: Final Scoping Study	01/04	277/04
	Énergies modernes et réduction de la pauvreté: Un atelier multi-sectoriel. Actes de l'atelier régional. Dakar, Sénégal, du 4 au 6 février 2003 (French Only)	01/04	278/04
	Énergies modernes et réduction de la pauvreté: Un atelier multi-sectoriel. Actes de l'atelier régional. Douala, Cameroun du 16-18 juillet 2003. (French Only)	09/04	286/04
	Energy and Poverty Reduction: Proceedings from the Global Village Energy Partnership (GVEP) Workshops held in Africa	01/05	298/05
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	Africa Gas Initiative – Angola: Volume II	02/01	240/01
Benin	Energy Assessment (English and French)	06/85	5222-BEN
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	Tuli Block Farms Electrification Study (English)	07/87	072/87
	Household Energy Issues Study (English)	02/88	--
	Urban Household Energy Strategy Study (English)	05/91	132/91
Burkina Faso	Energy Assessment (English and French)	01/86	5730-BUR
	Technical Assistance Program (English)	03/86	052/86
	Urban Household Energy Strategy Study (English and French)	06/91	134/91
Burundi	Energy Assessment (English)	06/82	3778-BU

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Burundi	Petroleum Supply Management (English)	01/84	012/84
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	Household Energy Strategy Study (English)	02/90	110/90
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	Power Sector Efficiency Study (French)	02/92	140/91
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	Africa Gas Initiative – Côte d'Ivoire: Volume V	02/01	240/01
Ethiopia	Energy Assessment (English)	07/84	4741-ET
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	Agricultural Residue Briquetting Pilot Project (English)	12/86	062/86
	Bagasse Study (English)	12/86	063/86
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Gabon	Energy Assessment (English)	07/88	6915-GA
	Africa Gas Initiative – Gabon: Volume VI	02/01	240/01
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Ghana	Energy Assessment (English)	11/86	6234-GH
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	Sawmill Residues Utilization Study (English)	11/88	074/87
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	Status Report (English)	05/84	016/84

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	Power Loss Reduction Study (English)	09/96	186/96
	Implementation Manual: Financing Mechanisms for Solar Electric Equipment	07/00	231/00
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Liberia	Energy Assessment (English)	12/84	5279-LBR
	Recommended Technical Assistance Projects (English)	06/85	038/85
	Power System Efficiency Study (English)	12/87	081/87
Madagascar	Energy Assessment (English)	01/87	5700-MAG
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	Household Energy Strategy (English and French)	03/92	147/92
Islamic Republic of Mauritania	Energy Assessment (English and French)	04/85	5224-MAU
	Household Energy Strategy Study (English and French)	07/90	123/90
Mauritius	Energy Assessment (English)	12/81	3510-MAS
	Status Report (English)	10/83	008/83
	Power System Efficiency Audit (English)	05/87	070/87
	Bagasse Power Potential (English)	10/87	077/87
	Energy Sector Review (English)	12/94	3643-MAS
Mozambique	Energy Assessment (English)	01/87	6128-MOZ
	Household Electricity Utilization Study (English)	03/90	113/90
	Electricity Tariffs Study (English)	06/96	181/96
	Sample Survey of Low Voltage Electricity Customers	06/97	195/97
Namibia	Energy Assessment (English)	03/93	11320-NAM
Niger	Energy Assessment (French)	05/84	4642-NIR
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	Energy Assessment (English and French)	07/91	8017-RW
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SADC	SADC Regional Power Interconnection Study, Vols. I-IV (English)	12/93	-
SADCC	SADCC Regional Sector: Regional Capacity-Building Program for Energy Surveys and Policy Analysis (English)	11/91	-
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Senegal	Energy Assessment (English)	07/83	4182-SE

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	Industrial Energy Conservation Program (English)	05/94	165/94
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Zambia	Energy Assessment (English)	01/83	4110-ZA
	Status Report (English)	08/85	039/85
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	Urban Household Energy Strategy Study (English)	08/90	121/90
Zimbabwe	Energy Assessment (English)	06/82	3765-ZIM
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	Status Report (English)	08/84	019/84

