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1999 INSIGHTS

WORLD ENERGY OUTLOOK

Looking at Energy Subsidies: Getting the Prices Right

SUSTAINABLE DEVELOPMENT

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PREFACE

The International Energy Agency's most recent *World Energy Outlook*, released at the end of 1998, foresaw that developing and transition countries would account for two-thirds of the overall increase in global energy demand to 2020. The report also highlighted the issue of pricing distortions as a key uncertainty in the outlook for energy demand growth and for the fuel mix. This study, the first in a series addressing key issues raised in the *Outlook*, focuses on energy subsidies that encourage over-consumption by keeping prices below cost. It assesses quantitatively the extent of energy subsidies and provides an indicative estimate of the potential gains from removing them — in terms of energy savings, lower carbon dioxide emissions, improved economic efficiency and reduced burdens on government budgets.

The study demonstrates that energy resources are significantly under-priced in eight of the largest countries outside the OECD, which represent collectively around a quarter of world energy use. These price subsidies, most often designed to meet social policy goals, result in substantial economic losses and impose heavy burdens on the local and global environment. The detailed quantitative analysis presented here suggests that the removal of energy price subsidies in those eight countries could result in a tangible improvement in economic efficiency and could reduce energy consumption and related environmental impacts by a sizeable amount.

Most countries around the world, including all those covered here, are now pursuing policies aimed at increasing the role of the market in the economy and in the provision of energy supplies. In most cases, price-subsidy reduction or removal and the lifting of price controls constitute central features of these policies. Those energy subsidies that remain are focused increasingly on supporting activities that could bring long-run economic and environmental benefits, such as renewables research and development. Considerable progress has been made already in reducing energy subsidies in most OECD countries. This study demonstrates that much remains to be done, particularly in many non-OECD countries. While meeting the challenge is far from straightforward, the benefits — for the countries concerned and for the global environment — are potentially large.

This study was authored by Fatih Birol, Head of Economic Analysis Division of the Office of Long Term Co-operation and Policy Analysis and by Jan Horst Keppler, Principal Administrator. The core project team also included Trevor Morgan, Principal Administrator, and David Felman, consultant. The IEA Secretariat would like to place on record its gratitude for helpful comments and information it received from Member countries.

The book is published on my authority as Executive Director of the IEA.

Robert Priddle
Executive Director

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A project as large and broad as this one could not have been completed just by the Economic Analysis Division's core project team. Many people from inside and outside the IEA have contributed to it. An enormously important task, to which many of the energy or statistical experts listed below contributed, involved finding, verifying and processing large amounts of price and cost data. The conceptual and methodological framework for the study could not have been produced without helpful discussion with colleagues from the OECD, the World Bank, Asia Pacific Energy Research Centre, and World Energy Council. Outstanding statistical support was provided by Sandrine Duchesne. The manuscript was expertly prepared by Alison Sadin. All share the credit for accomplishing this complex exercise but they bear no responsibility for errors, omissions or misjudgement, these remains solely with the authors.

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Workshop on Energy Pricing Practices

The methodology and key findings of this book were presented and discussed at the Workshop on "Energy Pricing Practices: Impacts on Economy and Environment", in September 1999 in Tokyo. The book has substantially benefited from the comments and remarks made by the participants of this workshop.

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EXECUTIVE SUMMARY

Energy subsidies, particularly those encouraging energy consumption by keeping prices below cost, impose a heavy weight on economic efficiency, environmental performance and government budgets. While this is well known in principle, very few detailed quantitative estimates exist of the true costs of energy subsidies and the gains possible from removing them. Information is particularly poor for developing countries, which are projected to contribute two-thirds of the world's incremental energy demand in the next twenty years.

The International Energy Agency (IEA) decided to undertake this study to fill, at least in part, this information gap. The project makes important progress in identifying the key effects — on domestic consumption, carbon dioxide emissions and global energy markets — of energy subsidies in developing and transition countries.

Removing energy subsidies would support the three principal aims of sustainable development: social welfare, environmental protection and economic growth. Funds supporting subsidies could be redirected to social benefits and income redistribution. Environmental benefits accrue from proper pricing, which could reduce both local and global pollution (including CO_2 emissions). Economic growth would be boosted through improved efficiency and reduced budget costs. Subsidy removal can also have a longer-term impact. It contributes to per capita welfare over time by eliminating one stimulus for over-consumption (which leads to the rapid depletion of the stock of natural capital) and stimulates technologies capable of enhancing sustainable development.

The study confirms that pervasive under-pricing of energy resources occurs in eight of the largest countries outside the OECD: China, India, Indonesia, Iran, Kazakhstan, Russia, South Africa and Venezuela. On average, for all these countries end-use prices are approximately 20% below their opportunity cost or market-based reference levels, despite substantial progress in recent years to move towards more rational pricing and market-based policies. These price subsidies result in substantial economic losses and impose burdens on the environment. The detailed quantitative analysis suggests that the removal of energy price subsidies in these eight countries would:

- reduce primary energy consumption by 13%;
- increase GDP through higher economic efficiency by almost 1%;
- lower CO_2 emissions by 16%; and
- produce domestic environmental benefits, including reduced local air pollution.

Positive effects on a global scale are to be expected. Subsidy removal in all eight countries would cut energy consumption by 3.5% at world level, thus improving world energy intensity significantly. World CO_2 emissions would fall by 4.6%.

In addition to these benefits, subsidy removal entails a number of qualitative and dynamic gains. Global energy security would improve through a decrease in energy imports and increased availability of energy goods for export. World markets for natural gas and petroleum products would particularly benefit from such a shift. Most important, countries implementing energy-sector reforms would reap gains from the dynamisation of their energy industries — through improved transparency and accountability, accelerated development of technology and a more entrepreneurial approach to energy exploration, production, distribution and supply.

Indeed, artificially low energy prices caused by heavy subsidies are at the root of the poor financial performance of many state-owned energy companies in the developing and transition countries. This poor performance seriously reduces the ability of those companies to invest to meet the increasing demand, especially to those consumers who do not yet have the access to commercial energy. It also prohibits private and foreign investment in the energy sector of those countries.

There are large differences between the countries considered, in types and magnitudes of subsidy and in their policy objectives. The energy sectors of all the countries analysed have some degree of government intervention. In most cases, the objectives are to ensure end-use prices below the cost of supply, to encourage private or public energy consumption and to provide access to energy for the largest possible number of people. Many countries also subsidise energy production to protect local output and employment. Such subsidies, which may discourage consumption if they bring higher prices than would otherwise prevail, are discussed but not quantitatively analysed in this study.

Most non-OECD countries, including all those covered here, now pursue policies aimed at increasing the role of the market in the economy and in the provision of energy supplies. This process mirrors liberalisation policies and structural and regulatory reforms under way or already accomplished in OECD countries. In most cases, subsidy reduction and the removal of price controls are central features of these policies. OECD countries have made progress in reducing subsidies on energy consumption and production and in freeing energy prices. Nevertheless, they often use subsidies to protect domestic industries or to promote investments in energy efficiency and renewable-energy technology. The removal of subsidies in non-OECD countries, where they more often support social policy objectives rather than environmental or energy security goals, has progressed more slowly and with considerable variation in the pace of reforms

Leaders frequently see the discontinuing of energy subsidies as equivalent to abandoning social-policy objectives. Moreover, subsidy removal *can* impose short-term costs on producers and consumers. However, most social-policy objectives can be met in more cost-effective ways than through energy subsidies. A social security system aimed directly at the most disadvantaged parts of the population is more efficient than low energy prices. In many developing countries, the poor have no access to commercial energy even at subsidised prices, so energy subsidies are actually regressive. Moreover, most consumers are also taxpayers; as taxpayers, they will gain from subsidy removal.

To abolish subsidies in an overall economic restructuring is nonetheless far from a straightforward and painless process. The short-term costs imposed on some groups of society can induce strong political opposition. Yet the desirability of a general shift towards more open markets and more cost-reflective pricing is no longer in debate in most countries. The results of this study support the arguments favouring continuation and intensification of reform.

PART A

CONCEPTS, METHODS AND RESULTS

CHAPTER 1
THE FIRST STEP IN A DIALOGUE

The International Energy Agency's *World Energy Outlook 1998*[1], estimates that non-OECD countries will account for two-thirds of world economic growth and a concomitant share of the incremental demand for energy until 2020. This has important implications for national and international policy in the global economy, energy markets and the environment.

Governments subsidise energy consumption to achieve what they see as important policy objectives. Yet these measures impose severe restraints on economic growth, international trade and environmental performance. Policy-makers face conflicts between their intentions and the effects of the policies they choose. They cannot resolve them without a clear understanding of how various initiatives interact, and especially of what the costs may be. This study sets out the issues and provides basic information for a meaningful discussion of the problem.

Many non-OECD countries have quickly changing energy markets, with fast rising demand and rapid structural change. The analysis of crucial issues such as pricing and subsidy policies has become increasingly important. This is the most thorough global study to date on the topic, relying on the International Energy Agency's unparalleled access to detailed energy data. The authors have selected eight developing countries with high energy consumption levels[2] and studied the impact of energy subsidies in three key areas:

- Economic efficiency,
- Energy exports and imports,
- Greenhouse gas emissions.

In addition, impacts on government budgets and potential revenues from an emissions-trading scheme have been quantified for illustrative purposes.

1. IEA (1998e).
2. China, India, Russia, South Africa, Indonesia, Iran, Kazakhstan and Venezuela.

Why Are the Costs of Energy Subsidies Important?

The costs of subsidies tend to decrease as countries introduce more market-oriented policies.[3] To the extent that the inefficient pricing of energy resources persists, however, it continues to impose high costs in terms of economic and environmental performance. Severe price distortions block development of the energy sector by giving inadequate incentives to both domestic and foreign investors. They can lead to insufficient investment, reliance on outdated technologies and a failure to improve energy efficiency. Over-consumption due to excessively low prices distorts supply and demand. Subsidies for energy consumption will increase import requirements and decrease the availability of fuels for export. This imposes either additional outlays or foregone receipts of foreign currency, or both. It raises world energy prices above what they would have been in the absence of the subsidies.

In addition to inefficiency, price subsidies also cause inequity. The link between subsidized energy prices and social disruption was put eloquently by the former Indian Minister of Finance, Manmohan Singh: "While existing users enjoy low electricity prices, millions and millions of small farmers are denied the benefits of using electricity by the present pricing policies which leave the State Electricity Boards bankrupt so that they do not have enough resources to invest in expansion of capacity."[4]

Box 1: **Progress in Liberalising Energy Markets in non-OECD Countries**

While many price distortions and subsidies remain, most non-OECD countries have made progress in increasing the role of the market in the economy generally and in energy services specifically. These moves echo actions under way or already accomplished in most OECD countries. These include:

- Removal of subsidies and price controls;
- Lowering or elimination of trade and investment barriers;
- Privatisation of state-owned industries; and
- Restructuring of the electricity and gas sectors, "unbundling" of natural monopoly activities, introduction of competition and regulatory reform.

3. See, for instance, Reid and Goldemberg (1998).
4. Singh (1996).

Liberalisation proceeds in very different ways in various developing and transition countries. Nowhere are these developments more dramatic than in the Former Soviet Union and Central/Eastern Europe, where painful efforts to replace centrally planned economic systems with market-based economies continue. China has made considerable progress in energy price reforms, but many deep-seated structural problems remain, notably in China's huge coal mining industry. India has started liberalising its energy sector, but has made little progress in removing price controls and reducing subsidies. Brazil and South Africa have all made impressive strides in cutting fossil-fuel consumption subsidies, although significant production subsidies remain. Argentina and Chile are, in many respects, at the forefront of non-IEA countries in energy-sector liberalisation and structural reform. By contrast, Indonesia has made little headway in reducing its enormous oil-sector subsidies.

Energy subsidies critically affect global warming through energy-related greenhouse-gas emissions. Most non-OECD countries have no obligations under the United Nations Framework Convention on Climate Change (UNFCCC) to reduce or limit their future greenhouse-gas emissions. This study demonstrates (but does not forecast) the order of magnitude of possible emission savings from subsidy removal (see Chapter 4). Removing or reducing energy subsidies would also help to reduce emissions of airborne pollutants such as SO_2, NO_x and particulates, thus relieving local environmental problems.

Economic efficiency, energy security and environmental performance would all benefit from the removal of energy subsidies. Subsidies prevent the reflection of true costs in prices, leading to higher energy use and emissions than otherwise for every unit of output. In a dynamic perspective, prices that reflect the true costs and scarcities of energy products establish the transparency and confidence necessary to build efficient markets and attract investors. These indirect, dynamic effects may have even more importance in the long run than the substantial one-off benefits from energy-subsidy removal.

The results are impressive. The reduction of energy subsidies would yield energy savings of 13%. This would lead to a reduction of CO_2 emissions by 16%. More important, however, many developing and transition countries have concerns about local environmental problems due

Table 1: **Energy Consumption and CO_2-Emissions in the Countries Surveyed in this Study**

COUNTRY	Total Primary Energy Supply (TPES)		CO_2 Emissions	
	TPES (1000 toe)	TPES Relative to GDP[1]	CO_2 Emissions (tons)	CO_2 Emissions Relative to GDP[2]
1. China	1,101,980	1.11	3,132,411	3.16
2. Russia	591,982	1.34	1,456,239	3.29
3. India	461,032	1.29	880,714	2.47
4. Indonesia	138,779	0.65	256,515	1.19
5. Iran	108,289	0.68	285,282	1.78
6. South Africa	107,220	1.35	345,252	4.34
7. Venezuela	57,530	0.61	136,755	1.44
8. Kazakhstan	38,418	1.53	126,649	5.05
All Eight Countries	2,605,230	1.10	6,619,817	2.80
Per Cent of non-OECD	58.5	N.a.	64.0	N.a
Per Cent of World	27.4	N.a.	28.8	N.a
Non-OECD average	N.a.	0.80	N.a.	1.85
OECD average	N.a.	0.21	N.a.	0.78

Notes: 1. Tons of oil equivalent (toe) per $1 000 of GDP. 2. In kg per US dollar of GDP. All figures are based on 1997 data.

to energy consumption, and local environmental benefits would come as an *additional* benefit from the removal of energy subsidies. While data and resource constraints have prevented the systematic provision of quantitative information on local environmental effects in this study, some of the country chapters do consider them.

No Easy Choices

If removing energy subsidies were politically easy, it would already have happened. Formidable forces oppose subsidy removal. Hikes in energy end-use prices are felt immediately by everybody, sometimes painfully so by the poorer segments of the population. In extreme cases, energy price increases can lead to violent reactions — especially without proper information and education about the benefits of subsidy removal and when an inadequate social-policy framework cannot guarantee the universal provision of life's necessities, including energy.

Many subsidies aim to further widely agreed policy objectives. This study confines itself to indicating the *costs* of subsidies, without commenting on their benefits. It does however, set out why measures other than energy subsidies can reach most policy objectives more efficiently, and how political asymmetries can lead to the persistence of subsidies that are no longer justified.

These political hurdles, including drastic reactions to price increases, do not justify the indefinite maintenance of subsidies; they do mean, however, that subsidy removal must be implemented gradually, within a larger policy context. The most promising first step frequently involves the reform of existing subsidies rather than their straightforward abolition. In some cases, they can be converted into transparent financial transfers (a process known as "budgetisation"). Transparency and a clear view of the costs of subsidies are necessary preconditions to achieving economically and environmentally sound, sustainable development. Good policy emerges only when all arguments are put on the table and all stakeholders contribute to the debate.

The Nature of this Study

For each country that it reviews, this study asks the question, "What would have happened to energy consumption, exports/imports and CO_2 emissions if all subsidies for energy end-use had been removed?" It provides no predictions, but builds an analytical framework based on the most detailed data available for 1998 (1997 in those cases where no later data was available), to assess the direction and magnitude of potential changes following the removal of energy subsidies. To assure feasibility and comparability, it concentrates on price distortions in the main segments of the energy market, leaving aside specialty fuels. It provides a detailed overview of energy demand and its main determinants in each country. Chapter Four gives detailed calculations of the results of subsidy removal. The individual-country chapters in Part B provide a richer qualitative background for these quantitative calculations. The development of the quantitative estimates naturally required working with a number of technical constraints and assumptions. That is why the results of the study represent indications rather than forecasts, and policy options are suggested, rather than prescribed.

Box 2: **Brazil**

Brazil is not among the eight countries included in the study. It was considered for inclusion, then omitted because its energy-subsidy situation is sufficiently different from the others to make it an exception to, rather than an illustration of, the study's general conclusions. Nonetheless, Brazil is an important country with a large energy sector, and it deserves a place here.

With 162 million inhabitants and a GDP of $716 billion (1998 dollars), Brazil is the fifth most populous country and the ninth largest economy in the world. It accounts for roughly a third of the population of Latin America, 30% of GDP and 30% of energy use. It is the fifth largest energy user outside OECD, with TPES shares of: oil, 50%, biomass, 24%, hydropower, 14%, coal, 7% and gas, 3%. Petroleum meets most of Brazil's demand for fossil fuels and Hydro accounts for 95% of total electricity. Gas consumption, still low, is slated to increase sharply over the next decade, and coal is used almost exclusively in the steel industry. Total supply of energy amounted to 172 million tons of oil equivalent in 1997, some 40 Mtoe of which came from biomass, mainly wood, charcoal, and sugarcane-derived transport fuels.

Brazil's energy sector displays some characteristics that set it apart from other non-OECD countries examined in this report. Despite a highly urbanised population (around 80%) with a relatively high per capita GDP ($4,425), per capita energy consumption remains relatively low at 1.11 toe. Energy intensity is also relatively low at 0.25 toe/$1000 of GDP, compared to an average of the countries analysed in this study of 1.10 toe. The country's high reliance on hydroelectricity and biomass means that the rate of CO_2 emissions per unit of output in Brazil (0.44 tonnes of CO_2/$1,000 of GDP) is much lower than the sample average of 2.82 tonnes.

Brazil's energy subsidies amount to only 1.6%. This stems partly from recent efforts to liberalise the energy sector. An elimination of remaining subsidies would yield only minimal benefits in terms of reduced energy consumption and CO_2 emissions (less than 1%). Brazil does have energy subsidies that do not show up in the price-gap approach used in this study. It still produces an estimated 200,000 barrels per day of subsidised ethanol from sugarcane, predominantly for transportation. This programme, launched in the 1970s as a means of reducing oil imports, relies heavily on government subsidies. Contrary to all other subsidies discussed in this study the Brazilian subsidies for ethanol production actually reduce CO_2 emissions while leaving energy consumption unchanged.

The quantitative calculations use a price-gap approach. This approach compares consumer prices like the price of a litre of gasoline at the pump, with reference prices (full production costs or world-market prices including all costs of transport, refining and distribution). The difference between an end-use price and a reference price is the price gap, and subsidy removal amounts to its elimination.

Conceptually transparent and analytically robust, the price-gap approach is the preferred tool for analysing the impact of consumption subsidies — subsidies that reduce end-use prices below those that would prevail in a competitive market. Subsidies aimed at domestic production prevailing in OECD countries, such as import tariffs, may not significantly touch or may even raise consumer prices; the price-gap approach does not capture them, but the individual-country chapters do discuss them.

Box 3: **Energy Subsidies and Sustainable Development**

Sustainable development focuses on maintaining per capita welfare over time. On a sustainable path, future generations will receive the same or more, but no less wealth than the current generation. Here wealth includes produced assets, natural resources, healthy ecosystems and human resources. Sustainable development maintains the goal of increased basic energy services. It calls for enhancing these services in ways that respect the environment and economic development. Investment into appropriate technologies may help to bridge the gap between basic needs for energy and concerns over the environment and resource depletion. The recent literature suggests that a commitment to maintaining current levels of welfare for future generations equates with a commitment to productive investment. Energy subsidies can have a dramatic effect on future wealth of future generations as prices influence the investment necessary to preserve the welfare.

Several authors have linked sustainability with underlying capital stock, which includes natural capital (natural resources and environmental assets), man-made capital (physical capital and financial assets) and human capital (health and education). "Strong sustainability" assumes limited substitutability between human-made capital and some types of natural capital. Certain natural capital must therefore be held constant (or increased) as a condition for "strong sustainability". "Weak sustainability" assumes that substitution of man-made assets for natural resources is permissible and essential. According to the OECD *Three-Year Project on Sustainable Development*, due for completion in 2001, the key is not whether a resource will be available indefinitely, but whether ingenuity can combine *all* capital resources to meet human needs. It may prove impossible or prohibitively expensive to preserve all natural resources from one generation to the next. If natural capital is depleted, investment in other forms of capital will become a prerequisite for maintaining well-being.

Investment requires proper incentives, such as prices that reflect scarcity rents. Subsidies that spur energy consumption diminish scarcity rents, causing the capital stock to decline faster disabling investment in human-made capital rapidly and depleting the natural-capital stock through increased consumption. As the total capital stock falls, energy subsidies may jeopardise long-term welfare, except if productivity increased to such an extent that the capital stock recouped its losses. Advances in technology can hardly occur without substantial investment from rents; subsidies risk suffocating rather than stimulating technologies for sustainable development. Producer subsidies hurt sustainability as well. They encourage inefficiency. Protectionist policies reduce competition, diminish incentives to innovate and cause both prices and costs to rise, thus squeezing back rents and investment.

Although responsibility for investing scarcity rents falls primarily on exporting countries, importing countries also bear responsibility for sustainable energy consumption, as well as for investing rents from their domestic fuel production. Consciousness of environmental harm, which is rarely reflected in prices, is central to sustainability. In strong sustainability conditions, emissions may not be tolerable, as damage to the climate may be irreversible, posing long-term threats to the resilience of ecosystems.

The OECD suggests in its *Three-Year Project on Sustainable Development* that sustainable development encompasses three dimensions of welfare: social, environmental, and economic. Removing energy subsidies in less developed countries may support all three dimensions.

Deepening the Dialogue on Energy Policies

As a first step, this study concentrates on countries where subsidies go to energy consumption. This approach offers the intriguing possibility of identifying "win-win options", which would realise economic as well as environmental benefits. Future studies might concentrate on subsidies to the domestic production of energy, a form of subsidisation that tends to raise, rather than lower, consumer prices, with reversed implications for energy trade and the environment. This is now the prevalent form of subsidisation in OECD countries. Such work could not rely on the simple and intuitive methodology of the price-gap approach, but would have to go forward on a case-by-case basis.

The study of energy subsidies in developing countries and countries with economies in transition thus represents only a first step in a process of dialogue and communication. Energy trade and investment take place in global markets. Many environmental problems can be solved only through global co-ordination. Neither OECD nor non-OECD countries can escape these new interdependencies.

Many non-OECD countries have made efforts to move toward more efficient pricing and to make markets more competitive. This study aims to contribute to the debates going on in non-OECD countries themselves. Necessary global solutions must build carefully on successive stages of mutual consultation and negotiation. This study sees itself as part of the information process to make the costs of subsidies and the benefits of their removal transparent. It does not pretend to offer the final word on energy subsidies, but it does seek to take the discussion one step further, in the hope that other steps will follow.

CHAPTER 2
THE INCREASING WEIGHT OF NON-OECD COUNTRIES

Every second year the IEA publishes the *World Energy Outlook* to examine how world energy markets may develop in the long term. This chapter presents the major results of the *World Energy Outlook 1998*, with emphasis on the increasing importance of the non-OECD countries. The key long-term trends of developing regions, such as high energy demand, emissions growth and a significant rise in oil import dependency, underline the crucial importance of efficient policy-making in these countries. The chapter also provides a brief discussion of energy pricing as a crucial determinant of energy demand and energy efficiency.

Approach and Key Assumptions

The *Outlook's* projections of energy demand to 2020 are derived from application of the IEA's large-scale World Energy Model. The model contains a set of economic relationships involving energy demand and supply as well as macroeconomic and price data, using the conventional approach to sectoral disaggregation in energy statistics. Projections were based on a "Business as Usual" (BaU) framework. This framework illustrates how energy supply and demand are likely to develop if recent trends and current policies continue. It assumes that no major new policy initiatives will be introduced over the outlook period. Although recent history suggests that energy policies will indeed change over time, and the IEA expects that the future for world energy could be quite different from that described in the BaU projections, this approach facilitates discussion of major uncertainties. Projections of energy supply and demand entail a high degree of uncertainty. Box 4, summarised from the *Outlook*, provides an overview of the key uncertainties surrounding the projections.

The most important assumptions behind the projections concern economic growth. The BaU broadly continues the past rate of world economic growth — 3.1% per annum — from 1995 to 2020, GDP in OECD countries grows by 2%. Non-OECD countries grow significantly faster at above 4%.[1] Assumptions for world fossil-fuel price developments rest on the relationships between prospects for demand and supply and on the likely cost of marginal supplies. They hold world oil prices flat up to 2010 at the 1991-1995 average of $17 per barrel (1990 dollars). They then let prices increase gradually through 2015, to reflect an expected transition to unconventional oil. Other fossil-fuel prices follow similar trends.

Primary Energy Outlook

Three major conclusions emerge from the *Outlook* projections of primary energy demand. First, world primary energy demand and carbon emissions grow steadily, by 65% and 70% respectively, between 1995 and 2020. Second, fossil fuels will account for more than 90% of total primary energy demand in 2020. Third, a structural shift in the shares of different regions will occur in world energy demand, with the OECD share declining in favour of non-OECD countries.

Figure 1 shows the expected evolution of world primary energy demand. The fuel mix does not change significantly; oil remains the dominant fuel with around 40% of total demand in 2020. Transport oil use contributes more than 60% of incremental oil demand between now and 2020. Gas demand rises rapidly, primarily in the power-generation sector. Where gas is available and delivery systems are in place or can be built, gas is the preferred fuel for power generation, heating in buildings and industrial applications. The share of gas in the world energy mix approaches that of coal, which remains almost constant. Nuclear generation remains stable in world terms, as the commissioning of new plants broadly matches plant retirements. Hydropower increases steadily, but its growth will be limited by the availability of suitable sites and environmental considerations, particularly in the OECD area. Renewable energy, though the fastest-growing energy type, still remains at low levels in 2020.

Box 4: **Major Uncertainties Surrounding the Business-as-Usual Projections**

Economic Output and Structure. Economic growth projections vary considerably, especially for developing countries. In the transition economies of the former Soviet Union and Eastern and Central Europe,

1. The *Outlook's* long-term economic growth assumptions are based on OECD (1997b), while short-term and medium-term GDP growth assumptions are based on OECD (1998b).

the pace of economic restructuring and adoption of market economies proceeds unevenly, especially for the major industrial sectors.

Fossil-Fuel Supplies and Extraction Costs. The amount of economically recoverable reserves of oil and natural gas remains in debate. Experts' assessments become dated as new technologies accelerate discovery and exploitation. Competitive pressures and the application of new technologies have cut production costs over the last decade. Many believe that technical change will go on yielding increasing reserves and low production costs for many decades to come. Others stress the likelihood of diminishing reserves.

Energy Subsidies. In many developing countries, government policies set energy prices, especially for electricity, well below the full cost of supply. In some transition economies, heat and electricity sell very cheaply. Over time, prices are expected to rise toward the full cost of supply, but the timing of these changes is unknown.

Technical Change and Capital-Stock Turnover. The pace of technical change remains inherently uncertain. Moreover, when new types of energy-using equipment *do* become available, the extent to which they affect energy use depends on the rate at which they are actually adopted and deployed.

Changing Environmental Objectives and Policies. Many governments have extended environmental policies that affect energy; they now cover particulates, heavy metals, acid gases and greenhouse gases. Perhaps the greatest uncertainty currently affecting energy projections surrounds the policy choices that governments will make to meet their Kyoto commitments.

Energy intensity should decline for the world as a whole at 1.1% per year, as total energy use rises by 2% a year while economic activity is assumed to climb by 3.1%. This continues the trend observed over the past 15 years. CO_2 emissions rise with primary energy demand, and the rate of increase is slightly faster now than in the past, due mainly to a lull in the growth of nuclear power generation and continued rapid growth in coal use in countries such as China and India.

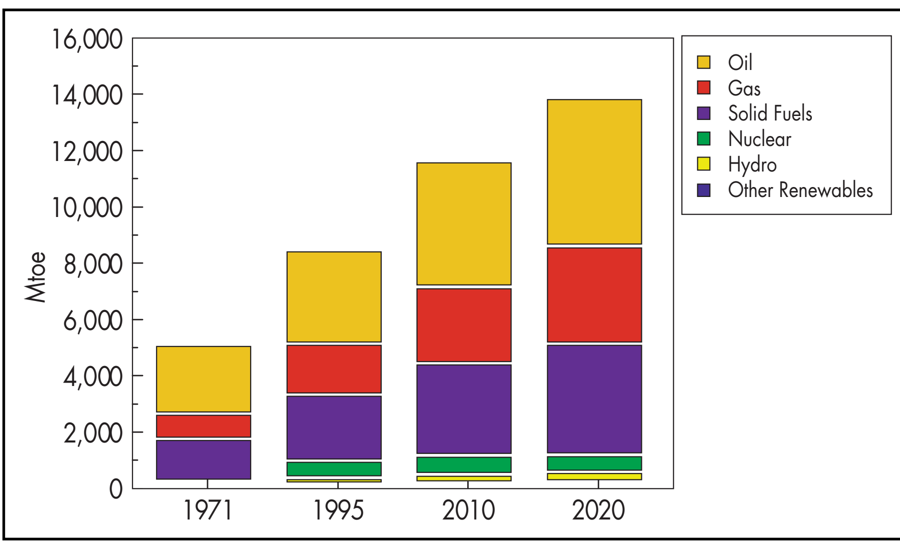
Towards A New Global Energy Panorama

Both the OECD and the IEA expect the share of non-OECD countries in the global economy to increase substantially. Based on the economic growth assumptions underlying the *Outlook*, Figure 2 compares regional patterns of world output in 1997, 2010 and 2020 at constant 1990 purchasing-power parities (PPPs).[2] The main expected changes are:

- World economic output will slightly more than double from 1997 to 2020, with the non-OECD countries accounting for about 70% of the increase;
- The non-OECD share of world GDP will rise from 45% to 58%, and most of that increase will reflect growth in Asia;
- China is expected to become by far the largest economy in the world by 2020, with a GDP slightly less than half that of the OECD countries combined.

In parallel with these economic shifts, non-OECD countries will also lead the growth in world energy demand. With total primary energy demand projected to double by 2020, the share will climb from its current 46% to close to 60% in 2020. China's projected increase alone will be about equal to that of the entire OECD area China will account for almost a quarter of the increase in world energy demand. The underlying reasons for

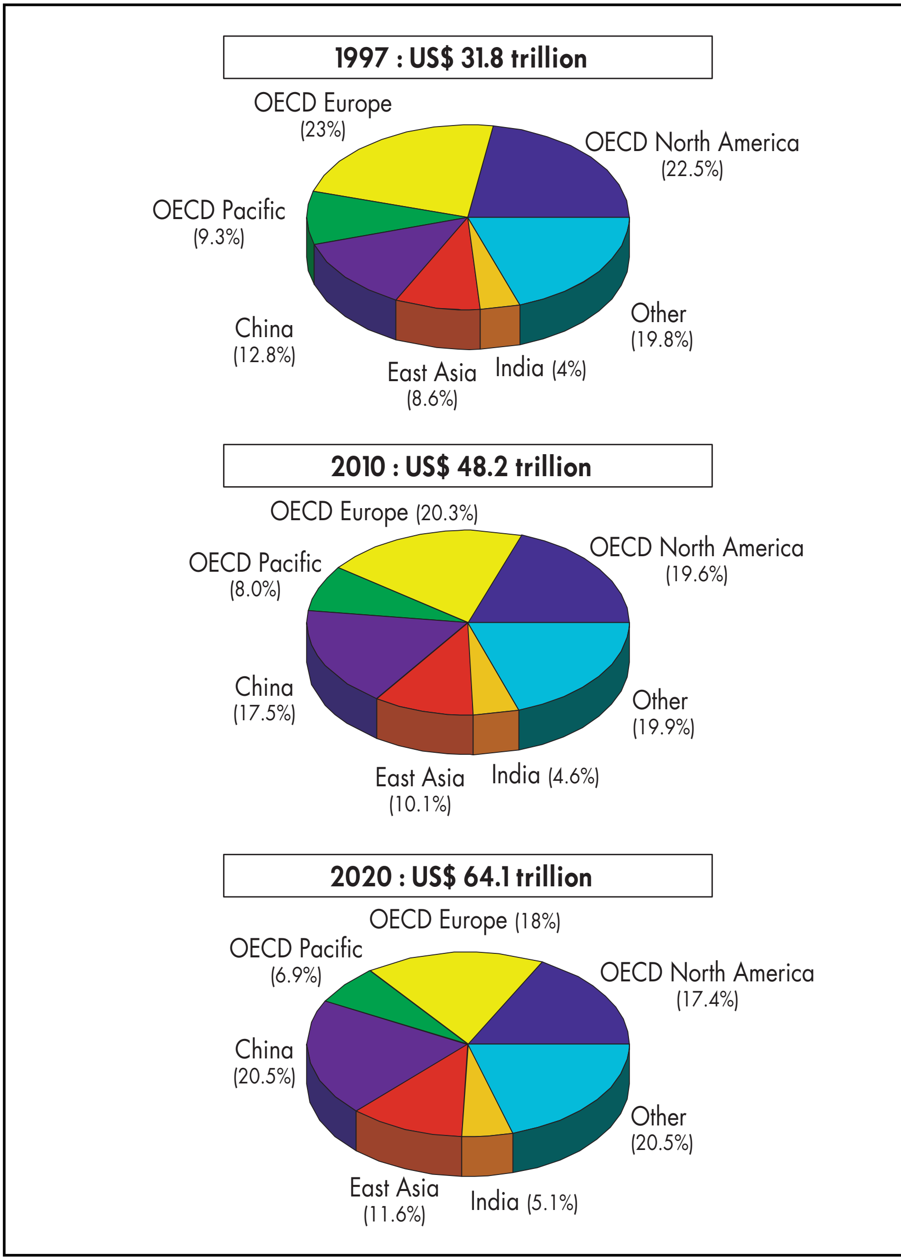
Figure 1: **World Primary Energy Demand**



Source: IEA (1998e).

2. For a detailed discussion of the future role of non-OECD countries in the world economy, in particular the so-called big five, Brazil, China, India, Indonesia and Russia, see OECD (1997b).

Figure 2: **Shares of World GDP by Region**
(GDP in PPP terms, in 1990 US dollars at PPP exchange rates)



Source: IEA (1998e).

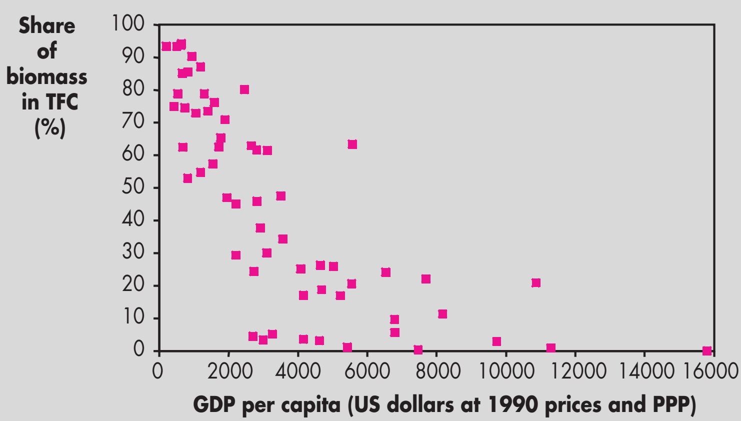
this strong increase in non-OECD countries include their high rates of population increase and urbanisation; their rapid economic growth and industrial expansion; their substitution of commercial for non-commercial fuels (see Box 5); and, most relevant for this study, the absence in many countries of adequate price signals to energy.

Box 5: **Non-Commercial Energy Use in Developing Countries**

The figures presented in the body of this study refer to commercial energy only, but this does not in fact tell the whole energy story. In many developing countries, non-commercial energy, or "biomass" (wood and charcoal, agricultural and animal residues and derived fuels) still dominates the energy scene.

IEA statistics indicate that biomass energy currently represents approximately 14% of the world's final energy consumption, a higher share than that of coal (12%). In developing countries,[3] biomass accounts on average for one-third of total final energy consumption. In countries that are predominantly rural and rely heavily on subsistence agriculture, this share can reach 80% and more. As illustrated in the figure below, cross-country comparisons and available historical series show that the importance of biomass in the energy matrix of developing countries is strongly linked to per capita income and industrialisation.

Shares of Biomass in the Energy Mix in Relation to Per Capita GDP in 60 Developing Countries, 1995



3. Defined here as the non-OECD countries of Africa, Latin America, East Asia and South Asia and China.

The omission of such an important energy source would distort the analysis of past trends in total energy use and lead to misleading indications for the future. The *1998 World Energy Outlook* contained a special study of the current status of biomass energy in developing countries. An effort was made to include this energy form in the modelling framework and to develop projections of future biomass consumption. The results of this study indicate that final consumption of biomass in developing countries is likely to increase by 1.2% per year between 1995 and 2020. This rising trend results from two contrasting tendencies. On the one hand, the expected growth in average per capita GDP will lead progressively to lower per capita biomass use, as people, especially in urban areas, gradually switch to conventional fuels and as biomass end-use efficiency slowly increases. On the other hand, expected rates of population growth means that increasing numbers of people will use biomass, driving up total consumption.

Nevertheless, projected final consumption of conventional fuels grows even faster than does biomass. The share of biomass in total final consumption of developing countries will decline from 34% in 1995 to 22% in 2020. This still very significant use of biomass means that it must be kept in mind in all energy policy discussions.

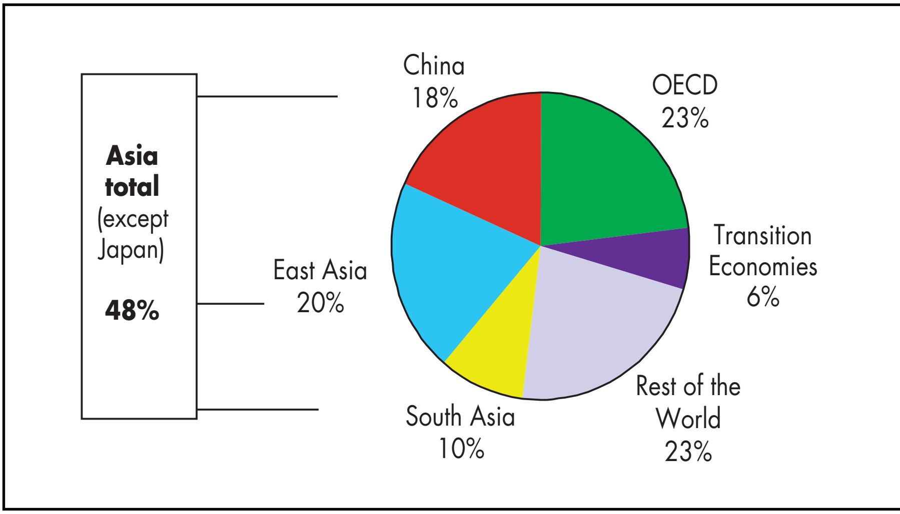
Oil

The increasing importance of non-OECD countries shows up very strongly in oil. As Figure 3 indicates, developing Asian countries will account for about half of world oil demand growth between now and 2020. World oil demand is projected to increase from around 75 million barrels per day (mbd) today to 112 mbd in 2020. This amounts to about 2% per year, significantly faster than over the past two decades (1.3% over the past twenty years). It arises mainly from strong growth in non-OECD countries, continuing increases in OECD transport demand and the lack of substitution possibilities in industry and household use.

The main drivers of high oil-demand growth in the developing countries will be the transportation and household sectors. Increasing income levels will induce rising needs for mobility. Reflecting this trend, growth in the vehicle fleets of many non-OECD countries should remain strong. In the household sector, switches from non-commercial fuels, such as fuelwood to oil products such as LPG or kerosene, and the absence of adequate gas infrastructure will be the two main contributors to high demand growth.

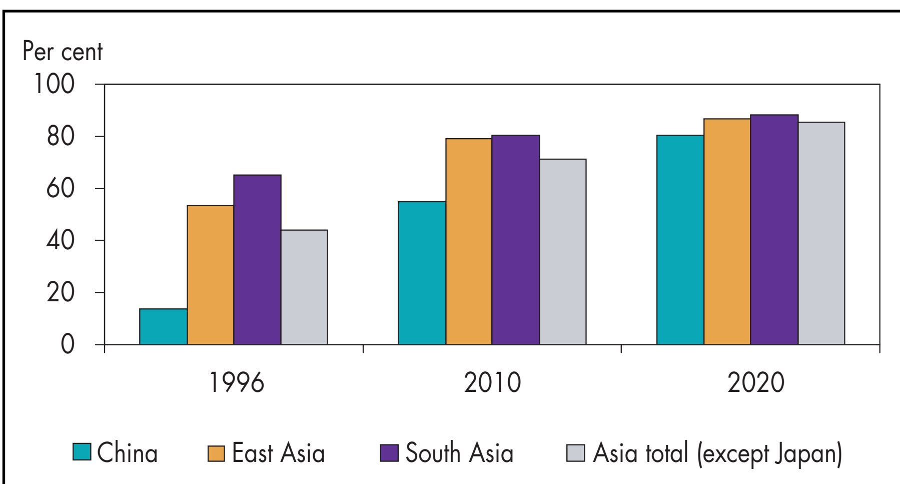
The developing Asian countries' projected high oil demand, combined with their sluggish oil-production prospects suggests that their oil-import

Figure 3: **Regional Shares in Incremental Oil Demand Growth (1995-2020)**



Source: IEA (1998e).

Figure 4: **Oil Import Dependency**



Source: IEA (1998e).

dependency will rise substantially in the next two decades (see Figure 4). In China, especially, the gap between domestic production and demand widens. China is projected to import eight mbd by 2020, making it a major importer in world oil markets. In comparison, the OECD Pacific region is projected to have net imports of only 7.6 bd. India's oil-import requirements will grow to almost 4 mbd by 2020.

Box 6: The World Energy Outlook 1998 and the Impact of Economic Turmoil in Asia On Oil Prospects

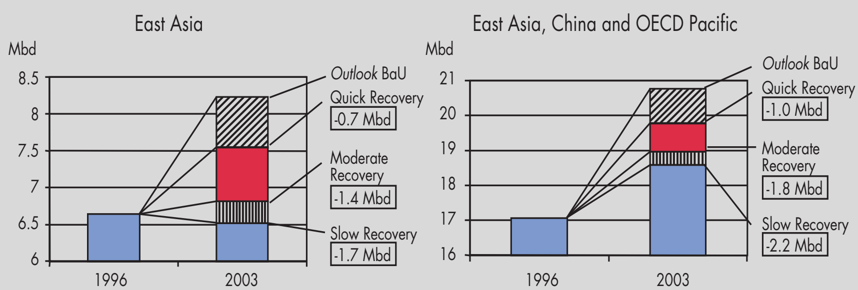
The IEA used short-term and mid-term GDP growth estimates released by the OECD and the IMF late in 1997 for the 1998 *Outlook's* projections. Both organisations later substantially revised their GDP estimates due to Asian financial turmoil. Because of the magnitude of these revisions, and because the IEA does not plan to publish another full-scale *World Energy Outlook* until 2000, its authors developed an update for the oil outlook for three Asian regions: East Asia, China and the OECD Pacific area.

Revisions to GDP Growth Estimations
(Growth rates in per cent per year)

Country	Estimates for 1998			Estimates for 1999		
	OECD, Dec. 1997	OECD, Dec. 1998	Difference	OECD, Dec. 1997	OECD, Dec. 1998	Difference
Korea	5.5	-6.5	-12.0	6.0	0.5	-5.5
Malaysia	6.0	-4.7	-10.7	6.2	-0.5	-5.5
Singapore	6.0	0.0	-6.0	6.5	0.5	-6.0
Japan	1.7	-2.6	-4.3	2.1	0.2	-1.9
China	8.9	7.4	-1.5	9.4	7.0	-2.4
	IMF, Oct. 1997	IMF, Dec. 1998	Differences	IMF, Oct. 1997	IMF, Dec. 1998	Differences
Indonesia	6.2	-15.3	-21.5	n.a.	n.a.	n.a.
ASEAN 4[1]	5.4	-10.6	-16.0	n.a.	n.a.	n.a.

Note: 1. Indonesia, Malaysia, Philippines and Thailand.
Sources: OECD (1998b), IMF (1997), *World Economic Outlook*, Washington, IMF, October; and IMF (1998), *World Economic Outlook and International Capital Markets — Interim Assessment*, Washington, IMF, December.