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	Improving the Technical Efficiency of Decentralized Power Companies	09/99	222/99
	Air Pollution and Acid Rain Control: The Case of Shijiazhuang City and the Changsha Triangle Area	10/03	267/03
	Toward a Sustainable Coal Sector In China	07/04	287/04
	Demand Side Management in a Restructured Industry: How Regulation and Policy Can Deliver Demand-Side Management Benefits to a Growing Economy and a Changing Power System	12/05	314/05
Fiji	Energy Assessment (English)	06/83	4462-FIJ
Indonesia	Energy Assessment (English)	11/81	3543-IND
	Status Report (English)	09/84	022/84
	Power Generation Efficiency Study (English)	02/86	050/86
	Energy Efficiency in the Brick, Tile and Lime Industries (English)	04/87	067/87
	Diesel Generating Plant Efficiency Study (English)	12/88	095/88
	Urban Household Energy Strategy Study (English)	02/90	107/90
	Biomass Gasifier Preinvestment Study Vols. I & II (English)	12/90	124/90
	Prospects for Biomass Power Generation with Emphasis on Palm Oil, Sugar, Rubberwood and Plywood Residues (English)	11/94	167/94
Lao PDR	Urban Electricity Demand Assessment Study (English)	03/93	154/93
	Institutional Development for Off-Grid Electrification	06/99	215/99
Malaysia	Sabah Power System Efficiency Study (English)	03/87	068/87
	Gas Utilization Study (English)	09/91	9645-MA
Mongolia	Energy Efficiency in the Electricity and District Heating Sectors	10/01	247/01
	Improved Space Heating Stoves for Ulaanbaatar	03/02	254/02
	Impact of Improved Stoves on Indoor Air Quality in Ulaanbaatar, Mongolia	11/05	313/05
Myanmar	Energy Assessment (English)	06/85	5416-BA

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Papua New Guinea	Energy Assessment (English)	06/82	3882-PNG
	Status Report (English)	07/83	006/83
	Institutional Review in the Energy Sector (English)	10/84	023/84
	Power Tariff Study (English)	10/84	024/84
Philippines	Commercial Potential for Power Production from Agricultural Residues (English)	12/93	157/93
	Energy Conservation Study (English)	08/94	--
	Strengthening the Non-Conventional and Rural Energy Development Program in the Philippines: A Policy Framework and Action Plan	08/01	243/01
	Rural Electrification and Development in the Philippines: Measuring the Social and Economic Benefits	05/02	255/02
Solomon Islands	Energy Assessment (English)	06/83	4404-SOL
	Energy Assessment (English)	01/92	979-SOL
South Pacific	Petroleum Transport in the South Pacific (English)	05/86	--
Thailand	Energy Assessment (English)	09/85	5793-TH
	Rural Energy Issues and Options (English)	09/85	044/85
	Accelerated Dissemination of Improved Stoves and Charcoal Kilns (English)	09/87	079/87
	Northeast Region Village Forestry and Woodfuels Preinvestment Study (English)	02/88	083/88
	Impact of Lower Oil Prices (English)	08/88	--
	Coal Development and Utilization Study (English)	10/89	--
	Why Liberalization May Stall in a Mature Power Market: A Review of the Technical and Political Economy Factors that Constrained the Electricity Sector Reform in Thailand 1998-2002	12/03	270/03
	Reducing Emissions from Motorcycles in Bangkok	10/03	275/03
Tonga	Energy Assessment (English)	06/85	5498-TON
Vanuatu	Energy Assessment (English)	06/85	5577-VA
Vietnam	Rural and Household Energy-Issues and Options (English)	01/94	161/94
	Power Sector Reform and Restructuring in Vietnam: Final Report to the Steering Committee (English and Vietnamese)	09/95	174/95
	Household Energy Technical Assistance: Improved Coal Briquetting and Commercialized Dissemination of Higher Efficiency Biomass and Coal Stoves (English)	01/96	178/96
	Petroleum Fiscal Issues and Policies for Fluctuating Oil Prices In Vietnam	02/01	236/01
	An Overnight Success: Vietnam's Switch to Unleaded Gasoline	08/02	257/02
	The Electricity Law for Vietnam—Status and Policy Issues—The Socialist Republic of Vietnam	08/02	259/02
	Petroleum Sector Technical Assistance for the Revision of the Existing Legal and Regulatory Framework	12/03	269/03
Western Samoa	Energy Assessment (English)	06/85	5497-WSO

SOUTH ASIA (SAS)

Bangladesh	Energy Assessment (English)	10/82	3873-BD
	Priority Investment Program (English)	05/83	002/83
	Status Report (English)	04/84	015/84
	Power System Efficiency Study (English)	02/85	031/85
	Small Scale Uses of Gas Pre-feasibility Study (English)	12/88	--
	Reducing Emissions from Baby-Taxis in Dhaka	01/02	253/02