Quick, slow and moderate recovery scenarios based on the OECD's new figures and inserted into the IEA's World Energy Model suggested significant oil-demand reductions from the original *Outlook* results. If Asia's battered economies recover from the continuing financial crisis along a moderate time path and at moderate speed, the region's demand for oil will be 1.8 mbd less in 2003 than the *Outlook*. That represents a drop of 10% from the projection presented in this Chapter. In 2020, Asian demand will be 2.4 mbd, or 8%, below *Outlook* expectations. If the Asian recovery turns out to be rapid and robust, Asian oil demand in 2003 will still be one mbd lower than the *Outlook* projections in both 2003 and 2020. If, however, the recovery is slow and weak, Asian oil demand in 2003 and 2020 will be 2.2 mbd lower than the *Outlook* projections, with the gap widening to nearly 4 mbd in 2020. In this slow-recovery case, oil demand from East Asia may not even reach its 1996 level by 2003. East Asian demand would, in fact, be a significant 21% lower than the *Outlook* estimates. By 2020, the gap would have widened to 23%.

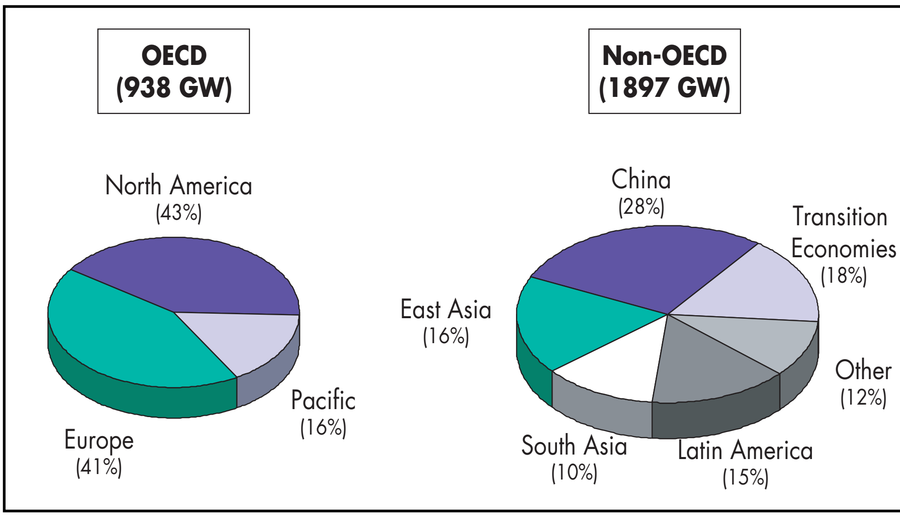


The persistence of very low energy demand in Asia could have important consequences in the region and throughout the world. Despite the severity of the crisis, however, the IEA believes that most fundamentals remain unchanged. Some signs already indicate a strong revival. In the long term, the adverse affects of the economic crisis will be seen as only a short disruption in the continuing expansion of Asian economic output and oil demand.

Electricity

As the fastest-growing element of final energy consumption, world electricity demand will rise in line with increasing GDP to 2020, averaging an annual rate of growth of 3%. While projected electricity-demand growth for the OECD area remains at 1.9%, non-OECD economies should see significantly higher rates — 5.4% in China and 5% in both India and East Asia. This would translate into a doubling of per capita electricity demand for non-OECD countries, from 0.85 MWh currently to 1.8 MWh in 2020, still only 20% of per capita demand in OECD Europe.

Figure 5: **Incremental Power Generation Capacities 1995-2020**



Source: IEA (1998e).

Expected high rates of electrification in non-OECD countries will require heavy expansion of power generation capacity (Figure 5 above). About a third of projected new capacity will be built in the OECD area and about half in China and the other developing countries. This implies very substantial capital expenditures in developing countries. Table 2 gives projections for the investment needed for new generation capacity, excluding new transmission lines. It suggests total projected annual requirements for developing countries' power-sector investment at slightly over $60 billion. The World Bank estimates $50 billion.[4]

4. World Bank (1995).

Table 2: **Projected Capital Expenditures on New Generating Plant**
(Billions of US dollars at 1990 prices)

	1995-2010	**2010-2020**	**Total**
OECD Europe	194	182	376
OECD North America	231	222	453
OECD Pacific	157	166	323
Transition Economies	207	222	429
China	323	306	629
Latin America	211	150	361
South Asia	125	98	223
Africa	47	48	95
East Asia	137	144	281
Middle East	40	68	108
World	**1,673**	**1,607**	**3,280**

Source: IEA (1998e).

Although a significant portion of total investment currently goes to the power sector, many developing countries, have difficulties generating sufficient funds to carry out expansion plans.[5] The electricity-supply industry is often publicly owned and perceived by both governments and consumers as providing a public service. Consequently, government is seen as having responsibility for generating investment funds and setting electricity prices. Decision making in this area is often influenced by subsidies granted on social and economic grounds.

Energy Use and CO_2 Emissions

Historical Trends

Energy use is the main source of the build-up of greenhouse gases in the atmosphere. Energy accounts today for about 85% of the greenhouse-gas emissions of Annex I Member countries, and a smaller but growing share in

5. Power shortages often reflect an inability to finance power-plant expansion. Many major developing countries today face power shortages and blackouts, which interrupt economic life. In India, for example, the total cost of power shortages to the industrial sector has been estimated at 1.5% of GDP (World Bank, 1995, World Development Report — Infrastructure for Development, Washington DC).

developing countries. As Table 3 shows, world carbon dioxide emissions increased on average by 1.7% per year from 1971 to 1995, while energy use grew by 2.2% a year. The drop in the average amount of carbon emitted to produce one unit of energy (carbon intensity) reached about 10% over the period. This means that carbon-intensive fuels such as coal, are slowly being substituted by less carbon-intensive fuels such as gas, or nuclear and renewables. Emissions from non-OECD countries increased fastest, at 5.2% per year, reflecting rapid growth in energy demand, at 5.5% annually and rapid economic development. The relationship between GDP and CO_2 emissions is closer to unity in developing countries than in more mature economies, primarily due to their larger shares of GDP in heavy industry. The services sector contributes a larger portion of GDP in the OECD economies.

Table 3: **Average Annual Increase in Energy Demand and Energy-Related CO_2 Emissions** (% per year)

	1971 to 1995		1995 to 2010		1995 to 2020	
	Energy	**CO_2**	**Energy**	**CO_2**	**Energy**	**CO_2**
OECD	1.4	0.7	1.3	1.5	1.0	1.2
Transition Economies	0.8	0.1	1.4	1.4	1.5	1.4
Developing Countries	5.5	5.2	3.7	3.6	3.5	3.4
World	2.2	1.7	2.2	2.3	2.0	2.2

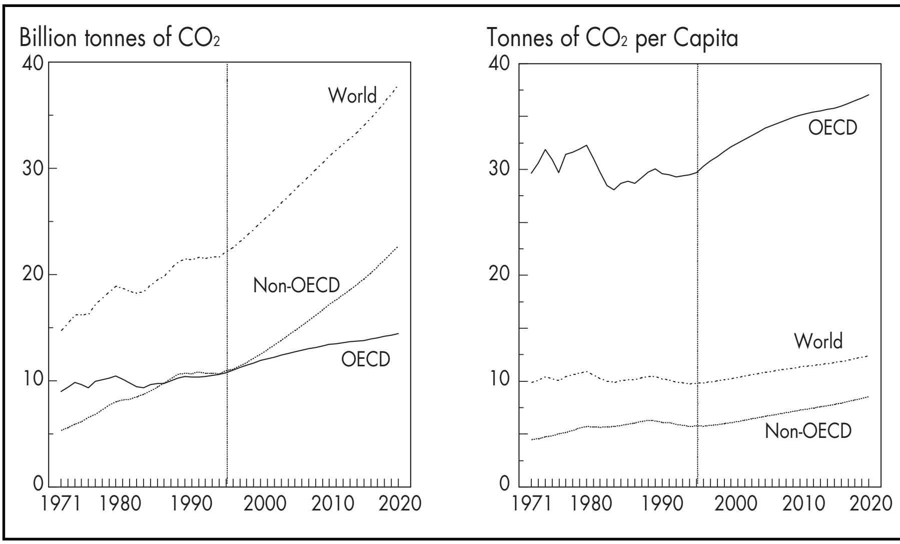
Source: IEA (1998e).

Regional fuel mixes are an important factor in the relationship between energy demand and CO_2 emission growth rates. In the OECD, for example, the significant difference between the historical growth rates of CO_2 emissions and energy consumption arose from the substantial use of nuclear power. The share of nuclear power in total primary energy increased from 1% in 1971 to 11% in 1995. Over the outlook period, the share of nuclear power in OECD countries is expected to decline. Consequently, the growth of CO_2 emissions may slightly exceed energy-demand growth.

The Outlook for CO_2 Emissions

As Figure 6 shows, the *Outlook* foresees a constantly rising trend for world CO_2 emissions. Expected global emissions will increase by 70% between 1995 and 2020. Projections in a "business as usual" case suggest that energy-related CO_2 emissions in OECD countries could rise 30% above 1990 levels in 2010. Past trends imply that closing the gap between rising energy-related CO_2 emissions and the commitments made by OECD countries in Kyoto will be a formidable task. The CO_2 emissions of non-OECD countries, most of which do not have any commitments under the Kyoto protocol, come close to those of OECD countries today and are projected to rise by about 130% over the outlook period.

Figure 6: **World Energy-Related CO_2 Emissions**



Source: IEA (1998e).

Among the non-OECD countries, China will remain the largest single source. China's expected emissions growth to 2020 around four billion tonnes of CO_2, slightly exceeds the projected increase of 3.7 billion tonnes for the whole OECD. Figure 6 also indicates that a substantial disparity in per capita CO_2 emissions will continue in 2020, primarily because of rapid population growth in non-OECD countries.

Coal is the major fuel for power generation and industry in the two fastest growing non-OECD countries, China and India. Coal is also the most carbon intensive of all conventional fossil fuels. It currently accounts for about three-quarters of total electricity generation in China and for about 70% in India. Electricity demand in both countries is expected to increase rapidly, and the share of coal in power generation will probably remain unchanged. The power-generation sector in these countries will contribute significantly to the increase in CO_2 emissions. Future national decisions related to electricity markets — on pricing, investment, etc. — could have effects on global CO_2 trends.

Energy Efficiency and Prices

Energy efficiency is a critical element for policies aimed at reducing energy consumption while maintaining or even boosting economic growth. To the extent that increases in technical efficiency lead to reduced energy use per unit of output, higher energy efficiency means lower energy imports, slower resource depletion, less environmental damage and lower costs per unit of output.

Energy Efficiency Improvements

Many people frequently confuse improvements in energy efficiency with decreases in the energy intensity of output. An improvement in energy efficiency, typically the introduction of a new technology, certainly *can* improve energy intensity. But other factors also determine intensity, such as energy prices, cultural habits, geography, climate and the level of development. At rising levels of aggregation, when the energy intensity of a plant, a sector, or a whole economy is studied, the link between technological efficiency and energy intensity grows more tenuous.

In competitive markets, the relative prices of energy, capital and labour will determine which available technology is selected. Higher energy prices will provoke energy-saving technologies with high shares of capital and labour. Conversely, lower energy prices will lead to technologies with a larger share of energy inputs and relatively lower shares of capital and labour. The actual changes will also depend on the substitutability of energy with other production factors as well as its absolute share in production.

The choice of technologies will in turn influence the overall energy intensity of production of a plant, a sector or an economy. A good example of how the price mechanism works with *existing* technologies is the choice of technology for power generation from coal. Whether a critical plant with 38% efficiency or a supercritical plant with 45% efficiency will get built will depend primarily on the price of coal. In the absence of regulatory constraints, the supercritical plant will be built only if the price of coal is high. From the point of view of a private decision-maker, it is of secondary importance whether the price of coal is high due to the scarcity of coal or to an environmentally-related price instrument, such as, a CO_2 tax.

The Crucial Role of Energy Prices

Prices thus are one of the fundamental variables to determine energy efficiency. Policy makers have several instruments at their disposal to influence the relative price of energy. These include taxes on energy use or on energy-intensive products and subsidies for alternative processes or products. A new set of price-based techniques was introduced in the Kyoto Protocol of 1997. They include trading schemes in which large energy consumers can trade a limited amount of "permits" for the emission of energy-related pollutants.

Comparing relationships between prices and energy intensity over different countries can provide interesting insights. But such simple comparisons do not tell the whole story. Climatic differences, average distances travelled (by motorists) and other structural parameters also influence energy intensity. Nevertheless, cross-country comparisons between energy intensity and energy end-use prices show a strong inverse relationship between the two, which is difficult to explain by structural factors. Figure 7 illustrates the point for electricity in 49 OECD and non-OECD countries. Prices clearly have a strong influence on electricity demand.

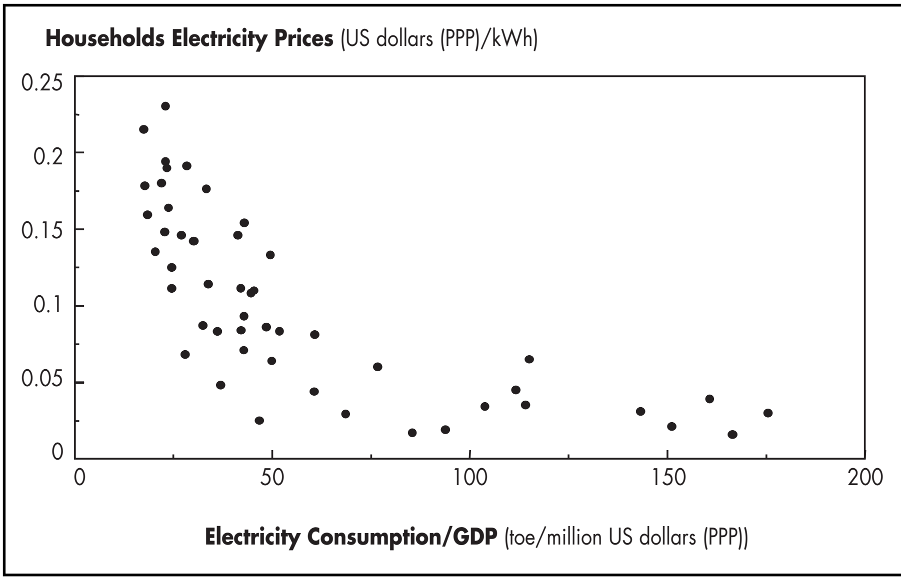
Prices reflecting the real value of the resources employed in the generation of electricity ensure that consumers receive the correct signals to use electricity in the most efficient possible way. There is also a good argument for efficient pricing on the supply side. Efficient prices indicate to power utilities the willingness of consumers to pay for electricity services, so that supply capacity may be augmented to meet demand.[6] Correctly set prices also ensure that the power sector can generate internally the funding needed for the requisite investment.

Economic theory holds that environmental objectives will be achieved through permanent changes in relative prices rather than through regulations that foster more efficient energy technologies. In particular, as the regulatory approach can create "rebound effects".[7]

6. See Munasinghe (1994) for a comprehensive discussion of this argument.

7. The "rebound effect" arises because technical improvements in energy efficiency do not fully translate into decreases in energy use per unit of output (energy intensity), either for the company or for the economy as a whole. As long as prices stay unchanged and some flexibility in production methods exists, the productivity increase in energy will make it profitable to use slightly less energy-efficient production methods. Given the increase in efficiency, total energy use might still be lower than the original level, but by a smaller amount than suggested by the technical parameters. In the wider economy, energy-intensive sectors will benefit more than other sectors from increases in energy efficiency, thus increasing their relative share of output. The resulting structural change will again counteract technical efficiency improvements to some degree. See also Birol and Keppler (1999 forthcoming).

Figure 7: **Electricity Prices and Electricity Use per GDP, 1996**
(27 OECD and 22 non-OECD countries)



Sources: IEA (1998c), IEA (1998d).

Previous sections of this chapter made clear the likelihood in the next two decades of strong, steady increases in global energy use and rising CO_2 emissions, with much of this growth taking place outside the OECD area. This section has highlighted the key role which energy prices play in the interaction between energy-technology choices on the supply side and energy-use patterns on the demand side. Price changes can indeed alter the tendencies revealed in the *Outlook*. Policy makers have many tools available with which to influence energy prices, and significant price changes will surely be needed to alter the *Outlook* trends.

CHAPTER 3
THE GENERAL APPROACH TO ENERGY SUBSIDIES

Historical Justifications and Present Questions

Discussions about what a subsidy is have never really settled on a consensus definition. This book takes a pragmatic approach because it has more interest in the impacts of subsidies than in their characterisation. It thus uses the broadest possible definition:

An energy subsidy is any government action that concerns primarily the energy sector and that
lowers the cost of energy production,
raises the price received by energy producers
or lowers the price paid by energy consumers.

This general definition covers all possible subsidies in at least a qualitative way. This does *not* mean that the quantitative analysis actually includes all subsidies The price-gap approach only captures those subsidies which have an impact on final consumer prices, and then only to the extent that they form part of the observable, *cumulative* price effects. The qualitative discussion in this chapter, however, escapes this constraint and attempts to include as many of the relevant conceptual issues related to subsidies as possible.

Governments in OECD and non-OECD countries alike have historically manipulated energy prices through regulation, outright ownership, taxes and direct or indirect support. Major policy objectives have included the achievement of energy security, the maintenance of certain levels of domestic energy production and the diversification of energy sources. Subsidies may also be seen as responding to social considerations, such as maintaining employment, furthering regional development or giving all income groups a minimum of energy consumption.

Access to energy, and in particular to electricity, is also sometimes being considered as having positive spillover effects beyond the immediate benefits derived from energy consumption. Electricity service, for instance, allows the installation of lighting, cooking and telecommunication equipment, with important benefits for hygiene, healthier life-styles and education. In recent years, the desire to safeguard the environment and reduce health hazards stemming from energy production and consumption has led to the introduction of new instruments. As the public good *par excellence*, the environment requires added incentive mechanisms beyond those provided by traditional commodities markets. These incentives can include subsidies for the adoption of energy technologies with reduced environmental impacts.

In addition, the production and the network-based distribution of electricity and gas involve large fixed costs and the expectation of increasing returns to scale. In such so-called "natural monopolies" unregulated ownership by private entities leads to market inefficiencies, which have provided reasons for further government intervention.[1] In developing countries, the absence of well-developed financial markets and limited experience with large-scale energy projects can constitute a further reason for government intervention or participation.

A final reason for interfering with energy markets follows from the low elasticity of energy demand. This means that consumers change their behaviour only little in response to a change in energy prices. Taxing energy to raise general revenues generates comparatively fewer distortions than the taxation of goods with higher demand elasticities and larger changes by consumers in response to price changes. Energy taxation yields about 4% of total tax revenues in OECD countries.[2] The share varies considerably from country to country and reaches almost 10% in some of them.

Box 7: **Win-Win Opportunities**

Many discussions about subsidies, particularly in the energy sector, refer to so-called win-win opportunities that can be captured through subsidy removal. This implies that more than one kind of benefit can

1. The argument goes that a private owner would restrict supply by raising prices to exploit demand inelasticities. A public operator, the argument says, would equate prices with the economically optimal short-run marginal cost and finance the large fixed costs through general taxes. Note that monopoly power depends on the technically determined size of the fixed costs and the size of the market. The widening of markets, through the abolition of entry restrictions, thus reduces efficiency losses stemming from monopoly pricing.
2. The form of taxation in which goods with elastic demand are taxed less than goods with inelastic demand in order to minimise overall welfare losses while achieving a given amounts of government revenue, is also known as "Ramsay taxation".

arise without additional costs. Healthy scepticism is always appropriate towards claims that offer the proverbial "free lunch", but policy advice based on economic analysis would be relatively worthless if it could not to offer indications of net improvements. Being sceptical of undifferentiated claims about the existence of win-win opportunities does not mean denying possibilities that they can exist.

The term "win-win opportunity" applies here to a situation in which the removal of a subsidy not only confers economic-efficiency gains, but also creates positive effects in another dimension, for instance improved environmental performance. Usually there are trade-offs between benefits in one dimension and benefits in another one — improving the environment is usually not cost-free. Even if subsidy removal is the correct choice from the point of view of the whole economy, it is unlikely that there will be absolutely no costs connected with it. Even the most egregious subsidy benefits somebody, somewhere. Economic theory distinguishes in this context between strongly and weakly Pareto-superior situations (named for the economist Vilfredo Pareto, who first described them). If in one new economic constellation at least one person is better off than before and nobody else is worse off, then this new situation is characterised as being strongly Pareto-superior to the old one. In practice, the policymaker usually confronts *weakly* Pareto-superior situations, in which the winners' gains are greater than the losers' losses.

The British economist, Nicholas Kaldor has proposed that policy makers should concentrate on such weakly superior constellations. If the winners would then compensate the losers, they would create a true win-win situation.

However, it should be kept in mind that a policy is worth implementing if it offers a simple win-opportunity. If the overall gains from subsidy removal outweigh the costs, then the subsidy should be removed.

Every subsidy has some supporters. Yet such support is suspect, for several reasons. Four of these reasons are discussed below. It is no coincidence that the focus of many governments changed in recent years from intervention, subsidisation and taxation to market deregulation. The causes of this tidal shift include improved energy security due to international co-operation, the establishment of mature and transparent markets, technological developments that lower the fixed costs of energy generation and a heightened awareness of the "costs" of interventions in terms of lost economic efficiency. Awareness of subsidies that increase energy consumption has been further heightened by efforts to limit emissions of greenhouse gases, of which more than three-quarters are energy-related.

Taken together, the following four arguments put the onus of justification on the providers and recipients of subsidies, rather than on those arguing for their removal. Transparency and a more rigorous assessment of the full social costs and the expected benefits of subsidies, as well as the opportunity to discuss and challenge them, offer the best assurance that public policies reflect citizens' true preferences.

Economic Efficiency

Many of the historical reasons for energy subsidies were based on valid public policy objectives, yet subsidisation may not have been the most efficient policy choice to meet them. If a public-policy objective is to be met by increasing energy production beyond the point of economic efficiency, there has to be strong evidence that this contributes to an important policy objective, which only can be reached in this way. In practice, such a link can be hard to prove. Can social cohesion really be achieved only by subsidising coalmines, which sometimes produce coal several times more costly than imports? It is often cheaper and more efficient to finance a public-policy objective directly. Generalised income transfers can further social cohesion without distorting the allocation of productive resources among sectors.

Box 8: **Subsidies in OECD Countries**

Most OECD countries have reduced or eliminated direct energy subsidies and lifted price controls over the past two decades, as part of a general move away from heavy government intervention in energy markets and other sectors of the economy. This move reflects both a more stable world energy and oil situation and a profound shift in government attitudes, resulting from the perceived failure of past interventionist policies.

Those subsidies that remain are often intended to protect domestic industries and employment. This is particularly the case with subsidies for coal mining in Germany, Japan and Spain; for peat in Finland and Ireland and for biofuels in France. Subsidies may also promote more environmentally benign and renewable energy sources and technologies and clean coal. They typically take the following forms:

- Grants and credit instruments in the form of soft loans and interest-rate subsidies applied directly as government transfers to producers or consumers of energy. Grants for energy services or appliances commonly encourage the use of energy efficient technologies. Such an approach is practised extensively in some countries, notably Denmark. The Danish government offers subsidies of up to 30% for investments in energy efficiency or conservation in industry and commerce, in addition to tax rebates on such investments for energy-intensive firms. A number of countries, including the United States and Australia, use tax credits to foster industry research and development.
- Regulations requiring or encouraging consumers to purchase a given fuel from a particular source, usually domestic, sometimes at a regulated price. Denmark, for example, requires utilities to burn minimum quantities of straw or wood in power stations.
- Differential taxation to encourage or discourage the production and use of certain fuels. Increasingly, OECD countries are restructuring their energy taxes to penalise the most carbon-intensive fuels. Some Scandinavian countries have imposed an explicit carbon tax.
- Public funding of research and development programmes. The governments of almost all OECD countries undertake energy R&D, either directly or indirectly through support for private-sector research and development. Generally, R&D are directed to those sectors where the country has a strong domestic production capability or to more environmentally-friendly technologies.
- Price controls to promote the supply and consumption of particular energy sources. An above-market price to encourage the supply of a given fuel would normally be accompanied by purchase obligations or grants to consumers. Underpricing a fuel would normally be combined with direct subsidies or grants to producers. Few OECD countries now use price controls to achieve social, economic or environmental goals, preferring in general grants, taxation, regulatory instruments and support for R&D.

The IEA and OECD promote actively the removal of subsidies. The IEA monitors regularly the financial support to coal production using a producer subsidy equivalent approach.[3] In addition, the IEA carries out periodically critical reviews of the energy policies of Member countries, containing recommendations on ways of improving policies.[4] The IEA has also reviewed the energy policies of some non-OECD countries, such as Russia, South Africa and most of the Central and Eastern European countries in recent years. These reviews identify any subsidies and, where appropriate, recommend their elimination, particularly where they lead to higher energy production and consumption levels. The OECD recently assessed the potential benefits of reducing subsidy for the environment, while several other authors have explored the likely implications of phasing out subsidies in selected OECD countries.[5]

For many developing and transition economies, it is argued that subsidies to energy consumption cannot be removed without causing real income losses for a wide range of citizens and provoking a political backlash. These arguments must be taken seriously. At closer sight, however, subsidies and the under-pricing of energy are a very inefficient way to support the real incomes of low-income groups. The straightforward distribution of money to needy parts of the population in amounts equivalent to the budgetary costs of the energy subsidies would better achieve social objectives while reducing the efficiency costs on the economy. Clearly such institutional adjustments need time and proper political support in order to develop into valid policy options.

Asymmetries between Winners and Losers

Even when experts agree that the cost of a given subsidy outweighs its benefits, it can be almost impossible to abolish it. Subsidies have a peculiar political economy: while their costs are spread widely throughout the domestic economy, their benefits accrue disproportionately to certain segments of the population. This creates asymmetric incentives for political leaders, an effect also known as a "political mobilisation bias". It is easier to lobby support for the deeply felt interest of small, homogenous groups, rather than for a comparatively vague "general interest".

3. See IEA (1999) Coal Information - 1998 for detailed information on data and the subsidy equivalent approach.
4. See, for example, IEA (Germany - 1998 Review), IEA (Spain - 1996 Review), IEA (Japan - 1999 Review), among others.
5. See OECD (1996a), OECD (1998c), Koplow (1993), Radetzki (1995), Okogu and Birol (1994).

Subsidies, if not justified by a unique and verifiable effort, create a "rent" for their recipients. The recipients of a rent will always have an interest in defending its continuation, because their gains exceed their costs. In principle, the providers of a subsidy, ultimately the mass of consumers or taxpayers, should have an opposite interest in demanding the delivery of a service in return for payment. But because the providers' per capita costs are lower than the recipients' per capita gains, the latter will always have the stronger incentive to mount effective political action. Information about economic-efficiency losses is hard to document with specific examples, whereas information about the effects of subsidy removal, can be strikingly concrete.

Structural Change

Even if an energy subsidy has historical justifications, the original rationale may have ceased to exist. The public-policy objectives aimed at originally may have been achieved. Earlier market imperfections, which required government intervention, may no longer be at issue. A changed policy environment with new preferences and objectives may require new priorities. Nevertheless, subsidies display strong inertia even in the light of new technological, economic and social developments.

For instance, while the natural-monopoly argument remains valid for certain aspects of grid-based distribution, technological developments, such as combined-cycle gas turbines, have lowered the fixed costs of power generation. This makes government intervention to ensure economic efficiency increasingly obsolete so far as power generation is concerned. Mature global markets, better information and new risk-management techniques help ensure energy security to a higher degree than ever before. Moreover, as citizens display an increasing concern for the quality of the environment, the case for more energy consumption has to be carefully weighed against the case for less. Continuing subsidies must reflect changing energy policy priorities.

Distributional Effects

Energy subsidies frequently cause unwanted distributional effects, despite a routinely re-iterated argument about the maintenance of purchasing power for lower income groups. More and more evidence reveals energy subsidies as actually *regressive*; their benefits accrue mainly to middle and higher-income groups, while their costs fall on the whole population and, in particular, on low-income groups. In many developing countries, many people have no access to commercial fuels but rely on unsubsidised biomass and thus do not share the benefits of lower conventional-energy prices (see Box 5 in Chapter Two).

Subsidies often go to large, capital-intensive projects at the expense of local labour-intensive solutions. A dam will be preferred to more efficient biomass burners. This can favour such undesirable side effects as internal migration and urbanisation. In such cases, subsidy removal would lead to a more level playing field, letting the most cost-effective solutions prove themselves in competition. Other negative side effects may be local and regional emissions from transport and power generation, which create health hazards that fall disproportionally on populations unable to avoid heavily congested and polluted urban areas.

Prices, Subsidies and Economic Efficiency

Consumer preferences, the structure of the economy, endogenous resources, the state of technology and the price of energy all determine the magnitude and mix of energy consumption. In the short run, however prices are the one variable most easily changed. Besides providing a dynamic impetus to new technologies, energy services and energy use habits, prices can have a profound impact on the energy intensity of an economy by influencing its choice of energy technologies.[6]

Prices are thus among the crucial variables that determine energy efficiency. Energy subsidies, especially to consumption, have a direct impact on energy prices, usually establishing them at levels lower than they otherwise would reach.[7] In addition to the loss of economic efficiency discussed above, this leads to higher levels of energy consumption with all the obvious implications for trade, greenhouse gas emissions and ultimately aggregate welfare. Subsidies thus lead to efficiency losses in private-good terms (those goods which are part of GDP accounts) and to lower growth, even if they do create benefits in terms of other public goods like energy security.[8]

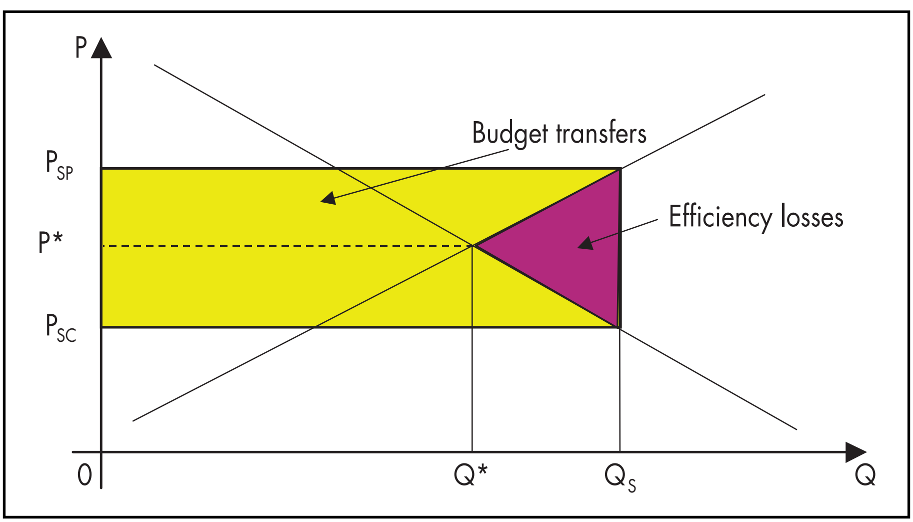
6. The energy intensity of an economy is usually measured as energy use per unit of GDP. This simple aggregate is an imperfect indicator of the degree of energy *efficiency* of an economy. The technical efficiency with which energy is used is only one of the factors that determine energy intensity. Other factors are country-specific characteristics such as population density, climate or industrial structure.
7. This depends, of course, on the form of the subsidy. In some cases, subsidies to domestic energy industries have taken the form of enforced contracts, which stipulated prices substantially *higher* than the cost of alternative supplies in order to stimulate domestic production.
8. The economist Paul Samuelson has shown in his "The Pure Theory of Public Expenditure" (Samuelson 1954) that economic optimality requires that the cost of public-good provision should be equal to the sum of the individual benefits derived from it. The cost of the public good in question can be measured as the efficiency losses caused by the provision of the subsidy.

While the general idea that subsidies do have costs is widely accepted, policy makers often imperfectly understand these costs. Subsidies impose efficiency costs because they provide price signals that distort perceptions. They obscure the economic scarcities of energy outputs and the inputs needed for their production.

Figure 8 shows how transfers lead to an increase in producer and consumer surpluses (the quadrangle minus the darker triangle). These increases, however, are smaller than the total amount of the transfers (the quadrangle), and this leads to the overall loss in welfare captured by the darker triangle. The static economic-efficiency losses from subsidies are thus smaller than the total amount of transfers. Concretely, this means that benefits to consumers from the last units of energy are smaller than the costs of producing the energy, also called the opportunity costs. In other words, consumers would do better to accept the amount of money that it costs to produce one unit of energy (P_{SP}) than the unit of energy itself.

Conversely, producers would do better to pay consumers the benefits they receive from energy consumption (P_{SC}) than to produce the energy. Of course, neither deal would ever be struck since the government would stop paying the subsidies. The final effect of the subsidy amounts to the

Figure 8: **The Efficiency Losses of Subsidies**



P* indicates the economically efficient price for Q, *i.e.* the price which includes all relevant costs. It may include externalities if they are considered relevant to economic welfare; it may not if welfare is measured only in terms of marketable goods. The only relevant fact is that subsidies lower the price by consumers below that which they would otherwise pay.

government paying out, each time a unit of energy is sold, the difference between the price which the producer demands (P_{SP}), and the price which the buyer is willing to pay (P_{SC}). Economic theory maintains, somewhat counter-intuitively, that it does not matter whether the subsidy is received by buyers or by sellers, so long as it is linked to the buying and selling of energy.

To decide whether a subsidy is justified, the economic-efficiency losses must be weighed against the public-good benefits. Because public goods are notoriously difficult to quantify, the analyst can only say that governments should increase the transparency of their decision-making on subsidies. This would allow the political process to weigh the perceived costs and benefits. An absolute, objective criterion rarely exists for deciding whether or not a subsidy is justified. Subsidies will always have beneficiaries, who will argue forcefully for the existence of public goods connected to them, asserting claims that are hard both to verify and to disprove.[9]

Different Effects of Energy Subsidies

The impacts of subsidies on economic efficiency arise because subsidies induce consumers and producers to exchange goods at points where the marginal utility of consumption is lower than the reference price, or the true opportunity cost, of the good in question. In other words, with prices lower than true opportunity costs, too many goods get consumed.[10] Along with the losses in economic efficiency already discussed, this increase in consumption leads to two important corollary effects.

The first effect is increased demand for energy imports, notably oil, and reduced export availability. This implies increased hard-currency expenditures for importing countries or decreased hard-currency revenues for exporting countries. The heightened demand will also increase the market power of the remaining exporters, potentially increasing their ability to raise prices.[11] The evidence in Chapter Two showed that the main

9. One could argue that subsidy provision will automatically be optimal, as people will object through the political process to paying for subsidies if they do not deliver a sufficient amount of public goods, assuming transaction costs are not too high. In the words of Voltaire's Dr. Pangloss we are already living "in the best of all possible worlds". This argument, however, overlooks the fact that attempts to influence decision-making on subsidies are themselves part of the dynamic process to arrive at better outcomes under new circumstances.

10. On the link between cost of production and the reference price against which subsidies are assessed, especially for petroleum products, see the section on "The Crucial Role of Reference Prices" in the Annex to Part A "Methods, Concepts and Data".

11. See Birol, Aleaghe and Ferroukhi (1995) for an estimation of the impacts of a subsidy phase-out policy on the export availability for three major oil exporting country. See also Paga and Birol (1995), for an empirical analysis of potential efficiency gains from subsidy removal policy for OPEC member countries.

increases in oil-import requirements over the next twenty years will come predominantly from non-OECD countries, which will also make the main contribution to global economic growth. These countries' energy policies, particularly their pricing policies, will have a determining effect on the supply and demand balance in global oil markets.

The second effect concerns the local and global environmental impact of energy-related airborne emissions. In many towns and cities, local pollution associated with the combustion of fossil fuels either in end-uses or in transformation activities (to oil products or power and heat generation) is a major human health problem. Table 1 shows the levels of emissions of the most important local pollutants in the largest cities of the countries covered in this study. Emissions are in most cases well above the World Health Organisation (WHO) maximum annual mean guideline levels for air quality, especially for particulates and nitrogen dioxide.

Table 4: **Airborne Emissions of Major Pollutants, 1995**

Country	**City**	**City Population** 1,000s	**Total Suspended Particulates** (micrograms per m^3)	**Sulphur Dioxide** (micrograms per m^3)	**Nitrogen Dioxide** (micrograms per m^3)
China	Beijing	11,299	377	90	122
Russian Federation	Moscow	9,269	100	109	n.a.
India	Delhi	9,948	415	24	41
Indonesia	Jakarta	8,621	271	n.a.	n.a.
Iran	Tehran	6,836	248	209	n.a.
South Africa	Capetown	2,671	n.a.	21	72
Venezuela	Caracas	3,007	53	33	57
WHO Guideline			**90**	**50**	**50**

Source: based on World Bank (1998d).

Subsidies that increase fossil energy consumption through lower prices also result in higher greenhouse gas emissions. Like local emissions, greenhouse-gas emissions are a so-called "negative externality" of energy consumption — with an effect on general welfare that is not reflected in the decisions of the relevant actors. The consuming country feels a part of this effect and so does the global community at large.

It can be argued that greenhouse gas emissions need not concern many developing countries. The increased risks due to domestic emissions alone are small for most of them.[12] Furthermore, seven of the eight countries under consideration in this study do not belong to the Annex I group of countries, which has assumed legally binding commitments to reduce their greenhouse gas emissions under the Kyoto Protocol.

However, climate change is a global problem and can be solved only through global efforts. This does not mean that all countries should contribute in equal or in proportional measure to the solution of the problem. Both the record of historical contributions to greenhouse-gas concentrations and current emissions levels offer arguments for an allocation of responsibilities similar to that agreed upon at Kyoto. Yet, independent of all consideration of emission rights and relative burden-sharing, one constant reality remains. Even if the main burden is borne by one particular group of countries, the participation of non-Annex I countries could produce benefits for *all* the parties.[13]

This study also calculates another magnitude: the “subsidy-equivalent budget outlay”, an indicator of the resources needed to achieve a subsidy-induced reduction in energy price. This value is also hypothetical. It nevertheless indicates the orders of magnitude involved. Subsidies come in diverse and sometimes unrecognisable forms, as described below. The most transparent and conceptually the simplest provides a payment directly from the government budget to either the buyer or the seller for each unit of energy bought or sold. Although this form is the exception rather than the rule, it is relatively simply to calculate for the other forms the amounts necessary to achieve the same lowering of price through direct government transfers.

To sum up so far, the study calculates five magnitudes that measure the effects of subsidy removal:

- economic efficiency gains,
- energy trade impacts,
- incremental greenhouse gas reductions,
- potential revenue gains, and
- subsidy-equivalent budget outlays.

12. This argument would not hold for large emitters such as China, Russia or India, whose emissions could affect the global total in a noticeable manner.

13. See Annex to Part B “The Potential Benefits of Valuing CO_2 Emissions Reductions through Global Emission Trading” for a detailed discussion about how and how much developing countries could gain by participating in global efforts to limit CO_2 emissions.

All five should be understood in light of the qualitative discussions of each country under consideration (Chapters 5-12). While they certainly do suggest directions for policy, they do not lead to policy *prescriptions.* Their chief purpose is to further a better understanding of the working and consequences of energy subsidies.

Different forms of energy subsidies

One final word on the different forms that energy subsidies can take. Governments rarely prefer the simplest and most transparent way to administer an energy subsidy — a per-unit payment to the seller or the buyer each time a unit of energy is sold. There are five main reasons for this. First, it could entail considerable accounting and transaction costs; simpler mechanisms, such as the generalised exemption of energy goods from a value-added tax (VAT) would have much the same effect. Second, certain forms of subsidisation, such as government involvement in the energy sector and the resulting access to cheap capital, are rooted in historic developments rather than conscious policy designs. Third, some forms of subsidies, such as accelerated depreciation allowances for capital-intensive investment, stretch across several sectors. Others, such as subsidies to miners' pension funds, are targeted more precisely at specific objectives inside the energy sector, rather than the sector as a whole. Fourth, some subsidies are kept off budget for distributional reasons, such as government-sponsored contracts between suppliers and consumers at artificial prices. In such cases, the subsidy is paid for by certain groups in society, rather than by taxpayers at large. Finally, and perhaps most importantly, transparent, on-budget subsidies present an easy target for taxpayers interested in reducing their tax bills.

The forms in which subsidies are administered can be grouped into several large categories. There are, first of all, direct and indirect subsidies. Direct subsidies have observable and, in principle, measurable effects on prices, whereas indirect subsidies are much more difficult to measure.

Another distinction, divides subsidies into those that aim to increase consumption in general and those that seek to raise output from domestic production. These two objectives can have different effects on prices. In principle, lower prices will always be accompanied by increased domestic consumption. An increase in domestic production can also lower prices if the subsidy stems from devices like preferential loan arrangements. But prices will rise under measures like an import tariff. The first example lowers production-input prices while the other underpins the prices which domestic producers can command in their home market.[14]

One of the most common forms of subsidisation in all sectors involves "tax expenditures", the exemption of certain goods from normal taxation. While a benchmark for "normal" taxation is not always easy to establish, there are clear instances in which specific goods are exempted from taxes applied to other goods. A tax expenditure is most easily understood as a reduction in Value Added Tax. Assuming a generally acceptable benchmark such as VAT, a tax expenditure works exactly like a per-unit payment from the government to either buyers or sellers at each transaction. The budgetary effects are the same, as the revenue shortfall corresponds to the unit value of the exemption times the quantity of the good exchanged. Because revenue shortfalls are less politically visible than outright payments, tax expenditures are a convenient and frequently used instrument.

A final question has recently drawn the attention of subsidy experts. Do "uninternalised negative externalities", environmental or otherwise, constitute a subsidy? Or, in other words, is someone who produces or consumes in a way that generates social costs but who does not have to pay for them, in some sense receiving a "subsidy"? The topic has considerable relevance to the energy sector.

Box 9: **Different Forms of Subsidies and Government Interventions**

Direct Financial Interventions

Transfers, grants, preferential loans and liability insurance

Grants and direct subsidies by financial transfer payments through retailers

Credit instruments such as interest rate subsidies, soft loans, loan guarantees

Payment guarantees and deficiency payments, support or indemnification for decommissioning, environmental liability, accident insurance, inherited liabilities

Transfers to the producers of inputs to energy production

Research and development grants

14. As specified in the annex to Part A "Methods, Concepts and Data", two subsidies, namely one that reduces factor prices and one that raises competing import prices, can have opposite price effects and could leave prices close to their unsubsidised level. This cancelling of price effects would also cancel the emissions impacts, but not the economic efficiency and trade effects, both of which would be additive.

Tax instruments

- Energy taxes and other levies on energy products
- Natural-resource royalties
- Emission fees
- Tax exemptions, tax relief, credits, deferrals, reduced VAT and income tax rates for energy products, inputs to energy production or energy-intensive products
- Accelerated depreciation allowances and the possibility of transfer pricing

Trade instruments

- Tariffs
- Quotas and restrictive licensing for importers
- Technical restrictions and chemical specifications on imports
- Political restrictions including embargoes

Indirect Administrative Interventions

Government management and ownership

- Government ownership, control or participation in energy companies
- Government agencies performing service function, such as providing market information
- Provision of energy-specific infrastructure, roads, harbours, docking stations
- Public research institutions concentrating on energy-relevant research
- Preferential treatment in civil and defence procurement

Regulation

- Demand guarantees through enforced contracts with long-term quantity setting
- Negotiated target setting and mandated market deployment rates, including voluntary agreements
- Price regulation
- Environmental legislation, emission limits, liability specification and siting rules
- Technical regulation and minimum energy-performance standards
- Emergency response measures
- Market access restrictions such as single-buyer provisions, rights of eminent domain
- Licensing, certification and labelling

From an abstract point of view, the argument can be resolved conclusively. In a social optimum, prices should reflect *all* costs and benefits connected with the production and consumption of a good. In other words, prices would rise if production or consumption causes negative externalities; producers and consumers would be remunerated when they cause positive externalities. In such abstract terms, an uninternalised, negative externality — a cost not reflected in prices — does indeed constitute a subsidy.[15]

If externalities were perfectly measurable in monetary terms and identifiable with specific inputs and outputs, this would be a useful argument. The main objection to it is that externalities, practically by definition, *cannot* be fully included in private cost accounting. They frequently involve new phenomena, still undergoing scientific verification and determination of quantitative causal relationships. Monetary estimates can, in some cases, be derived for externalities. But such measurements do not have the same degree of definiteness as the indications of costs and benefits expressed in market prices.