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India	Opportunities for Commercialization of Non-conventional Energy Systems (English)	11/88	091/88
	Maharashtra Bagasse Energy Efficiency Project (English)	07/90	120/90
	Mini-Hydro Development on Irrigation Dams and Canal Drops Vols. I, II and III (English)	07/91	139/91
	WindFarm Pre-Investment Study (English)	12/92	150/92
	Power Sector Reform Seminar (English)	04/94	166/94
	Environmental Issues in the Power Sector (English)	06/98	205/98
	Environmental Issues in the Power Sector: Manual for Environmental Decision Making (English)	06/99	213/99
	Household Energy Strategies for Urban India: The Case of Hyderabad	06/99	214/99
	Greenhouse Gas Mitigation In the Power Sector: Case Studies From India	02/01	237/01
	Energy Strategies for Rural India: Evidence from Six States	08/02	258/02
	Household Energy, Indoor Air Pollution, and Health	11/02	261/02
	Access of the Poor to Clean Household Fuels	07/03	263/03
	The Impact of Energy on Women's Lives in Rural India	01/04	276/04
	Environmental Issues in the Power Sector: Long-Term Impacts And Policy Options for Rajasthan	10/04	292/04
	Environmental Issues in the Power Sector: Long-Term Impacts And Policy Options for Karnataka	10/04	293/04
Nepal	Energy Assessment (English)	08/83	4474-NEP
	Status Report (English)	01/85	028/84
	Energy Efficiency & Fuel Substitution in Industries (English)	06/93	158/93
Pakistan	Household Energy Assessment (English)	05/88	--
	Assessment of Photovoltaic Programs, Applications, and Markets (English)	10/89	103/89
Pakistan	National Household Energy Survey and Strategy Formulation Study: Project Terminal Report (English)	03/94	--
	Managing the Energy Transition (English)	10/94	--
	Lighting Efficiency Improvement Program Phase 1: Commercial Buildings Five Year Plan (English)	10/94	--
	Clean Fuels	10/01	246/01
Regional	Toward Cleaner Urban Air in South Asia: Tackling Transport Pollution, Understanding Sources.	03/04	281/04
Sri Lanka	Energy Assessment (English)	05/82	3792-CE
	Power System Loss Reduction Study (English)	07/83	007/83
	Status Report (English)	01/84	010/84
	Industrial Energy Conservation Study (English)	03/86	054/86
	Sustainable Transport Options for Sri Lanka: Vol. I	02/03	262/03
	Greenhouse Gas Mitigation Options in the Sri Lanka Power Sector: Vol. II	02/03	262/03
	Sri Lanka Electric Power Technology Assessment (SLEPTA): Vol. III	02/03	262/03
	Energy and Poverty Reduction: Proceedings from South Asia Practitioners Workshop How Can Modern Energy Services Contribute to Poverty Reduction? Colombo, Sri Lanka, June 2-4, 2003	11/03	268/03

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EUROPE AND CENTRAL ASIA (ECA)

Armenia	Development of Heat Strategies for Urban Areas of Low-income Transition Economies. Urban Heating Strategy for the Republic Of Armenia. *Including a Summary of a Heating Strategy for the Kyrgyz Republic*	04/04	282/04
Bulgaria	Natural Gas Policies and Issues (English)	10/96	188/96
	Energy Environment Review	10/02	260/02
Central Asia and The Caucasus	Cleaner Transport Fuels in Central Asia and the Caucasus	08/01	242/01
Central and Eastern Europe	Power Sector Reform in Selected Countries	07/97	196/97
Central and Eastern Europe	Increasing the Efficiency of Heating Systems in Central and Eastern Europe and the Former Soviet Union (English and Russian)	08/00	234/00
	The Future of Natural Gas in Eastern Europe (English)	08/92	149/92
Kazakhstan	Natural Gas Investment Study, Volumes 1, 2 & 3	12/97	199/97
Kazakhstan & Kyrgyzstan	Opportunities for Renewable Energy Development	11/97	16855-KAZ
Poland	Energy Sector Restructuring Program Vols. I-V (English)	01/93	153/93
	Natural Gas Upstream Policy (English and Polish)	08/98	206/98
	Energy Sector Restructuring Program: Establishing the Energy Regulation Authority	10/98	208/98
Portugal	Energy Assessment (English)	04/84	4824-PO
Romania	Natural Gas Development Strategy (English)	12/96	192/96
	Private Sector Participation in Market-Based Energy-Efficiency Financing Schemes: Lessons Learned from Romania and International Experiences.	11/03	274/03
Slovenia	Workshop on Private Participation in the Power Sector (English)	02/99	211/99
Turkey	Energy Assessment (English)	03/83	3877-TU
	Energy and the Environment: Issues and Options Paper	04/00	229/00
	Energy and Environment Review: Synthesis Report	12/03	273/03