Where does this leave us? The answer follows from the arguments set out above. If there exist widely shared and accepted estimates of externalities, environmental or otherwise, cost accounting should include them. If not, it should not. The United States provides one concrete example. When a "market" for sulphur dioxide was created, the price of SO_2 emissions was internalised in the costs of producing electricity from coal-fired power plants. Exempting companies from paying for emission permits would now clearly constitute a subsidy.

None of the eight countries considered in this study has codified environmental externalities to a comparable extent. The study therefore does not include any environmental side effects in accounting the opportunity costs against which final consumption prices are assessed. In principle, damages to public health and production from SO_2 and particulate emissions could have been included in the reference prices as part of the full social costs of production. Similarly, the high mortality of coal miners in some countries due to missing or inadequate safety measures is a social cost resulting from an implicit subsidisation of coal mining. Monetising these costs however, would have far exceeded the resources available for this study. They have therefore been included in the qualitative discussions in the eight country chapters, but not in the quantitative estimates of subsidies.

15. Conversely, an unremunerated positive externality is not necessarily equal to a tax. For a generally accepted definition of taxes as "unrequited payments to general government" see OECD (1998d), p. 30. One difference between an unremunerated positive externality and a tax would be that the latter is compulsory and the former is not. This distinction is not applicable to uninternalised negative externalities and subsidies; neither the provision of the externality nor the acceptance of the subsidy is compulsory.

CHAPTER 4
QUANTITATIVE RESULTS

Necessary Caveats, Once Again

As this chapter embarks upon a presentation of the study's key quantitative results, the authors must re-emphasise — even if at the risk of redundancy — their indicative character and the limitations of any study of this kind. The limitations persist, notwithstanding that the IEA has had access to better price and cost data as well as a larger network of energy and country experts, than any previous study on energy subsidies.

Two limitations stand out particularly. First, the price-gap approach accounts only for those subsidies that *lower* the end-use price of energy. Where subsidies, like those to domestic producers, *raise* end-use prices, the price-gap approach will not capture them. Price-raising subsidies counteract the impact of price-lowering subsidies on consumption, but add to the negative effects on economic efficiency and growth. Second, this study, like any counterpart, identifies only static effects. It compares given situations with and without subsidies, holding all other things equal. Those other things, of course, never stay unchanged, especially when energy subsidies fall away. The dynamic effects of the removing of energy subsidies may well bring larger benefits than the static results presented here. They include increased transparency of prices and costs, the efficiency-enhancing effects of increased competition and greater accountability, accelerated technological development, in particular energy-efficiency improvements, and better responsiveness to consumer demands.

Both these consideration suggest that the study *underestimates* rather than overestimates the impact of energy subsidies on economic efficiency, CO_2 emissions and energy security. The results should be seen as a lower bound of the true costs of energy subsidies, at least as far as their effects on economic efficiency are concerned.

The limitations grow out of the price-gap approach, but all the alternative methods have equally serious shortcomings. It would be possible, of course, to do a thorough country study, looking at each market distortion individually, measuring its effects, emissions and energy security, then assessing the interactions of the different distortions and finally summing up the individual findings.[1] But such detailed studies are almost impossibly resource-intensive. The United States, the only country for which they exist, is probably the best documented, with large amounts of information readily available. The countries studied here have quite different situations, with fast-changing environments in which some key decisions depend on single actors or on opaque institutional mechanisms. The country chapters in Part B do try to take account of the most important of these essentially dynamic effects.

One alternative method amenable to international comparisons, the producer-subsidy-equivalent (PSE) approach, looks at the value of subsidies to their recipients as a measure of their impact. While this method offers a feasible way to pursue the magnitude of impacts over time, the sole calculation of the PSE, if used here, would provide no information about effects on economic efficiency, greenhouse-gas emissions or energy security.[2]

Box 10: **Other Projects, Other Methods**

As energy subsidies have important consequences for human welfare, the environment and economic efficiency, they have received considerable attention from international organisations in recent years. Previous studies have questioned implicitly whether decisions by governments to subsidise energy fulfil their intended objectives or whether those objectives might be more effectively or efficiently achieved by other means. Such studies have helped to shape the discussion on energy subsidies, providing a valuable foundation and complement for this IEA project.

The approach used in this study resembles that pioneered in 1992 by Bjorn Larsen and Anwar Shah of the World Bank, combining the price gap with elasticities to estimate the welfare and environmental costs of energy subsidies. Other approaches include producer-support estimates (PSEs) and the marginal effective tax rate. PSEs, used by the OECD for agriculture since 1987 and by the IEA for coal since 1988, indicate transfers from consumers and the government to producers arising from policy measures. This approach does not lend itself easily

1. Two such studies have been undertaken for the United States: US Energy Information Administration (1992) and Koplow (1993). To our knowledge, no such studies of the same range and quality are available for other countries.
2. First attempts to use PSE figures as part of a broader assessment are currently being undertaken in the OECD Directorate for Food, Agriculture and Fisheries with the AGLINK model and the Policy Evaluation Matrix (PEM). No published results are yet available.

to estimating effects on final consumption. The marginal effective tax rate is an estimated implicit tax rate, based on per-unit subsidy calculations, which affect consumer behaviour. This approach is seldom used because of its hefty information requirements.

Before this study, Larsen and Shah produced the only known quantifications of the potential for global CO_2 emission reductions and economic-efficiency gains resulting from subsidy removal.[3] This study estimates CO_2 emission reductions at 4.6% of world emissions, compared to Larsen and Shah's 8.7%, and at 16.1% of domestic emissions versus their 20%. Total estimated economic-efficiency costs of subsidies in the countries Larsen and Shah studied amounted to $33 billion, about double the $17.2 billion for the countries in this IEA project. The largest determinants of these differences are (1) different pools of countries studied, (2) different emissions base years (1987 for Larsen and Shah versus 1997 for the IEA), and (3) recent efforts made by non-OECD countries to reduce subsidies.

CO_2 Emissions Reductions
(per cent)

	IEA	Larsen-Shah
Total emissions reduction/total domestic emissions	16.0	20
Total emissions reductions/world emissions	4.6	8.7

In addition to the Larsen and Shah study, this project also benefits from much work by the OECD. *Environmental Effects of Liberalising Trade in Fossil Fuels*[4] is based on a variation of the price-gap method, excluding taxes from both reference and end-use prices to determine distortions which increase producer prices. As this IEA study focuses on subsidies to consumption, taxes are included in reference and end-use prices to replicate the prices that consumers actually do or would face. The country chapters offer qualitative descriptions of those specific subsidies, such as import tariffs or direct producer payments that raise prices, although in the countries studied most subsidies in fact result in lower consumer prices. The OECD study instead attempts to capture trade effects through the price gap approach.

3. Larsen and Shah (1992). The countries analysed by Larsen and Shah include the Former Soviet Union, China, Poland, India, South Africa, Czechoslovakia, Mexico, Brazil, Argentina, Venezuela, Indonesia, Saudi Arabia and Egypt.
4. OECD (1998d).

Another OECD study, *Reforming Energy and Transport Subsidies*[5], analyses the effects of subsidy removal in the United States and Russia in a spirit very similar to that of this study. *Improving the Environment through Reducing Subsidies*[6], again from the OECD, provides a valuable classification of subsidies and their effects on prices as well as far-reaching policy recommendations, among them a call for increased transparency of support measures. Finally, the IEA project is linked to the OECD horizontal project on sustainable development, due for completion in 2001.

In view of the foregoing considerations, the price-gap approach remains the best path to a quantitative assessment of energy subsidies. While further dialogue and refinement are certainly desirable, one principal conclusion arises unambiguously from the lower-bound estimates that this study has produced: energy subsidies trammel economic efficiency, the environment and energy security.

The Results

Tables 5 and 6 give succinct displays of the outcomes of the research. The remainder of this chapter discusses them in more detail. The first table contains background data on the different national energy systems, as well as measures of the absolute declines in energy and carbon intensity that can be expected from subsidy removal. The second table gives all the other results in terms of percentages or percentage changes.[7] Following the methodology described in the previous chapters and the annex to this part of the book, each country has been analysed, fuel-by-fuel, to determine the effects of subsidy removal and answer the key question, "How would economic and environmental performance, as well as energy security, look if end-use prices corresponded to reference prices?"

The Effects on Performance

Bear in mind once again that, while every care has been taken to establish precise underlying data sets, these numbers should be used in an indicative sense for the establishment of policy priorities.

5. OECD (1997a).
6. OECD (1998c).
7. Detailed figures by country, such as end-use and references prices, appear in the data Annex at the end of the book.

Table 5: **Main Energy Characteristics of the Countries Studied**

GDP	TPES (1,000 toe)	CO_2 emissions (1,000 tns.)	Energy Intensity (Toe/$1,000*) With subsidies	Energy Intensity (Toe/$1,000*) Without subsidies	Carbon intensity (Tonnes/$1,000*) With subsidies	Carbon intensity (Tonnes/$1,000*) Without subsidies
China 8, 216 billion Yuan (US$ 992.3 billion)	1,101,980	3,132,411	1.11	**1.01**	3.16	**2.73**
Russia 2,563 billion Rubles (US$ 442.6 billion)	591,982	1,456,239	1.34	**1.10**	3.29	**2.73**
India 14,714 billion Rupees (US$ 356.8 billion)	461,032	880,714	1.29	**1.20**	2.47	**2.12**
Indonesia 625 506 billion Rupiah (US$ 215.0 billion)	138,779	256,515	0.65	**0.60**	1.19	**1.06**
Iran 280 731 billion Rial (US$ 160.1 billion)	108,289	285,282	0.68	**0.35**	1.78	**0.90**
South Africa 367 billion Rand (US$ 79.5 billion)	107,220	345,252	1.35	**1.26**	4.34	**3.99**
Venezuela 52 030 billion Bolivars (US$ 95 billion)	57,530	136,755	0.61	**0.45**	1.44	**1.06**
Kazakhstan 1 963 billion Tenge (US$ 25.1 billion)	38,418	126,649	1.53	**1.24**	5.05	**3.90**
Total Sample	**2,605,230**	**6,619,817**	**1.10**	**0.96**	**2.80**	**2.35**
Per cent of non-OECD	58.45	64.03	N.a.	N.a.	N.a.	N.a.
Per cent of World	27.35	28.79	N.a.	N.a.	N.a.	N.a.
Non-OECD GDP US$ 5.595 trillion	4,457,038	10,338,193	0.80	0.74	1.85	1.66
OECD GDP US$ 23.939 trillion	5,067,517	12,654,663	0.21	0.21	0.53	0.53
World GDP US$ 29.35 trillion	9,524,555	22,992,856	0.32	0.31	0.78	0.74

Note: * Energy and carbon intensity are measured per unit ($1,000) of GDP.

Table 6: **The Results of Subsidy Removal**

	Average Subsidisation (Per cent of reference price)	**Annual Economic Efficiency Gains (Per cent of GDP)**	**Reduction in Energy Consumption* (Per cent)**	**Reduction in CO_2 Emissions (Per cent)**
China	10.89	0.37	9.41	13.44
Russia	32.52	1.54	18.03	17.10
India	14.17	0.34	7.18	14.15
Indonesia	27.51	0.24	7.09	10.97
Iran	80.42	2.22	47.54	49.45
South Africa	6.41	0.10	6.35	8.11
Venezuela	57.57	1.17	24.94	26.07
Kazakhstan	18.23	0.98	19.22	22.76
Total Sample	**21.12**	**0.73**	**12.80**	**15.96**
Percentages of:				
Non-OECD	N.a.	N.a.	7.48	10.21
World	N.a.	N.a.	3.50	4.59

Note: * The percentage reduction in energy consumption was calculated by adding the gross calorific value of the reductions of the different fuels under consideration and expressing the sum as a percentage of TPES. Because the calculations in this study did not take into account the refinery sector (a 5% reduction in gasoline use can amount to a reduction of TPES of more than 5%), the number thus derived constitutes again a lower bound to the true reductions in energy consumption.

Energy Consumption

The eight countries analysed in this study form two very distinct clusters with respect to energy intensity per unit of GDP. Those with the higher intensities include Kazakhstan, South Africa, India and Russia. The lower-intensity group contains Iran, Indonesia and Venezuela. China lies between the two. Even more pronounced differences appear in per capita energy consumption, which ranges from a staggering 4.02 toe per year in Russia (next are Venezuela with 2.52 and South Africa with 2.47) to lows of 0.69 toe in Indonesia and 0.47 toe in India.

Numbers for energy intensity per unit of GDP should never be taken as indications of economic or technical efficiency in the energy sector. Temperatures, geography, lifestyles and other structural parameters influence energy intensity too heavily to permit such an extrapolation.

Energy intensity per unit of GDP also declines with increasing levels of per capita income, as economies shift from primary, resource-based activities to less energy-intensive manufacturing and services.[8] The two countries with the highest average energy subsidies (Iran with a huge 80.42% and Venezuela with 57.57%, compared to a sample average of 21.12%) have relatively low energy intensities per unit of GDP, reflecting comparatively benign climates and higher standards of living. High levels of per capita income also help to explain the difference between the average figures for OECD countries and non-OECD countries.

The numbers for per capita energy consumption, display a strong positive relationship with levels of per capita income. Here the sample average is 0.96 toe per person, very close to the 0.97 toe average for non-OECD countries, whereas OECD countries are far ahead with 4.63 toe. This is unsurprising, given average income levels — $871 in the sampled countries, $1,220 in non-OECD countries and $21,885 in OECD countries.

The impact of energy subsidies, therefore, does not show up directly in cross-country comparisons, but only through comparing the "with-subsidy situation" and the "without-subsidy situation" in each country. For the sample as a whole, the removal of energy subsidies would lead to a total reduction in energy consumption of 12.8%, reducing average energy intensity from 1.10 toe to 0.96 toe per $1,000 of GDP. In Iran, subsidy removal could reduce energy consumption by almost half (47.54%). Venezuela would follow with a reduction of about one-quarter (24.94%). Russia and Kazakhstan would reduce their consumption by about one-fifth and China by one-tenth, whereas India, South Africa and Indonesia would reduce their consumption between 6% and 8%.

In general, therefore, a close relation holds between the measured subsidy rates and the potential for energy savings. Indonesia is an exception; it has high subsidies (27.51%) but relatively low energy savings (7.09%), the second-lowest in the sample. The reason for this deviation lies in the particularities of the Indonesian situation: a high percentage of biomass and a concentration of energy subsidies on petroleum products, which have very low elasticities of demand and hence less scope for energy savings from subsidy removal.

8. See Birol and Keppler (1999 forthcoming) for a discussion of the distinction between energy intensity and energy efficiency.

Economic Growth

Energy subsidies distort prices. Where energy is sold below its true opportunity costs, its use imposes a burden on the economy. This burden can be expressed as increase in growth that would occur if subsidies were removed. These potential gains amount, for the sample as a whole, to 0.73% of annual growth, and range from a high of 2.22% per cent in Iran, through 1.54% in Russia, to an almost negligible 0.1% per cent in South Africa. Given their high subsidy rates, Venezuela and Kazakhstan would also gain substantial economic growth from subsidy removal. The gains for the other countries lie below 0.5%.

Calculating the net present value of these annual differences in growth at a seven per cent discount rate yields a total amount close to $257 billion, about 11% of the combined annual output of the eight countries. While such numbers are rather notional, given uncertainties about the exact impact of subsidy removal and differences in discount rates, they do provide orders of magnitude, which clearly indicate the issues at stake. Moreover, because all of these static efficiency gains represent only a lower bound of the *true* efficiency gains from subsidy removal, the dynamic gains may reach even further. Such gains arise from changes in attitudes and behaviour. To the extent that prices begin to fulfil the function of providing information about opportunity costs, they will increase the confidence of investors and consumers, reducing information costs, furthering investment and boosting growth.

Energy Security

A reduction of energy subsidies that leads to reduced consumption and will feed through to reduced import demand and increased availability of energy goods for export. This has particular relevance in the oil sector.

China and Indonesia are both significant oil producers. Each has become or is on the verge of becoming a net importer of petroleum products.[9] Among the importing countries, India has most to gain in improved energy security through subsidy removal. Its substantial imports of kerosene and liquefied petroleum gas would cease completely, if the very high subsidies on these products (53% and 32% of the world market price, respectively) were abolished. India's limited coal imports would also become unnecessary. Indonesia and South Africa could reduce their imports to a

9. The focus in this study is on refined petroleum products. Crude prices have not been included in the analysis, because subsidies in the refining sector are much less identifiable than those to end-use consumers.

lesser degree. Indonesia could discontinue its kerosene imports and reduce its imports of automotive diesel fuel by about 10%. South African kerosene imports would also decline by about 10%.

The effect of such shifts on a country's net trade in petroleum and its products depends on its weight as an exporter. Venezuela, already a heavy exporter, would increase its exports only marginally in relative terms even if its own consumption were drastically reduced. On the other hand, in a large country with little energy trade, such as India, small changes in domestic consumption would make available relatively substantial resources on the trade side.

China, Russia, Iran, Venezuela and Kazakhstan are all net exporters of energy, while South Africa exports coal and Indonesia natural gas. For these countries, reduced consumption would make more resources available for export. China, for example, could increase its already substantial coal exports several times over if it eliminated all subsidies. Kazakhstan, South Africa and Venezuela could increase their exports by amounts ranging downward from two-thirds to 5% of current exports. Iran, Kazakhstan, Venezuela, Indonesia and Russia could all increase their exports of natural gas in response to the removal of subsidies. Iran and Kazakhstan would be able to raise them several times over, with the others could go up by around ten per cent.

Iran could roughly double the quantities of petroleum that it makes available to world markets for gasoline, automotive diesel oil, LPG and heavy fuel oil, if it removed its 60%-90% subsidies on petroleum products. Russia could add a third to its exports of heavy fuel oil, and Venezuela 10% to its exports of gasoline. Again, the dynamic effects might prove more important than the static ones. Reduced imports and increased export availability might well contribute to lower long-run prices on world markets. Secondary effects, such as improved energy efficiency in the countries under study would re-inforce this effect.

Greenhouse-Gas Emissions

Subsidy removal reduces CO_2 emissions, substantially ranging from 8.1% for South Africa to 49.5% for Iran. Venezuela, Kazakhstan and Russia also have a very high potential and Indonesia's is only somewhat lower. China's and India's potential reductions lie closest to the weighted sample average of 16%. Global emissions would be reduced by 4.6%.

Reduction possibilities are greater in percentage terms for CO_2 emissions than for energy consumption in all countries except Russia, for two reasons. First, because non-conventional biomass consumption was not included in the subsidy calculations, the analysis captured a very large part of all energy uses that produce CO_2 emissions, but a slightly smaller part of *total* energy uses. Hence, CO_2 emission reductions are assessed against a relatively smaller total than reductions in energy consumption. The largest differences between reductions in consumption and reductions in CO_2 emissions are in India, China and Indonesia, all countries with large shares of biomass consumption. The opposite tendency appears for Russia because its energy supply contains a substantial share of heavily emitting sub-bituminous coal, which was also not included in the analysis.

The second reason stems from the structure of energy subsidies themselves. Coal, which produces more CO_2 emissions per unit of calorific value than any other fuel, is often heavily subsidised, whereas the consumption of petroleum products with relatively lighter emissions is subsidised only slightly or not at all in most countries (notable exceptions are Iran and Venezuela).

Like energy consumption per unit of GDP, CO_2 emissions per unit of GDP and per capita also display large differences between countries. Perhaps even more than for energy intensity, the carbon intensity of different countries depends on national particularities, as well as the energy mix, which to a very large extent reflects natural endowments. Thus Kazakhstan's 5.05 tonnes of CO_2 emitted for every $1,000 of GDP (compared to a sample average of 2.80 tonnes) are a function of its ample coal reserves and the high share of coal in its energy supply. Yet low coal prices, subsidised by an average 21% also play a role.

Other countries with large coal shares in their power supplies also have high CO_2 emission intensities, compared to both OECD and non-OECD countries. South Africa's carbon intensity is more than double the average for other non-OECD countries. Russia's, China's and India's are also very high. Iran and Venezuela have comparatively low carbon intensities despite their high subsidies, reflecting their low coal consumption. Indonesia, the lowest, also has a high biomass share.

The removal of energy subsidies would change the overall ranking of countries only slightly, but countries would move closer together within the two clusters. South Africa would become the economy with the highest carbon intensity, reflecting its structural reliance on coal and the relatively small effects of subsidy removal. The high coal-share countries would reduce their spread by about one-third and the three low coal-share countries by about one half. This probably reflects a double causal relation: first, countries' positions are broadly determined by high or low shares of coal in their energy consumption; second, within those categories, subsidy removal moves carbon intensities towards the average value for each group.

Without subsidies, overall carbon intensity in the eight countries would drop from 2.80 tonnes to 2.35 tonnes per $1,000 of GDP. Structural determinants keep this average considerably higher than the average for non-OECD countries of 1.66 tonnes. The ending of subsidies, however, would have achieved an almost 16% reduction in carbon emissions in the eight countries.

Government Budgets

Finally, energy subsidies constitute a drain on government budgets, both directly through payments to producers and distributors and indirectly through reduced growth and revenues. This project has calculated the budgetary impacts of energy subsidies in the individual country chapters. The "equivalent budgetary impact" corresponds to what would have been spent if all subsidies were financed directly through budgetary outlays.[10] In practice, things are not quite that straightforward. National energy companies may offset the costs of subsidies against profits, or costs may be reduced due to access to cheap capital available because of implicit or explicit government guarantees. Thus, in many cases the "equivalent budgetary outlay" can be significantly larger, than the true impact on government budgets. They have nonetheless been reported in the country chapters for illustrative purposes.

10. The number is arrived at by multiplying the total quantity consumed by the difference between the reference price and the end-use price.

ANNEX TO PART A
METHODS, CONCEPTS AND DATA

The Price-Gap Approach: Strengths, Limitations and Extensions

In a quantitative project in an area where much remains to be done and there are few fixed points, choices must be made not only about the depth of the analysis and the sample size, but also about the method for the quantitative analysis. To quantify the effects of energy subsidies as far as possible, any approach must be *transparent*, to allow effective communication with key audiences, *robust* enough to deliver comparable results for eight different countries and *relevant* in delivering results with implications for policy. A number of options are available, none of them fully satisfactory, but despite the fact that the price-gap approach captures only some of the impacts of energy subsidies its robustness and transparency made a decision in its favour relatively easy.[1] Max Corden laid down the theoretical foundations of the price-gap approach in 1957. Gavin McCrone (1962) undertook an early application to agriculture subsidies in the United Kingdom in 1962. Bjorn Larsen and Anwar Shah, both of the World Bank, introduced the technique to a wider public in 1992.[2]

The price-gap approach is based on the idea that subsidies to consumers and producers of energy lower the end-user prices of energy products and thus lead to higher levels of consumption than would occur in their absence. Its central feature compares actual end-use prices with reference prices, those that would prevail in undistorted markets in the absence of subsidies. The difference between the two sets of prices is the "price gap". Combining the percentage change in prices (the price gap divided by the undistorted price) with the elasticity of demand yields the change in consumption that would result from an elimination of the price gap, or, in other terms, an elimination of subsidies.[3]

1. For a presentation of alternative approaches see the Box "Other Projects, Other Methods".
2. See Cordon (1957), McCrone (1962), and Larsen and Shah (1992).
3. See the later section of this Annex, "Steps in the Quantitative Analysis" for a detailed presentation of the calculation of energy savings.

As conceptually simple as these steps are, a considerable amount of reflection and computational effort has to go into determining the demand elasticities and, in particular, the reference prices. The reference price indicates the opportunity cost of consumption of one unit of energy, its true economic value. It corresponds either to the border price for internationally traded energy products or to the costs of production for non-traded ones, both adjusted for transport and distribution costs. In undistorted markets, the border price and the domestic production costs are the same. The actual determination of a reference price depends on a number of factors specific to each case and has to be carefully adjusted every time.[4]

The price-gap approach captures the effects of subsidies on economic efficiency to the extent that they lower the end-use price of the good in question. This leads to more trades than in the absence of subsidies, especially trades that occur only so long the government fills the gap between costs and prices. Examples of filling the gap are a VAT rebate or reduced capital costs due to preferential lending schemes. Other forms of subsidies, especially those, like import tariffs, which are designed to support domestic production, would *raise* final consumption prices. It thus is theoretically possible for the end-use price to exceed the reference price. We have found, however, for the countries under consideration here that most end-use prices fall below their reference prices, because subsidies go mainly to support overall consumption, rather than domestic production.

When more than one subsidy applies to the same good, a frequent occurrence, the price gap measures only the net price effect of all the different subsidies together. In reality, however, the effects on economic efficiency of coincident subsidies are *not* netted out, but add up. For instance, the combined application of a subsidy to capital costs and an import tariff might well leave end-use prices close to the reference price. In this case, the price-gap approach would yield little or no insight, but double efficiency losses do occur. So work based on price differentials cannot measure all efficiency losses associated with government policies.

Trade effects, the reduction of imports or the additional availability of exportable fuels, are particularly affected by this analytical limitation. Depending on the specific forms of the subsidies, their removal might have much greater impacts than simply closing or narrowing the price-gap. Removing a capital subsidy and an import tariff might change prices little, but it would have very strong trade implications.

4. See the section below on "The Crucial Role of Reference Prices".

The price-gap approach establishes lower bounds for the impacts on economic efficiency and trade. The impacts of subsidy removal might be larger in reality than is indicated by the price-gap approach, but they will never be smaller. The price-gap approach applied in this study captures a relatively large share of the potential effect of subsidy removal, because the vast majority of subsidies in non-OECD countries are indeed subsidies to consumption. This approach would not be the ideal method to assess subsidies in OECD countries, because many of those subsidies aim at stabilising domestic production, and enhancing energy security and diversity, rather than increasing consumption.

The inability of the price-gap approach to capture the full impact on economic efficiency, if price effects go in different directions, does *not* extend to the calculation of reductions in greenhouse-gas emissions due to subsidy reform. Final consumption, and hence greenhouse gas emissions, are determined by final energy prices, independently of how those prices are determined. The price-gap approach can thus be used without problems to calculate potential emissions reductions from subsidy removal. It provides good answers to the question: "How much less energy would be consumed if final end-use prices corresponded to reference prices?"

Final End-Use Prices As Determinants of Consumption

The price-gap approach is based on the difference between end-use prices to consumers and reference prices. The end-use price is the actual price to energy consumers, be they households, manufacturers, service providers or power generators. These prices determine customers' decisions. For final end-use prices, this project uses national averages to the extent that regional variations were reported. We have drawn from a large number of sources, whose credibility was verified by country experts. Amongst the accessible sources, the most reliable were selected according to expert judgement. All taxes, fees, levies, surcharges and so forth, as well as all rebates and reductions, were included in actual prices as long so they were related to the buying or selling of energy on a per-unit basis. A distinction was drawn, however, between taxes levied specifically on energy and general transaction taxes such as value-added tax (VAT).

Taxes levied specifically on energy offset to some extent the impact of subsidies on prices and consumption. Depending on the form in which the subsidies are administered, taxes can also offset their impact on prices, at least to some degree. For example, if subsidies lead to lower capital costs for power generation, a tax on electricity would offset the increased consumption due to lower prices. Energy taxes, however, would not offset the efficiency losses induced by an inefficient factor mix, such as a bias towards capital-intensive forms of energy production bolstered by a capital-cost subsidy.[5]

Box 11: **Calculating End-Use Prices**

There are at least three different possibilities for presenting domestic energy-price data:

- in the domestic currency;
- in an internationally accepted currency, after exchange-rate conversion; or
- in an internationally accepted currency, after conversion with the appropriate purchasing power parity.

The differences between the three possibilities usually are not large for countries with open markets and freely convertible currencies. Within the limits defined by transaction and information costs, arbitrage pushes the values towards each other.

In practice, however, comparisons of purchasing power, popularised, by the "Big Mac Index" of *The Economist*, reveal considerable differences between what a dollar's equivalent can buy in different countries, even in open economies. To allow meaningful international comparisons and to aid comparisons of domestic end-use prices with international reference prices, the concept of purchasing-power parity (PPP) helps. The PPP is a conversion factor for the prices of similar goods. It is based on the notion that one dollar, converted at PPP into the currency of a given country, can buy in that country the same amount of goods as in the United States.

5. Energy-specific taxes do not play a major role in the countries under consideration. India, Russia and Venezuela levy minor taxes on transport fuels. Because their end-use prices nevertheless remain very low, it is likely that these taxes result from institutional weaknesses (government revenues are easier to collect from private consumers than from producers), rather than from any intention to influence the mix or level of energy consumption. The analysis also includes only legal taxes on energy. China, for example, has a number of unsanctioned charges and fees on electricity at the local level. Because this is a policy-oriented project aimed at assisting the decision-making of policy makers, the analysis confines itself to elements, which are part of the formal framework.

The differences in US dollar terms, calculated with PPPs and with market exchange rates, can be remarkable. In one study, energy intensity calculated on the basis of exchange rates for a sample of non-OECD countries emerged as three times *higher* than for a sample of OECD countries. Comparison of the same samples on the PPP basis gave the non-OECD countries a *lower* intensity than the OECD countries.[6]

The use of purchasing power parities has also several disadvantages. They are costly and time-consuming to establish and therefore frequently outdated. Moreover, it is practically impossible to compare like with like in different countries. A Big Mac, the same physical product in two countries, is consumed as a staple in one and as an exotic luxury in another. Finally, "PPP" is not a clearly defined concept; there exist different ways to calculate it.

This study chose a mixed approach, which reflects the different character and the different economic roles of different fuels. The domestic currency of the country under consideration always served as the basis for all calculations of economic cost, alternative demand and budgetary costs. For traded fuels, such as petroleum products, gas or coal, the international market prices used as reference prices were converted from US dollars into domestic currency units using the official exchange rates. Because the hard currency used to buy or sell the traded energy goods is acquired or sold at this rate, the amount of domestic currency thus calculated constitutes the relevant opportunity cost.

For non-traded energy commodities, such as electricity, domestic prices were compared to domestic cost estimates. The domestic currency units of the countries under consideration thus remained the unit of account throughout the project. This had the great advantage of allowing us to work inside each country with a single unit and relating prices and price differentials to GDP, imports, exports, and budgets, all expressed in the same unit. This technique avoided a whole layer of potential distortions and, country by country, yielded a more precise picture.

6. Birol and Okogu (1997), p. 12.

The case is somewhat different for general transaction taxes such as VAT. The reference prices include these taxes, which show up in the actual end-use prices of all goods. Such taxes are part of the cost of doing business. Unlike energy-specific taxes or subsidies, they do not change relative prices between energy and other goods, and thus do not change final quantities and allocations. In a partial-equilibrium approach like that employed here, they do not affect efficiency.

Finally, a quantitative analysis based solely on prices and the working of the price mechanism has some general limits. Prices, particularly in developing countries, are far from being the only signals perceived by consumers. Constraints may exist on the physical availability of a fuel. Low sulphur coal is cheaper than high sulphur coal in Beijing but has a limited availability, for example. Fuel prices will not reflect certain subsidies for energy consumption, mainly those for complements to energy use, such as company cars, or general subsidies to capital cost. Administrative decisions or regulations that constrain consumer choice will affect also fuel consumption. When energy prices are kept artificially low, no sufficient incentives for supply may exist, depending on the particular incentive mechanisms on the supply side. Depending on the precise form of the subsidies, those supplies may be diverted to domestic uses rather than be exported contributing to higher prices in world markets.

Structural barriers may also impede the smooth functioning of markets and the working of the price mechanism. Such "market failures" can particularly affect developing countries. In part, they reflect historical and specific characteristics of the country in question and may deserve to be safeguarded for non-economic reasons — but they may also reflect an inadequate informational and financial infrastructure and thus call for mitigation by other policy actions. Such market barriers in the energy sector can include:

- inadequate information,
- high perceived, and often real risk in the implementation of new technologies,
- high transaction costs,
- credit constraints, and
- weak institutions.

Such structural barriers remind us that policies for subsidy removal cannot be considered in a social and political vacuum. They also remind us that prices are not the only determinants of energy supply and demand. At the same time, however, the cross-country comparisons between fuel prices and per capita consumption in Chapter One demonstrate that price effects tend to supersede structural considerations even when countries differ strongly in national characteristics.

The Crucial Role of Reference Prices

Reference prices correspond to the "efficient" prices that would prevail in the absence of subsidies. They are equal to the opportunity cost of the last unit consumed, which indicates how much revenue could be gained or how much production cost could be saved by *not* consuming a unit of energy. Economic efficiency requires that prices correspond to opportunity costs. In principle, the reference price would prevail in a competitive market, making it in a certain sense the "true price" of energy. In some cases the reference price is easy to see. For exportable goods in competitive world markets, for example, it is the free-on-board (fob) export price adjusted for distribution and VAT. In other cases the reference price is not obvious and must be constructed from dispersed cost data. In still others, it can be a politically negotiated figure. In all these cases, the reference price constitutes a benchmark against which to assess actual prices. It has a strong normative character. To the extent that reference prices correspond to the prices prevailing in an ideal market and capture the full opportunity costs of consumption, including all social costs, economic theory holds that they would also maximise overall welfare.

The reference price thus reflects either the price of a good traded in a competitive international market or the long-run marginal cost of production (LRMC), usually the short-run average cost for a non-traded good. With no export restrictions, the international price corresponds to the LRMC of the marginal supplier. For oil, gas and coal, regional or global reference prices exist. For electricity, the costs of production apply. These amounts require adjustment for transport, including insurance and distribution costs. To sum up, reference price f*or an exporting country* is the export border price (fob) + internal distribution + VAT. *For an importing country*, it is the import border price (cost, insurance, freight) + internal distribution + VAT. *For non-traded goods*, it is cost of production + internal distribution + VAT.[7]

7. See also the Technical Annex B of OECD (1998). VAT should be included only for items, such as goods for household consumption, for which equivalent items are taxed with VAT; see discussion below.

Box 12: **Calculating Reference Prices for Coal**

The calculation of reference prices required great care. Because overestimating them could overstate subsidy rates, the calculations used country-specific data, carefully verified. The steps described below for coal, the fuel that requires the most complex reference price calculations, illustrate the procedure.

(1) Begin with an export (fob) or import (cif) border price, if the country is a net exporter or importer.

(2) Adjust prices for net calorific value to capture differences between traded and domestically consumed coal.

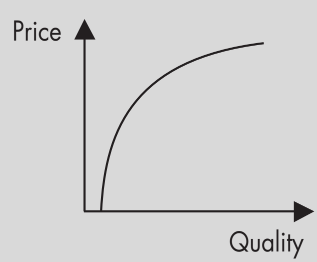
(3) Further adjust prices to account for the higher sulphur and ash content of domestic coal. Prices for coal decline over-proportionally with decreases in calorific value, reflecting higher transportation and handling costs (see Figure below). Domestically consumed coal, even with a higher calorific value than exported coal, is also likely to contain more sulphur and ash.

(4) Add or subtract transport costs from the port, depending on whether the country is a net importer or exporter, to estimate coal prices "back at the mine".

(5) Add internal distribution costs, to reflect variations in transport methods and distances.

(6) Finally, add a country-specific VAT for residential coal. Industry and power generators do not pay VAT in the countries studied.

Quality and the Price of Coal



A sample calculation of steam-coal reference prices for China illustrates the process. China was a net exporter of steam coal in 1998, so an export (fob) price, estimated at 266 yuan per tonne, is the starting point. According to IEA coal information, the net calorific values of steam coal are 0.499 for households, 0.541 in industry and 0.465 in power generation, compared with 0.531 for exports. Adjusting for these differences gives prices of 250, 271, and 233 yuan per tonne. The quality adjustment is then subtracted. To get the reference price "back at the mine", transport costs to export centres must then be subtracted, as domestic producers would not incur them on domestic sales. For a net importer, transportation cost must be added; transport, plus internal distribution costs, figures in the total cost to the consumer. Using an average transport cost of 79 yuan per tonne, yields "net back at mine" prices of 121, 138, and 108 yuan per tonne for the consuming sectors. Domestic distribution costs must now be added. An average transport rate of 99 yuan per tonne was calculated, based on haulage distances of 700 to 1,000 km to coastal China, the site of most industrial and power facilities. This rate exceeds transport cost to the mine because the size of shipments is generally smaller. Internal transport is estimated at 75% of the average for power generation, 125% of the average for industry and 150% of the average for households. Finally, 13% VAT was added to all prices; contrary to most other countries, VAT applies in China to coal sales in all sectors. The resulting reference prices are 306 yuan per tonne for households, 297 for industry and 206 for power generation. For coking coal, the calculations are similar.

Border Prices and Cost of Production

This section discusses the different components of reference prices in more detail. Most internationally traded energy products have *deep* markets, such as the highly liquid world markets for petroleum and petroleum products. Regional markets for coal, stimulated by decreasing transport and communication costs are combining to create an increasingly competitive world market with great numbers of buyers and suppliers.[8] Even for gas, competition is growing in some regional markets, including North America, Europe, the Former Soviet Union and even East Asia, and competition is driving prices down in the direction of the cost of production.

For a small country which is an exporter or potential exporter of petroleum, coal or natural gas, the opportunity cost of consuming an additional unit of product is the revenue that it could have received at its

8. Ellerman (1995) and Humphreys (1995).

border, the fob price. By exporting, the country would also save on distribution costs and VAT, where applicable, so these two items must be added to the opportunity costs of consumption, as the cost of foregoing an opportunity to save. Because actual end-use prices contain taxes and distribution, the price gap would be distorted if these two items were not included.[9] In other cases, subsidised domestic distribution costs, particularly for coal, constitute a major component of subsidies.

For a small importing country, the cost of consuming an additional unit of product is the price that it has to pay at its border, including the cost of insurance and transport (cif), plus the costs of distributing the good and VAT.[10] For a non-traded good, such as electricity, the opportunity costs equal the costs of production plus distribution plus VAT. In this sector, the project relied on the long-run marginal costs of production, including capital costs, over the expected lifetimes of power-generation plants.

A special case occurs in international markets in which the cost of production diverges from the price where supply meets demand. The obvious example is the market for oil, which is highly liquid and competitive on the demand side. The supply price and eventually the world market price, however, is heavily affected by a producer cartel, and is kept significantly above production costs, even allowing for ample transport margins. What does this imply about the choice of reference price? In a country-by-country perspective, the relevant opportunity cost of importing or not exporting an additional tonne of oil is clearly the world market price (adjusted for transport costs), and this should hence be taken as the reference price. This would not have been the case, if a global, general equilibrium perspective had been taken.

An additional twist in the calculation of reference prices would have arisen if the study had considered countries with fuel exports large enough to influence world market prices. In such cases, the relevant opportunity cost would not have been the export price, but marginal revenue, *i.e.* the revenue from the last unit sold minus the decrease in price for all other units.[11] The project has proceeded, however, on the working assumption that none of the countries under consideration is individually capable of

9. Consider as an example a subsidised domestic-resource cost of five, a distribution cost of two and a world market price (fob) of seven. In this case, a price gap of two still exists, but it shows up only if the distribution margin is added to the reference price.

10. Because the analysis relies on end-use prices, prices for refined petroleum products rather than crude oil were used wherever possible. Where no prices for refined products exist, the costs of refining have to be added to the reference prices based on crude cif prices.

11. Marginal revenue (MR) is obtained by differentiating total revenue ($TR = p \times q$) with respect to quantity: $MR = \partial TR/\partial q = p \times \partial q/\partial q + \partial p/\partial q \times q = p + \partial p/\partial q \times q$, where $\partial p/\partial q < 0$.

manipulating prices on a world scale. Throughout, border prices and not marginal revenues served as the basis for the calculation of reference prices.

Using international market prices to calculate reference prices makes sense only if the goods in question are actually tradable. For coal, crude oil and petroleum products this undoubtedly holds. It is less obvious for grid-bound forms of energy, mainly natural gas and electricity, where international trade is much more limited. In the gas market, the possibility of trade in liquefied natural gas (LNG) and the existence of a relatively well-established international pipeline network allow approximations to a reference price, at least on a regional basis. This is not the case for electricity. None of the countries under consideration has significant electricity trade, so production-cost estimates form the basis for the reference prices, with both reference prices and domestic end-use prices expressed in the domestic currency. (See also box on "Calculating End-Use Prices").

Value-Added Tax

Doing business carries costs. Roads, the customs office, the police and the legal system all have to be paid for out of general taxes. Any reference price which reflects the full opportunity cost of consumption should therefore include this participation in the general economic system as a cost, at a "normal" level of taxation. Tax exemptions would then show up in the price gap. Such tax expenditures constitute one of the most prevalent and important forms of subsidisation, particularly in OECD Countries. The difficulty in handling them lies, of course, in the definition of a "normal" level of taxation. The OECD Fiscal Affairs Directorate has formulated the problem in the following way:

> Yet even equipped with… formal definitions, classifying statutory fiscal provisions as either part of the norm or an exception is difficult. Even among countries which employ a formal definition of a tax expenditure as a deviation from a benchmark, it is rare to find the use of a formal concept of the norm.[12]

As a proxy for such a normal rate of taxation the VAT rate was added to the costs of production where household and transport consumption were concerned. In industry or power generation the situation is less clear-cut. Power generation bears no general tax, and transaction taxes on industry are usually low. Calculating reference prices without taxes would presume that being tax-exempt is the norm for energy products used in

12. OECD (1996b), p. 10.

industry and power generation. Because this presumption holds across the countries studied here, reference prices for power generation were calculated without including VAT.

Externalities

Consistent with the discussion in Chapter Three, environmental externalities constitute a cost element only when societies have decided to measure and internalise them *via* environmental taxes. In this case, the reference prices should be augmented by the amount of the tax. For the time being, this issue has general conceptual interest, but little practical importance.

What Price Elasticities Does Energy Demand Have?

The price elasticity of demand (the percentage change in the quantity demanded in response to a percentage change in price) is the parameter used to proceed from the estimation of the price gap to the difference in consumption with and without subsidies. As higher prices usually reduce the quantities demanded, the price elasticity of demand is normally negative.[13] Unfortunately, the empirical estimation of price elasticities of demand for different energy products is not a straightforward affair. An econometric estimation would need a time series for energy price-quantity relationships relatively undisturbed by structural changes over a certain time. This hardly ever occurs in rapidly changing energy markets, especially in developing countries. The energy sector, with its infrastructure needs and high level of government involvement is particularly prone to structural change that is only imperfectly captured by economic variables.

In addition, consumers in some situations have faced quantity constraints in the energy market, precisely because of artificially low prices. When there is no adequate compensation for them (*e.g.* when a government works with a price ceiling rather than a financial transfer), producers will stop supplying. If the government releases the downward pressure on prices, this can lead to increased quantities of goods for sale. Measured econometrically, this produces the occasionally observed phenomenon of positive price elasticities of demand.

13. The quantity change in response to an elimination of the price gap, i.e., the equalisation of end-use and reference prices, is calculated by $\Delta q = \varepsilon \times \Delta p/P_o \times Q_o$, where Δp is the price gap, ε is the price elasticity of demand and P_o and Q_o are the original price and quantity. See also the last section of this Annex, on Steps in the Quantitative Analysis.

The classic situation, in which an increase in price would lead to a decrease in quantities sold, nevertheless remains the most relevant. In most cases of subsidisation in the countries under consideration governments are willing to shoulder the cost, and higher prices would indeed mean lower quantities. The increasing efficiency of energy markets in these countries also permits application of a comparative static approach, the comparative analysis of two market equilibria, in connection with the price-gap approach.

Two special issues in connection with price elasticities need discussion here. The first concerns short-run versus long-run price elasticities of demand. In the short run, consumers show low responsiveness, as entrenched habits and ways of doing things (like using the private car instead of public transport) make for low flexibility and generate only small changes in consumption in response to even a significant price rise. In the intermediate term, say, a year, flexibility mounts, as monthly metro coupons get bought and commuting time budgets adjust. In the long run, over several years, when politicians have reacted to voter pressure and installed better and faster public transport systems, and car manufacturers have developed smaller, more energy-efficient vehicles, the full impact of a price change on consumption occurs.[14]

Because the support policies of governments in the energy sector define a society's structural parameters in long-term policy decisions, this study focuses on long-run elasticities, and the reader should bear this in mind. If subsidy policies change, households, industry and power generators will adapt only over time. The adjustment period likely will witness other structural changes, unrelated to the price increases, that can obscure the measured results, especially in fast-growing developing countries. In fact, higher prices will accelerate the speed of technological change, in particular the development of new, more energy-efficient technologies. Such induced technological change would lead in the long run to even greater reductions of energy consumption than suggested by the price-gap approach.[15] The results of the analysis have therefore to be considered as a carefully constructed counter-factual to a distorted present and not as a prediction of the future, even if all energy subsidies were removed.