MIDDLE EAST AND NORTH AFRICA (MNA)

Arab Republic of Egypt	Energy Assessment (English)	10/96	189/96
	Energy Assessment (English and French)	03/84	4157-MOR
	Status Report (English and French)	01/86	048/86
Morocco	Energy Sector Institutional Development Study (English and French)	07/95	173/95
	Natural Gas Pricing Study (French)	10/98	209/98
	Gas Development Plan Phase II (French)	02/99	210/99
Syria	Energy Assessment (English)	05/86	5822-SYR
	Electric Power Efficiency Study (English)	09/88	089/88
	Energy Efficiency Improvement in the Cement Sector (English)	04/89	099/89
	Energy Efficiency Improvement in the Fertilizer Sector (English)	06/90	115/90
Tunisia	Fuel Substitution (English and French)	03/90	--
	Power Efficiency Study (English and French)	02/92	136/91
	Energy Management Strategy in the Residential and Tertiary Sectors (English)	04/92	146/92
	Renewable Energy Strategy Study, Volume I (French)	11/96	190A/96
	Renewable Energy Strategy Study, Volume II (French)	11/96	190B/96

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Tunisia	Rural Electrification in Tunisia: National Commitment, Efficient Implementation and Sound Finances	08/05	307/05
Yemen	Energy Assessment (English)	12/84	4892-YAR
	Energy Investment Priorities (English)	02/87	6376-YAR
	Household Energy Strategy Study Phase I (English)	03/91	126/91
	Household Energy Supply and Use in Yemen. Volume I: Main Report and Volume II: Annexes	12/05	315/05

LATIN AMERICA AND THE CARIBBEAN REGION (LCR)

LCR Regional	Regional Seminar on Electric Power System Loss Reduction in the Caribbean (English)	07/89	--
	Elimination of Lead in Gasoline in Latin America and the Caribbean (English and Spanish)	04/97	194/97
LCR Regional	Elimination of Lead in Gasoline in Latin America and the Caribbean - Status Report (English and Spanish)	12/97	200/97
	Harmonization of Fuels Specifications in Latin America and the Caribbean (English and Spanish)	06/98	203/98
	Energy and Poverty Reduction: Proceedings from the Global Village Energy Partnership (GVEP) Workshop held in Bolivia	06/05	202/05
	Power Sector Reform and the Rural Poor in Central America	12/04	297/04
	Estudio Comparativo Sobre la Distribución de la Renta Petrolera en Bolivia, Colombia, Ecuador y Perú	08/05	304/05
Bolivia	Energy Assessment (English)	04/83	4213-BO
	National Energy Plan (English)	12/87	--
	La Paz Private Power Technical Assistance (English)	11/90	111/90
	Pre-feasibility Evaluation Rural Electrification and Demand Assessment (English and Spanish)	04/91	129/91
	National Energy Plan (Spanish)	08/91	131/91
	Private Power Generation and Transmission (English)	01/92	137/91
	Natural Gas Distribution: Economics and Regulation (English)	03/92	125/92
	Natural Gas Sector Policies and Issues (English and Spanish)	12/93	164/93
	Household Rural Energy Strategy (English and Spanish)	01/94	162/94
	Preparation of Capitalization of the Hydrocarbon Sector	12/96	191/96
	Introducing Competition into the Electricity Supply Industry in Developing Countries: Lessons from Bolivia	08/00	233/00
	Final Report on Operational Activities Rural Energy and Energy Efficiency	08/00	235/00
	Oil Industry Training for Indigenous People: The Bolivian Experience (English and Spanish)	09/01	244/01
	Capacitación de Pueblos Indígenas en la Actividad Petrolera. Fase II	07/04	290/04
	Estudio Sobre Aplicaciones en Pequeña Escala de Gas Natural	07/04	291/04
Brazil	Energy Efficiency & Conservation: Strategic Partnership for Energy Efficiency in Brazil (English)	01/95	170/95
	Hydro and Thermal Power Sector Study	09/97	197/97
	Rural Electrification with Renewable Energy Systems in the Northeast: A Preinvestment Study	07/00	232/00
	Reducing Energy Costs in Municipal Water Supply Operations “Learning-while-doing” Energy M&T on the Brazilian Frontlines	07/03	265/03
Chile	Energy Sector Review (English)	08/88	7129-CH
Colombia	Energy Strategy Paper (English)	12/86	--
	Power Sector Restructuring (English)	11/94	169/94

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Colombia	Energy Efficiency Report for the Commercial and Public Sector (English)	06/96	184/96
Costa Rica	Energy Assessment (English and Spanish)	01/84	4655-CR
	Recommended Technical Assistance Projects (English)	11/84	027/84
	Forest Residues Utilization Study (English and Spanish)	02/90	108/90
Dominican Republic	Energy Assessment (English)	05/91	8234-DO
Ecuador	Energy Assessment (Spanish)	12/85	5865-EC
	Energy Strategy Phase I (Spanish)	07/88	--
	Energy Strategy (English)	04/91	--
	Private Mini-hydropower Development Study (English)	11/92	--
	Energy Pricing Subsidies and Interfuel Substitution (English)	08/94	11798-EC
	Energy Pricing, Poverty and Social Mitigation (English)	08/94	12831-EC
Guatemala	Issues and Options in the Energy Sector (English)	09/93	12160-GU
	Health Impacts of Traditional Fuel Use	08/04	284/04
Haiti	Energy Assessment (English and French)	06/82	3672-HA
	Status Report (English and French)	08/85	041/85
	Household Energy Strategy (English and French)	12/91	143/91
Honduras	Energy Assessment (English)	08/87	6476-HO
	Petroleum Supply Management (English)	03/91	128/91
Jamaica	Energy Assessment (English)	04/85	5466-JM
	Petroleum Procurement, Refining, and Distribution Study (English)	11/86	061/86
	Energy Efficiency Building Code Phase I (English)	03/88	--
	Energy Efficiency Standards and Labels Phase I (English)	03/88	--
Jamaica	Management Information System Phase I (English)	03/88	--
	Charcoal Production Project (English)	09/88	090/88
	FIDCO Sawmill Residues Utilization Study (English)	09/88	088/88
	Energy Sector Strategy and Investment Planning Study (English)	07/92	135/92
Mexico	Improved Charcoal Production Within Forest Management for the State of Veracruz (English and Spanish)	08/91	138/91
	Energy Efficiency Management Technical Assistance to the Comisión Nacional para el Ahorro de Energía (CONAE) (English)	04/96	180/96
	Energy Environment Review	05/01	241/01
Nicaragua	Modernizing the Fuelwood Sector in Managua and León	12/01	252/01
Panama	Power System Efficiency Study (English)	06/83	004/83
Paraguay	Energy Assessment (English)	10/84	5145-PA
	Recommended Technical Assistance Projects (English)	09/85	--
	Status Report (English and Spanish)	09/85	043/85
Peru	Energy Assessment (English)	01/84	4677-PE
	Status Report (English)	08/85	040/85
	Proposal for a Stove Dissemination Program in the Sierra (English and Spanish)	02/87	064/87
	Energy Strategy (English and Spanish)	12/90	--
	Study of Energy Taxation and Liberalization of the Hydrocarbons Sector (English and Spanish)	120/93	159/93
	Reform and Privatization in the Hydrocarbon Sector (English and Spanish)	07/99	216/99
	Rural Electrification	02/01	238/01
Saint Lucia	Energy Assessment (English)	09/84	5111-SLU
St. Vincent and the Grenadines	Energy Assessment (English)	09/84	5103-STV