The second issue involves the extent to which the demand for an energy product is independent from the demand for (and the prices of)

14. See, for instance, a discussion of the long-run response to the first oil shock in BIROL (1999), p. 11.
15. See Birol and Keppler (1999 forthcoming) for a more detailed discussion of this issue.

other energy products. Due to data constraints, this project, like all others, restricts itself to the calculation of the own price elasticities of different fuels, and assumes away the cross-elasticities between different fuels by ignoring them. This assumption has more or less plausibility depending on the size of category chosen for analysis. It is quite imaginable that the overall demand for transport fuels is more or less independent of the price of electricity, but quite implausible that the demand for leaded gasoline is unrelated to the price of unleaded gasoline. Narrowly defined product categories have closer relationships with other products than broadly defined ones. The own price elasticity of demand for energy is lower than the price elasticity for transport services, which is smaller than the price elasticity for gasoline. The more narrowly a good is defined, the easier it can be substituted and the higher its elasticity of demand. In general, the higher the elasticity of substitution with other goods, the higher the own price elasticity of demand.

Ultimately, the choice of appropriate categories as well as the relevant demand elasticities involves as much discretion as scientific knowledge. The overview table on the following page draws on several publications that produced estimates for the own price elasticities of demand for several fuels in different sectors and countries.[16] It would exceed the boundaries of this publication to discuss them in detail. Note that the results vary enormously; in several instances the differences exceed any limits set by plausibility. Several of the studies rely on incomplete data or have been made irrelevant by new developments.

Mindful of the limitations of the concept of elasticity and of the variation in most available empirical results, this study has taken a different route. On the basis of a broad discussion amongst in-house energy experts (Delphi method) the following three own price elasticities of demand were chosen for all countries:

- -0.25 for all mobility-related fuel demand,
- -0.5 for the demand for fuels employed in stationary uses in households and industry,
- -0.5 for the demand for electricity,

Inputs to power generation were adjusted by the percentage of reduction in electricity. In addition, a relatively low elasticity of -0.3 was applied to the remainder in order to reflect the impacts of the changes in the own price of the power generation input.

16. The publications chosen as a basis for the overview table are: IEA (1998b), Dahl (1994), Reid and Goldemberg (1998) and Birol, Aleagha and Ferroukhi (1995).

Table 7: **Price Elasticities of Demand According to Fuel and Sector**

Category	Brazil	China	India	Indonesia	Iran	Kazakhstan	Russia	South Africa	Venezuela	All Countries
All Energy	-0.25		-0.4	-0.3					-0.3	-0.6
Tot. Industry	-0.4		-0.7							
Tot. Households										-0.9
Oil Products	-0.5	-0.25	-0.6		-0.5		-0.3			
Households	-0.9	-0.25	-1.0	-0.1	-0.5	-0.25	-0.25	-0.2	-0.9	
Transport	-0.3	-0.4	-0.1	-0.2	-0.5	-0.25	-0.25	-0.4	-0.3	-0.5
Industry	-0.3	-0.25	-0.1	-0.4	-0.5	-0.25	-0.25	-0.1	-0.3	
Power Gen.	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	
Electricity										
Households	-0.1	-0.25			-0.5	-0.25	-0.25	-0.2	-0.1	
Industry	-0.6	-0.25	-0.1	-0.0	-0.5	-0.25	-0.25	-0.3	-0.6	
Natural Gas										
Households				-0.1	-0.5	-0.25	-0.25			
Industry	-0.1	-0.1	-0.1	-0.75	-0.5	-0.25	-0.25		-0.1	
Power Gen.	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	
Coal			-0.6					-0.6		
Households					-0.5	-0.25	-0.25			
Industry		-0.1		-0.1	-0.5	-0.25	-0.25			
Power Gen.	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	-0.75	

Sources: See footnote 16.

Clearly, this represents an imperfect way of proceeding, but rather than making ultimately untenable claims of scientific accuracy by quoting published figures from the literature, the authors preferred to choose a transparent procedure. This allows an open discussion and an easy recalculation of the results where readers feel that the demand elasticities chosen should have been higher or lower.

One should not overestimate the imperfection of this procedure. Any of the numbers chosen fall well within the range usually accepted as plausible by most experts. Inside that range good arguments exist for almost any number. The authors do not claim that the elasticities chosen have any superior standing inside that range of plausibility, but do consider their choices informed and defendable, and stand ready to discuss carefully any different elasticity estimates that might have higher plausibility. Elasticity estimation is a tricky field, unsuitable for grandstanding.

Steps in the Quantitative Analysis

Once end-use prices and reference prices were determined, the following steps took place for each country:

1. Determination of the price gap (PG)

PG = Reference price - consumer price.

2. Determination of the impact of the price gap on energy consumption

The impact of a removal of the price depends on the functional form of the inverse demand function that rules the relationship between prices and quantities demanded for consumption. A constant-elasticity inverse demand function of the form $q = p^{\varepsilon}$ ($a < 0$) was chosen. For this function the impact on consumption is established by the formula: $\Delta q = Q_o - Q_1$, where $\ln Q_1 = \varepsilon \times (\ln P_1 - \ln P_o) + \ln Q_o$. Here, Δq is the decrease in consumption if the price gap is removed; ε is the long-term demand elasticity; P_o and Q_o are the price and quantity before the removal of the price gap and P_1 and Q_1 are the price and quantity after the removal of the price gap. Constant-elasticity inverse demand functions have the advantage, as the name implies, that the demand elasticity stays constant along the whole range of possible values. In accordance with intuition, price changes at low prices generate relatively large quantity changes and *vice versa* when prices are high. An added advantage is computational ease.

3. Determination of impacts on CO_2 emissions and oil imports/exports

The greenhouse-gas emissions saved due to the abolition of subsidies (ΔCO_2) are determined according to the formula: $\Delta CO_2 = \Delta q \times CO_2EF$. Here, ΔCO_2 is the decrease in carbon dioxide emissions and CO_2EF is the relevant carbon dioxide emission factor. This calculation has to be performed for each fuel and the results added.

The impact on oil availability is indicated by Δq_{oil} as established in the previous step. It indicates additional imports due to subsidies for an importing country and reduced exports for an exporting country.

4. Determination of allocative inefficiencies due to underpricing

Efficiency losses due to lower than optimal fuel prices are indicated by the difference between total transfers ($TT = Q_o \times \Delta p$) and the increases in consumer and producer surplus. Assuming linear demand and supply functions, the welfare loss (WL) corresponding to the area under the supply curve can be calculated by $WL = (Q_s\text{-}Q^*)(P_{sp}\text{-}P_{sc})/2$, where P_{sp} and P_{sc} are the prices received by producers or paid by consumers in the presence of subsidies. In the notation employed above, the equation would read $WL = \Delta q \times \Delta p / 2$.[17]

5. Calculation of potential revenue in a global emission-trading scheme

The annex to Part B also calculates the revenues to be generated from valuing the CO_2 emission reduction due to subsidy removal in a yet to be implemented global emission trading scheme. These values, which can be substantial, are generated for indicative purposes only.

17. As has been mentioned before, this measure of welfare loss would capture only a part of all welfare losses. The efficiency impacts of two distortions with opposite price impacts (*e.g.* a production subsidy combined with a guaranteed minimum price) would enter the equation with different signs and only the efficiency impact of the cumulative price effects would be captured. The welfare losses arrived at with the help of the price gap approach can thus be considered a lower bound of the true welfare losses.

PART B

THE COUNTRY STUDIES

CHAPTER 5
CHINA

China relies heavily on coal. In a period of general economic slowdown, three major issues dominate Chinese energy policy. First, China became a net importer of petroleum in 1996, with important long-term consequences for energy security as well as for world oil demand. Second, a temporary oversupply of coal and the resulting pressure on price is causing a complete restructuring of the Chinese coal industry. Third, policy for power generation has a new focus on cleaner fuels, energy conservation and efficiency improvement. Capacity expansion, the primary issue for many years, has receded in importance. Despite some steps towards market reform in the energy sector, many distortions still remain. Their removal, particularly in the coal sector, could lead to increased economic and energy efficiency as well as reduced CO_2 emissions.

General Overview

The world's most populous country with over 1.25 billion inhabitants, China has enjoyed two decades of high economic growth. It is now trying to balance the transition from a planned economy to a market economy with the maintenance of a one-party political system. Under President Jiang Zemin, who is also head of the Chinese communist party, the Prime Minister, Zhu Rongji is responsible for day-to-day operations of the government. Economic policy is formulated primarily in the State Economic and Trade Commission (SETC). The State Planning and Development Commission (SPDC) is in charge of long-term planning and macro-economic oversight.

China's major political and economic developments are likely to have international or global repercussions, most immediately the country's negotiations for entry into the WTO. The major topic in domestic policy is the development of the relationship between the centre and the provinces, as the country passes through a time of rapidly increasing urbanisation and growing unemployment due to massive structural changes.

Main Economic Facts

In 1998 China's GDP reached about 8,200 billion Yuan or $990 billion,[1] (Table 8) which corresponds to 6,500 Yuan or $792 per capita. In comparison, the combined GDP of the OECD countries amounts to $23,149 billion in current US dollars and over $20,000 per capita. Purchasing Power Parity adjustments increase the relevant Chinese numbers several times over. Despite its recent growth and some internationally competitive sectors, however, China remains a developing country.

Table 8: **Key Economic Indicators for China, 1998**

Population (millions)	1,255,409,000
GDP (current Yuan)	8,216,316,000,000
GDP (current USD)	992,308,700,000
Real GDP growth rate	8.8%
GDP per capita (current USD)	790
Inflation (CPI)	-0.8%

Source: IMF (1999).

Economic growth averaged 10.5% annually from 1992 through 1997, but has slowed due to a mixture of internal and external factors, to 8.8% in 1998 and an estimated 7% in the first half of 1999.[2] In the first eight months of 1998, total energy output declined by 5.5%, while industrial output rose by 7.8%.[3] These last figures point towards a mix of questionable statistics, structural change toward less energy-intensive industries and energy-efficiency improvements

The current economic programme appears committed to further gradual liberalisation and market orientation of the economy, though does not exclude massive intervention by the State in areas that it considers to be in the national interest. In this fast-changing economy, agriculture is losing its once high share, industry is declining slowly, and services are growing fast. Self-sufficiency in almost all regards remains a coveted, albeit elusive, policy goal. It gives added importance to the issue of energy import dependency.

1. One Yuan currently equals US 12¢.
2. Chinese GDP data are notoriously unreliable. See, for instance the discussion in IEA (1998e), p. 276ff.
3. EIU (1999a), p. 21.

The reform of inefficient state enterprises, half of which make losses, presents one of the greatest challenges that the Chinese economy faces. The new key word in policy is "corporatisation". This means that state companies must now earn a profit or else face closure. This policy objective may be frustrated by the reality of rising unemployment, which has reached double digits in many cities. Energy industries are now in the forefront of the restructuring effort, after having lagged behind in previous reform initiatives.

After a brief flirtation with deflation (the consumer price index fell by 0.8% in 1998), China has published new price data that point again to modest inflation. Yet the underlying problems of overcapacity and lack of internal and external demand have not been solved, and the occasional imposition of price floors only delays necessary adjustments. A modest devaluation of the not-yet fully convertible Yuan was widely discussed as possible in late 1999 or early 2000. Devaluation could further reflate the economy, raising prices, lowering imports and making exports more competitive. Exports remain vital to the economy, and are especially strong in machinery, textiles and shoes. Exports grew by only 0.5% in 1998, but the current-account surplus stayed strong, as imports actually fell.

Other than smuggling, capital flight is apparently becoming a problem, in principle putting pressure on the Yuan. Nevertheless, any devaluation would be undertaken for internal economic reasons and not in response to external speculative pressures. China maintains a strong trade surplus, high inflows of foreign direct investment (the second highest in the world after those into the United States) and strong reserves ($140 billion in September 1998).

In sum, the years in which the world accustomed itself to see two-digit annual economic growth rates in China have probably passed. Overcapacity and production overhangs (excessive inventories) put pressure on prices and profits, plaguing some sectors, including the energy sector. While this complicates the current picture regarding subsides, it highlights the costs of past policies that provided indiscriminate support for capacity expansion.

The Energy Situation

China is the world's second largest consumer of primary energy behind the United States: almost 1,100 Mtoe in 1997. It is the third largest producer after the United States and Russia. Total primary energy supply actually *decreased* by 0.2% in 1997, and the China National Bureau of Statistics reported that energy production in China dropped 3.8% in 1998.

China has abundant coal reserves and potentially rich hydropower resources. Coal contributes 60% of its total primary energy supply (TPES). There is a geographic mismatch between resource-rich areas in the North and interior on the one hand and the centres of population and economic activity in the Southern and Eastern coastal areas on the other. Poor transport infrastructure and already high transport intensity compound this problem.

The Chinese economy consumes 46.4 MJ (megajoules) of energy per US dollar of GDP, 1.11 toe per $1,000, all at current exchange rates. This corresponds to an annual per capita energy consumption of 36.7 GJ (gigajoules) or 0.88 toe (see tables 9 and 10). The corresponding average values for OECD countries are 9.2 MJ per dollar of output, or 0.22 toe per $1,000 and 195 GJ (4.6 toe) per capita per year.

Table 9: **Key Energy Indicators for China, 1997**

Total Primary Energy Supply (Mtoe)	1,101,980
Total Primary Energy Supply per capita (toe)	0.88
Total Primary Energy Supply /GDP (kg/current US$)	1.11
Net oil exports (Mtoe)	-15.6
Net coal exports (Mtoe)	22.3
CO_2 emissions (million tonnes)	3,132.4
CO_2 emissions per capita (tonnes)	2.50
CO_2 emissions/GDP (kg/current US$)	3.16

Source: IEA Database.

Table 10: **Energy Balance of China, 1997 (Mtoe)**

	Coal	Oil	Gas	Electricity	Other	Total
Indigenous Production	686.4	160.7	21.1	0.0	228.6	1,097.2
TPES	661.1	193.8	18.8	-0.6	228.6	1,102.9
TFC	282.0	158.6	13.1	72.5	230.6	756.8
Industry	226.5	41.5	10.4	48.1	17.3	373.9
Transport	3.1	63.4	0.0	1.3	0.0	67.9
Residential/comm.	44.3	34.4	2.7	23.1	4.9	317.8
Non-energy	8.1	19.2	0.0	0.0	0.0	27.3

Source: IEA (1999).

The current re-structuring process is likely to continue, as China's energy policy is re-oriented in order to reflect the long-term goals of sustainable development and energy security.

Coal

Demand, Supply and Exports

The world's largest coal producer, China dug 1.37 billion tonnes of coal or 0.69 billion toe, in 1997, double the output of 1980 and about 60% of the country's total primary energy supply. With reserves estimated at 114.5 billion tonnes, or 11% of the global total, located mainly in the North and the Northwest, China could sustain current production rates for another 82 years.[4] Chinese coal is relatively high in ash with the national average around 30% and has a medium-to-high sulphur content. It is currently mined at an average depth of 330 metres, but depth will certainly increase in the years to come.

In 1997 coal fed 74% of all power generation, using about one-third of the coal output, with the other two-thirds going to domestic uses and industry. China exports around 30 million tonnes of coal per year mainly to Japan and Korea. This is 3% of total production but 6% of world coal trade. China has 94 large state-owned mines, 2,500 mines owned by local and provincial government and between 50,000 and 75,000 mines run by township and village enterprises. Many of the last are unlicensed and produce coal with no meaningful environmental or human safety measures. They produce about a third of output and employ about one million people. Of the state-owned mines, 85% are believed to lose money, due partly to inefficiencies (productivity at Chinese mines is low by international standards), partly to non-payment by other state-owned industries and partly to underpricing by village mines.

Coal production peaked in 1996 at around 1.4 billion tonnes and led to serious oversupply in 1997, with record stock levels of up to 200 million tonnes and a government-absorbed loss of 3.71 billion Yuan in 1998.[5] The government responded by shutting down coal production in February 1998, by transferring the 94 state-owned mines to provincial governments in August 1998 and by closing village mines. By May 1999, 23,000 village mines with a total capacity of 100 million tonnes had been closed with

4. IEA/CIAB (1999), p. 19.
5. IEA/CIAB (1999), p. 81.

officially counted layoffs amounting to 400,000.[6] With expected production for 1999 of less than 1.1 billion tonnes, and possibly closer to 1 billion tonnes, the industry hopes to return to profitability by 2000.[7]

Transport and Efficiency

Inefficiencies in production and transport hamper the Chinese coal sector. Inefficient transport pricing leads to demand that exceeds supply and to bottlenecks. The geographical mismatch between producing and consuming regions and underpricing have led to a freight intensity per unit of GDP, which is ten times that of India or Brazil.[8] Almost half of all Chinese coal is transported by rail, frequently by steam engine. In 1995, coal used 45% of China's rail-freight capacity.

Due to transport-capacity limitations for domestic coal, some coastal areas have begun to import it. In an attempt to address past under-investment, the government now dedicates 2.6% per cent of GDP to transport infrastructure, and has recently opened the railways system to foreign investment. Options that could relieve the transport problem include slurry pipelines and plans for "coal by wire", i.e. the construction of large power plants close to mine-mouths, with electricity transmitted subsequently to consumers by long-distance, high-voltage lines.

China has many small and inefficient power plants of up to 300 MW, designed to use low-quality coal. Their average thermal efficiency is around 28 per cent, compared to 38 per cent in OECD countries.[9] Moreover, only about a quarter of China's coal is currently washed. Huge potential savings in coal consumption could emerge from larger, more efficient plants and by burning washed coal. Proper price signals could further accelerate energy-efficiency improvements (see below).

Oil

Demand and Supply

China is Asia's largest oil producer, and the world's sixth largest. It is the second largest consumer after Japan. China's estimated on-shore reserves, mainly in the Northeast and the West, amount to 3.3 billion

6. Local unemployment in former coal mining towns runs up to 30%, considerably higher than the official national rate of 3.5% (*Financial Times*, 16 March 1999).
7. *Bridge News*, 8 January 1999.
8. IEA/CIAB (1999), p. 37.
9. IEA/CIAB (1999), p. 24.

tonnes, with offshore reserves estimated more speculatively at 22.5 billion tonnes. Given production at about 3.2m b/d, 90% of it on-shore, current on-shore production could continue up to 20 years. Historically China was an oil exporter, with half of its shipments going to Japan. That changed when China became a net oil importer in 1993.

Chances to reverse this situation are scant. The slogan "stabilising the east, developing the west" embodied the hope, so far disappointed, of offsetting declining production in the traditional wells in the Northeast with new findings in Western China, especially the Tarim basin. Foreign investment, however, continues unabated. In 1997 and 1998 alone, Chinese companies and foreign investors signed 30 on-shore and offshore contracts.[10]

Increasing demand for mobility means high oil demand growth. Estimated car ownership has risen in recent years by 13% a year and is likely to continue to do so. It is estimated that China will import 50 million tonnes of oil by 2000, up from 33.9 million in 1997.[11] Chapter 15 of the *IEA World Energy Outlook 1998* estimates that by 2010 China will import 50% of its oil, which corresponds to imports of around 200 million tonnes.

Policy Responses to Growing Import Dependency

Policy responses to the new oil situation fall into three main categories: new international policy initiatives, the extension of the pipeline system and market reform. On the diplomatic front, the Chinese government has sought to improve its relations with Russia and Central Asian republics. It has built new ties in the Middle East, improving its relationship with Israel and holding discussions with Egypt, Sudan, Oman, Yemen, Iraq and Iran. The facilitation of foreign investment in offshore exploration also falls into this category.

To develop pipeline networks for crude oil, refined oil and gas, the China National Petroleum Corporation (CNPC), has merged its pipeline construction and operation activities.[12] It is also constructing, at a cost of $2.3 billion, a 4,300km oil pipeline from Kazakhstan, which will be able to carry 25 million tonnes a year. The project is slated to be finished in 2007. CNPC is moving toward partial privatisation between now and mid-2000. It has offered 30% of its stock for $10 billion in a Hongkong share listing.

10. FACTS (1998a), pp. 13-15.
11. *Reuters*, 2 February 1999.
12. EIU (1999a), p. 29.

This move has some connection with raising funds for development of this "energy silk road".[13]

The State Economic and Trade Commission (SETC) has begun to reorganise the domestic oil sector, with CNPC and Sinopec (the China Petrochemical Corporation) being both transformed into independent, integrated oil companies. While CNPC and Sinopec will compete in most segments of the market, retailing will be divided into monopoly supply zones for each company; the exception is Beijing, where both will be active. The two companies still display strong differences. CNPC has an upstream tradition in exploration. The slightly smaller Sinopec has concentrated on refining and retailing.[14] Sinopec is exploring the Hongkong stock market through the listing of a petrochemical subsidiary.[15] These differences can lead to opposing views on policy in the oil sector.[16] The third, considerably smaller Chinese oil company, the China National Offshore Oil Corporation (CNOOC), will remain confined to exploration and LNG imports.

A price reform accompanied the corporate restructuring, to replace the previous administered-price system. The State Planning and Development Commission now adjusts the price of crude monthly on the basis of the Singapore spot market and sets baseline retail prices for refined products. The companies themselves set refinery-gate and wholesale prices, and can adjust retail prices for refined products within a 10% band. Early experience with the new system has been inconclusive. Real retail prices frequently fell lower than the baseline retail band due to "grey" imports and smuggling during the period of low international prices, which bottomed out in March 1999. This affected profitability, and both companies ran up losses for the first time in their history in early 1998. Profitability has apparently improved in the second half of the year.

Free oil trading and retail competition remain medium-term policy goals. Preparing China's oil sector for full competition has a bearing on China's application for WTO membership. If the bid succeeds, implicit or explicit protection, as well as remaining inefficiencies, will be more readily apparent.

13. *The Times*, 30 June 1999.
14. FACTS (1998b), p. 5.
15. *International Herald Tribune*, 7 June 1999.
16. *Bridge News*, 27 July 1999.