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Sub Andean	Environmental and Social Regulation of Oil and Gas Operations in Sensitive Areas of the Sub-Andean Basin (English and Spanish)	07/99	217/99
Trinidad and Tobago	Energy Assessment (English)	12/85	5930-TR
	GLOBAL		
	Energy End Use Efficiency: Research and Strategy (English)	11/89	--
	Women and Energy--A Resource Guide The International Network: Policies and Experience (English)	04/90	--
	Guidelines for Utility Customer Management and Metering (English and Spanish)	07/91	--
	Assessment of Personal Computer Models for Energy Planning in Developing Countries (English)	10/91	--
	Long-Term Gas Contracts Principles and Applications (English)	02/93	152/93
	Comparative Behavior of Firms Under Public and Private Ownership (English)	05/93	155/93
	Development of Regional Electric Power Networks (English)	10/94	--
	Roundtable on Energy Efficiency (English)	02/95	171/95
	Assessing Pollution Abatement Policies with a Case Study of Ankara (English)	11/95	177/95
	A Synopsis of the Third Annual Roundtable on Independent Power Projects: Rhetoric and Reality (English)	08/96	187/96
	Rural Energy and Development Roundtable (English)	05/98	202/98
	A Synopsis of the Second Roundtable on Energy Efficiency: Institutional and Financial Delivery Mechanisms (English)	09/98	207/98
	The Effect of a Shadow Price on Carbon Emission in the Energy Portfolio of the World Bank: A Carbon Backcasting Exercise (English)	02/99	212/99
	Increasing the Efficiency of Gas Distribution Phase 1: Case Studies and Thematic Data Sheets	07/99	218/99
	Global Energy Sector Reform in Developing Countries: A Scorecard	07/99	219/99
	Global Lighting Services for the Poor Phase II: Text Marketing of Small “Solar” Batteries for Rural Electrification Purposes	08/99	220/99
	A Review of the Renewable Energy Activities of the UNDP/ World Bank Energy Sector Management Assistance Programme 1993 to 1998	11/99	223/99
	Energy, Transportation and Environment: Policy Options for Environmental Improvement	12/99	224/99
	Privatization, Competition and Regulation in the British Electricity Industry, With Implications for Developing Countries	02/00	226/00
	Reducing the Cost of Grid Extension for Rural Electrification	02/00	227/00
	Undeveloped Oil and Gas Fields in the Industrializing World	02/01	239/01
	Best Practice Manual: Promoting Decentralized Electrification Investment	10/01	248/01
	Peri-Urban Electricity Consumers—A Forgotten but Important Group: What Can We Do to Electrify Them?	10/01	249/01
	Village Power 2000: Empowering People and Transforming Markets	10/01	251/01
	Private Financing for Community Infrastructure	05/02	256/02

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	Stakeholder Involvement in Options Assessment: Promoting Dialogue in Meeting Water and Energy Needs: A Sourcebook	07/03	264/03
	A Review of ESMAP's Energy Efficiency Portfolio	11/03	271/03
	A Review of ESMAP's Rural Energy and Renewable Energy Portfolio	04/04	280/04
	ESMAP Renewable Energy and Energy Efficiency Reports 1998-2004 (CD Only)	05/04	283/04
	Regulation of Associated Gas Flaring and Venting: *A Global Overview and Lessons Learned from International Experience*	08/04	285/04
	ESMAP Gender in Energy Reports and Other related Information (CD Only)	11/04	288/04
	ESMAP Indoor Air Pollution Reports and Other related Information (CD Only)	11/04	289/04
	Energy and Poverty Reduction: Proceedings from the Global Village Energy Partnership (GVEP) Workshop on the Pre-Investment Funding. Berlin, Germany, April 23-24, 2003.	11/04	294/04
	Global Village Energy Partnership (GVEP) Annual Report 2003	12/04	295/04
	Energy and Poverty Reduction: Proceedings from the Global Village Energy Partnership (GVEP) Workshop on Consumer Lending and Microfinance to Expand Access to Energy Services, Manila, Philippines, May 19-21, 2004	12/04	296/04
	The Impact of Higher Oil Prices on Low Income Countries And on the Poor	03/05	299/05
	Advancing Bioenergy for Sustainable Development: Guideline For Policymakers and Investors	04/05	300/05
	ESMAP Rural Energy Reports 1999-2005	03/05	301/05
	Renewable Energy and Energy Efficiency Financing and Policy Network: Options Study and Proceedings of the International Forum	07/05	303/05
	Implementing Power Rationing in a Sensible Way: Lessons Learned and International Best Practices	08/05	305/05
	The Urban Household Energy Transition. Joint Report with RFF Press/ESMAP. ISBN 1-933115-07-6	08/05	309/05
	Pioneering New Approaches in Support of Sustainable Development In the Extractive Sector: Community Development Toolkit, also Includes a CD containing Supporting Reports	10/05	310/05
	Analysis of Power Projects with Private Participation Under Stress	10/05	311/05
	Potential for Biofuels for Transport in Developing Countries	10/05	312/05

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