Gas

Demand and Supply

With a production of 22.7 billion cubic metres (bcm), most of which goes to fertiliser production or other chemical uses, natural gas currently contributes only 2%, or 18 million toe, to China's total primary energy supply. Proven reserves of 1.16 trillion cubic metres (tcm) would support a production at current rates for 52 years.[17] Estimates for unproven reserves, mainly in Sichuan province in central China vary between 38tcm and 58tcm. Gas production is projected to rise. The large offshore field known as Yacheng 13-1 will contribute to the increase; it began production in 1996, providing gas to Hainan Island and Hongkong for power generation.

New Pipeline and LNG Projects

A number of projects exist to import gas. Of three planned LNG terminals, one near Shenzen, in Guangdong province, has been approved and could be ready by 2004-2005 at a cost of $1.5 billion. Several other pipeline projects are under study. China showed its ability to mobilise resources in 1998 when it built a 350km pipeline from the Qaidam Basin in the Northwest to Dunhuang, central China, in only 150 days. CNPC and Enron are collaborating on a pipeline in Southern China. An important project for the near future is the construction of a pipeline from Siberia to China.

The most ambitious project, however, involves constructing a pipeline of several thousand kilometres all the way from Kazakhstan through Turkmenistan, Uzbekistan and China to Japan. Like Shell and Enron before them, Exxon, Mitsubishi and CNPC have recently completed a feasibility study. If construction began in 2000, this pipeline could be ready by 2005. The commercial viability of these pipeline projects depends largely on the comparative prices of LNG and on domestic production.

Box 13: **Coal-Bed Methane**

An alternative to new gas exploration is the use of coal-bed methane (coal gas), which is chemically equivalent to natural gas. The estimated 20 bcm of coal-bed methane that escape each year into the

17. IEA/CIAB (1999), p. 19.

atmosphere roughly correspond to Chinese natural gas production.[18] Mine ventilation alone releases about six bcm of methane every year. Of the estimated 260 bcm of methane emissions, only five have so far been recovered and converted into energy. In order to prevent further waste of this energy source, the use of coal-bed methane has been declared one of the "strategic projects" of the coal industry, demonstration projects have been started and preferential development loans have been earmarked. In 1998, the first commercial development contract was concluded with Texaco for a project with reserves of 60 bcm and a planned annual output of 0.5 bcm.

Electricity

Demand and Supply

China has an installed power generation capacity of about 250 GW (gigawatts), the second largest in the world. It produced about 1,150 tWh (terawatthours) in 1997. China's annual per capita consumption is 904 kWh, compared to 8,600 kWh in the OECD. Coal produces 74% of all power, hydro 17%, oil 7% and nuclear plants only 1%. Power shortages, once a serious brake on economic development, is no longer the main problem. Instead, the system suffers from *overcapacity*, the result of a lack of demand and a rapid capacity build-up in 1997 and 1998 stimulated by subsidies. Demand grew by 8% a year between 1980 and 1996 then stabilised in 1997 due to a mix of price reform, economic slowdown, structural adjustment in industry and improving efficiency.

Renewables

Renewable forms of energy, other than biomass, play only a marginal role in the Chinese energy supply. Biomass fuels rural households, its demand share remaining roughly stable at one-fifth of TPES. Because biomass contributes to deforestation and local emissions, its impact on the environment is ambivalent at best. Other forms of renewable energy have the most use in remote areas, where grid connection would be costly. Geothermal energy is used in Tibet and wind energy in Mongolia. There is some experimentation with tidal energy.

18. IEA/CIAB (1999), p. 56f.

Box 14: **Adjustments in Hydropower and Nuclear Energy**

In light of current overcapacity, the government is reviewing a number of power projects — including the pharaonic Three Gorges dam on the Yangtse River in Hunan province, which has recently met international as well as domestic criticism. One of the issues is the project's cost of up to $29 billion, with a funding shortfall of $3 billion that has to be plugged. There will be no assistance from the World Bank or US commercial banks, which have declined to participate. Other issues are the forced relocation of 1.13 million people, silting and the loss of a landscape of some cultural value. Widespread construction defects have been discovered; apparently 17 of 20 bridges are faulty and one has collapsed. These defects are due largely to corruption, which has passed orders to unqualified contractors.[19] But the project may well be too far advanced for cancellation. It is slated to become operational in 2003 with full completion planned for 2009.

Two additional hydropower projects along the upper Yangtse River 700km and 300km upstream from Three Gorges have recently been announced with combined production of BGW. The larger dam (12 GW) would cost $13.3 billion and take twelve years to build.[20]

The government has imposed a three-year moratorium on the construction of new nuclear power plants.[21] It had originally planned to expand nuclear capacity to 20 GW by 2010, as against just over two GW today.

Environment and Technology Transfer

Environmental problems, particularly local and regional effects of energy-related emissions (SO_x, NO_x, volatile organic compounds (VOCs) and particulates) receive increasing attention in China. The State Environmental Protection Agency gained ministerial status in 1998 with a mandate to focus on pollution control. Climate-change issues have a much lower priority, despite their interest to the international community. This is no doubt due both to China's size and its heavy reliance on coal.

China emitted over three billion tonnes of energy-related CO_2 in 1997, 13% of the global total. Per capita emissions amounted to about 2.5

19. *Financial Times*, 8 June 1999.
20. *Bridge News*, 6 July 1999.
21. *Financial Times*, 30 April 1999.

tonnes, while emissions per US dollar of GDP amounted to 2.5 kg. The corresponding figures for the OECD are 11.2 tonnes and 0.53 kg. Although China's per capita emissions remain relatively low, their GDP intensity, large share of global emissions and rapid growth make them worthy of close attention. Other than from fuels, greenhouse-gas emissions emanate from coal gas and spontaneous combustion, which consumes an estimated 100 million tonnes of coal each year.[22]

Besides reducing energy consumption through subsidy removal and price reform, the most cost-effective solutions currently available would increase energy conservation and speed up industrial restructuring. Opportunities exist in the steel, chemical, cement, pulp and paper and textiles industries, with payback periods of less than five years, sometimes less than one.[23] Prices that reflect the full costs of producing energy will also make energy-saving technologies financially more attractive.

The most important local and regional pollutants are sulphur dioxide and particulates. They contribute to heavy damage to human health, agriculture and structures. One study estimates the total costs at $13 billion per year.[24] Emissions from Chinese industries and power plants have begun to affect Korea and Japan. Acid rain from sulphur dioxide emissions now affects 30% of China. While the national average is about two tonnes of SO_2 per square kilometre (comparable to the United States), the Chongquing urban area is reported to have a staggering 600 tonnes per square kilometre.

The main sources of local and regional pollutants are industry (steel, cement, oil and chemicals), power plants, cars, dust and coal-based residential heating and cooking. Coal burning produces 85% of total SO_2 emissions while 30% comes from power plants, which also contribute 28% of particulate emissions. Emissions from power plants may be the easiest to deal with. With the progressive installation of electrostatic precipitators and scrubbers for particulates, concentrations have fallen from 16.5 grams per kWh in 1980 to 4.2 grams per kWh in 1996. Flue-gas desulphurisers (FGDs) are used in some cases for SO_2 control.[25]

The transfer of environmentally more benign and more energy-efficient technologies could constitute a major part of the solution. Two recent agreements on energy-technology co-operation between the United

22. IEA/CIAB (1999), p. 49.
23. Zhongxiao (1996).
24. Battelle Memorial Institute (1998).
25. IEA/CIAB (1999), p. 74-77.

States and China could act as important catalysts. During the Sino-American summit meeting in October 1997, an agreement was signed that included joint research, the sharing of data, the increased use of clean fuels such as gas and the facilitation of trade and investment in energy technologies.[26] Another new agreement to finance the export of US clean technologies was concluded in April 1999.[27] Technology agreements of varying scope have been concluded with Japan, the Netherlands, Norway, and Germany.

Energy Pricing, Market Reform and Subsidy Removal

Subsidies to support policy objectives or loss-making enterprises have a long tradition in China. Subsidies to grain, cotton and oil alone amounted to around 3% of GDP during the early 1980s, then fell to about 1% in the mid-1990s.[28] Such direct subsidies, however, do not fully capture past and existing market distortions in the Chinese energy sector. With its planned-economy legacy of decisions made on political rather than economic grounds, the energy sector is only slowly developing towards a system of markets based on economic criteria.

Even if progress has been made, there is still some way to go. This study reveals average distortions in energy prices of some 11%. Their removal would lead to energy savings of almost 10% and reduction of CO_2 emissions by about 13% (Table 11). China would gain 0.4% per cent of economic growth per year, not counting future "dynamic benefits". Some impetus for reform comes from trade and investment. As the Chinese economy begins to integrate with the world economy, costs and prices begin to move towards international levels.

A particularly thorny issue is the reform of the state enterprises. While most of them are unprofitable and constitute a drain on the government budget, they still fulfil a number of social obligations, which would otherwise have to be shouldered by the government. Change, albeit slow, does move in the direction of more transparency, greater accountability and stronger market forces. The same study undertaken ten years ago would have found considerably greater distortions.

26. US EIA (1999a), p. 5.
27. *Agence France Presse*, 12 April 1999.
28. OECD (1999), p. 114.

Table 11: **Energy Subsidies in China: Summary of Results**

	Estimated Subsidy Rate (% of reference Price)[1]	Energy-Saving Potential Due to Subsidy Removal (%)[2]	Efficiency Cost of Subsidies (million Yuan)	Indicative Budget costs (million Yuan)
Gasoline	0.0	0.0	0.0	0.0
Auto Diesel	0.0	0.0	0.0	0.0
LPG	0.0	0.0	0.0	0.0
Kerosene	0.0	0.0	0.0	0.0
Light fuel oil	0.0	0.0	0.0	0.0
Heavy fuel oil	0.0	0.0	0.0	0.0
Electricity	38.2	21.4	19,433.6	179,869.0
Natural gas	18.7	12.8	333.4	4,003.5
Steam coal	8.3	14.8	2,848.8	26,784.8
Coking coal	73.1	40.1	7,409.1	30,813.5
Total	**10.9**	**14.1** (**9.4**)[3]	**30,024.8**	**241,470.8**

Notes: Calculations are based on 1998 prices and quantities. 1. Weighted average. 2. TPES saved/TPES for the sectors covered in the study. 3. Figure in parentheses is calculated using TPES for all sectors and fuels, including those not covered in the study.

Market Distortions in the Coal Sector

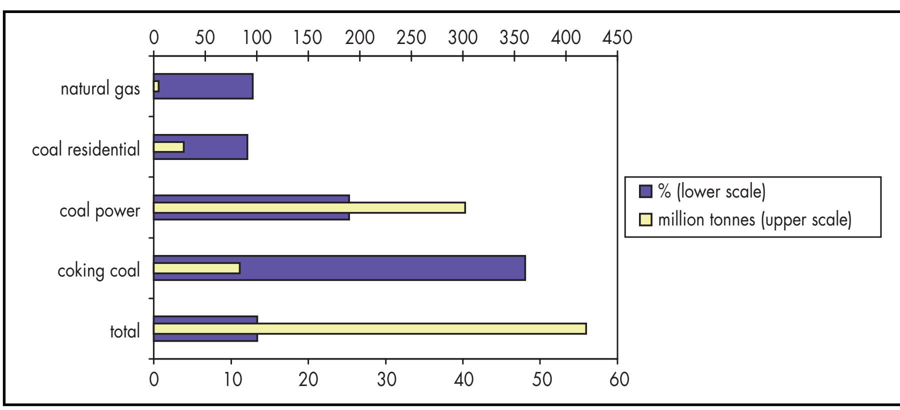
The largest remaining pricing inefficiencies exist in the huge coal sector, which was long sheltered from outside influences. Before 1996, it had a dual pricing system. Coal from state mines was allocated at artificially low prices, and village mines sold on an open market. The state mines operated at a loss, with no incentive to improve quality through measures such as washing. The coal price reform in 1996 raised the price for the state mines by letting prices float, which worked as a signal for the village mines to expand production and undercut the state companies. The reform was part of a progressive reduction in aid to the state mines, which had fallen from 5.75 billion Yuan in 1992 to 0.6 billion Yuan in 1996. The industry posted its first overall profit of 200 million Yuan in 1997, but massive capacity due to past subsidisation proved unsustainable under realistic prices. The 1998 coal glut caused new losses of 3.71 billion Yuan, which the public purse absorbed. Such losses are systemic rather than a sign of especially great inefficiencies in the coal sector. By November 1998, defaults on coal purchases from state mines totalled Yuan 36.1 billion.[29] The insurance of losses by the government still leaves a bias to maintain more activity levels higher than the market can sustain.

As the most transport-intensive good in the Chinese economy, coal also receives indirect subsidies through the transport subsidisation. The relative price of rail transport is about 20 per cent lower than the actual cost, despite the phase-out of general transport-cost compensation for loss-making enterprises.[30] The construction of new rail capacity is financed through loans from the Ministry of Railways, which are practically never repaid, and transport construction funds. In addition, state-owned transport companies have frequently benefited from income tax rebates.

A particular form of subsidisation consists in the lack of safety and environmental measures in the township mines. In 1995, China had 5,990 fatal mining accidents, and this was a 15% decline from 1994. Some 72% of the accidents happened in township mines, a third of which work without permit and two thirds of which fail to comply with even minimal safety requirements.[31] The lack of safety measures to keep costs and prices low represents an implicit subsidy for coal production and consumption and it appears as such in the price-gap approach.

The subsidisation of about 10% of the price of steam coal (about 75% for coking coal) identified in this study are well-founded in fact. The study shows that the bulk of energy and CO_2-emission savings to be gained by raising coal prices and reducing subsidies would also accrue in the coal sector itself.

Figure 9: **Reductions in CO_2 Emissions through Subsidy Removal**



29. IEA/CIAB (1999), p. 44.
30. OECD (1999), p. 139.
31. IEA/CIAB (1999), p. 44.

Market Distortions in the Oil Sector

Oil production has also benefited from large subsidies. The government-imposed monopolies CNPC and Sinopec are both well-positioned to extract surplus rents from captive markets. Further regulation might attenuate overpricing at the retail level, but government-formulated "profit targets" indicate that the profitability of the companies will not be at risk. Subsidies to the oil sector have been administered through a number of additional mechanisms: direct financial transfers, income tax refunds, preferential tax rates, accounting changes and accelerated depreciation allowances. Accumulated subsidies during the 8th Five-year plan from 1990 to 1995 amounted to 166 billion Yuan, or 70% of all oil-related investments.[32]

Recent developments modify this picture. The "corporatisation" and planned partial privatisation of CNPC and Sinopec will reduce the scope for direct budgetary transfers and creative accounting. The domestic underpricing of Chinese oil products compared to world market prices, which was prevalent until the mid-1990s ceased with the low oil prices of 1998. The link established with the Singapore spot market price, as well as the profitability targets mentioned above indicate that underpricing is unlikely to resume. On the contrary, low international oil prices during 1998 slowed the liberalisation due to concerns about the profitability of the two companies. The most serious market distortion in the oil sector remains the state-sanctioned dual-monopoly structure all along the oil supply chain.

Given the limited nature of Chinese oil reserves, the push for production in recent years has not sufficiently taken resource depletion into account. An optimal extraction path for a depletable resource would reflect increasing "user cost" — the cost of depletion itself — through an increase in prices over time. The Chinese will probably exhaust their reserves in the lifetime of people alive today, so the question of intergenerational equity does not come up. But it is right to question whether the subsidisation of present over future extraction is optimal for both economic efficiency and energy security.

The price-gap analysis in this study did not reveal any subsidies for oil, despite the evidence offered here, because subsidies in the oil sector have been administered in a form that benefited domestic producers rather than consumers. The rampant smuggling of oil products indicates that retail prices do not reflect the true costs of supply. Yet current prices seem to be set primarily with the profitability of the national oil companies in mind.

32. IEA/CIAB (1999), p. 42.

Only after the current transitional period, when the new price regime is fully functional, will international markets truly serve as the benchmark for China's domestic markets.

Market Distortions in the Electric Power Sector

Electricity prices remain in theory controlled by the government according to a dual system of grid (or listed) price and retail (or guide) price. Both are centrally set by the Price Bureau of the SPDC and the Electric Power Department of the SETC. Because the government owns the grid, the grid price is non-negotiable. Adjustments to the retail price can be made by local or provincial governments, subject to approval by the Price Bureau. Prices are based on production cost.[33] In practice, however, only projects with foreign capital are subject to the strict approval process. In many cases, arbitrarily high tariffs, including local and provincial "surcharges", at which there were at least 560 different ones give a very heterogeneous picture, difficult to summarise.[34]

Generating capacity has been subsidised through reduced capital costs *via* the Power Generation Infrastructure Fund, which is financed through a small levy on the price of electricity. This easy access to capital has contributed to the overcapacity in some regions. Reduced VAT rates, or VAT rebates, for generation and transmission, although not for fuels have also been used.[35] Recently, the State Power Corporation (SPC) announced the reshaping of its provincial subsidiaries into limited liability companies, as part of an envisioned separation of grid management from power generation. Special tariffs for certain industries, such as irrigation or chemical fertiliser production, are also being phased out and replaced by direct subsidies.

Subsidies to electricity that are identified in this study remain at about 40%, considerably higher than subsidies to the coal used in power generation. This is unsurprising, as subsidies were made mainly to capital expenditures. The government's guaranteeing fixed returns to independent power producers, which has now been ended, may have also lowered the cost of capital.

At the same time, however, an implicit tax has been levied on foreign investors in the power sector. Legal insecurity regarding intellectual property rights hampers investment and technology transfer. Dispute

33. IEA/CIAB (1999), p. 18-19.
34. Martin (1999), p. 2f.
35. OECD (1999), p. 127.

resolution through the court system is still discouraged in favour of arbitration. And while a legal framework now exists, it changes frequently and is applied unevenly, discouraging all but the most risk-loving foreign investors.[36]

Conclusions and the Way Forward

In China, the move towards the market proceeds in fits and starts rather than as a smooth, gradual process. Such sudden changes cause many problems of transition. Government policy reflects a desire to capture the benefits of the market without relinquishing final control. The phrase coined in connection with the recent reform in the oil sector, "prices yes, markets no" captures some of the ambiguity that exists when wholesale and refinery prices are set by companies but crude and retail prices remain controlled.

Leaving aside many individual practices in the Chinese energy sector that probably would not stand the test of economic rationality, four general issues stand out:

- The removal of remaining price controls would greatly contribute to convincing foreign investors that even in the energy sector the market is the final arbiter of the viability of an investment. While China is the world's second largest recipient of foreign direct investment, only a comparatively small portion of it goes to the energy sector.
- Any regulatory system needs a strict separation of regulatory oversight and operational control, to avoid collusion between regulators and the industries they regulate. Regulatory reform can provide this separation. The collusion usually takes place to the detriment of either the consumer or the taxpayer. As long as governments determine profit margins or guarantee the survival of companies, and retain the means to manipulate markets accordingly, efficiency may prove elusive.
- Enterprises should be freed from social obligations. Coal companies, which support other enterprises through artificially low prices and resort to inefficient, labour-intensive production methods to reduce unemployment, will have difficulties in returning to profitability. China does face real social issues, including rising unemployment, which it must deal with. But doing so by delaying enterprise reform

36. IEA/CIAB (1999), p. 64.

instead of establishing a general social safety net will also delay efficiency improvements and hurt China's international competitiveness.

- Perhaps most important, the energy sector and the economy as a whole need transparency and the rule of law, because markets depend on clear rules and the security of transactions. Technology transfer will occur on a large scale only with some positive expectation that intellectual property rights will be respected. Repeatedly tolerated non-payment is a direct subsidy to inefficient companies. Similarly, corruption allows inefficient companies to gain contracts they would otherwise not receive. In the end, the discipline of the market will create the expected benefits only if its most important loopholes have been plugged.

CHAPTER 6
THE RUSSIAN FEDERATION

Russia has made considerable progress since the early 1990s in moving the energy industry onto a more commercial and market-based footing, including establishing more rational, cost- and market-based prices. Sizeable subsidies remain, however. Underpricing of energy results in major distortions in energy consumption and significant economic and environmental costs. The impact and cost of the consumption subsidies in Russia are most significant in the natural gas and electricity sectors. Removal of those subsidies could reduce electricity use by a quarter and gas use by more than a third, bringing about substantial financial benefits to producers and suppliers and improved resource allocation. Overall, primary energy consumption would be reduced by more than a quarter or 107 Mtoe, were price subsidies to be removed. CO_2 emissions would also fall by a quarter. These results, based on 1997 data, take no account of the practicalities of price reform or of the structural and economic barriers to investment in general in Russia and specifically omit investment to enhance energy efficiency. The rate of subsidisation has already been greatly reduced in the oil sector. Non-payment and the widespread use of barter deals to settle debt are major problems and constitute a source of implicit subsidies, in the electricity, gas and coal industries. Political stability and recognition of the necessity for reform will be important prerequisites for progress in establishing more rational pricing structures as part of the overall energy sector restructuring process.

Economic and Political Overview

The Russian Federation was formed as an independent federal republic on the break-up of the Soviet Union in 1991. The head of state is President Boris Yeltsin, in power since 1991. The legislative branch consists of the democratically elected State Duma and the Federation Council. The current Prime Minister, Vladimir Putin, was nominated by President Yeltsin and approved by the Duma in August 1999 — the fifth person to fill the post since the beginning of 1998. Presidential elections are due to be held in 2000.

Despite a wealth of natural resources, a well-educated population and a diverse industrial base, Russia continues to struggle to make the transition from the centrally planned economy of the Soviet era to a modern market economy. The reform process was launched for the most part at the beginning of the 1990s and implementation continues. Key objectives include:

- Abolition of central allocation for production and distribution, price liberalisation, fiscal reform and the introduction of hard-budget constraints in government and publicly owned enterprises;
- Structural reforms, including administrative decentralisation, privatisation and de-monopolisation;
- The establishment of a transparent legal framework for business transactions; and
- Opening the economy to foreign trade and investment.

Table 12: **Key Economic and Energy Indicators in Russia, 1997**

Population (mid-year, millions)	147.1
GDP (current rubles, billion)	2,563.0
GDP (current US$, billion)	442.7
Real GDP growth rate over 1996 (%)	0.8
GDP per capita (current US$)	3,009
Inflation (annual % change in consumer price index)	14.6
Total Primary Energy Supply (mtoe)	592.0
Total Primary Energy Supply per capita (toe)	4.0
TPES/GDP (toe/$ million)	1,338
Energy production/TPES	1.57
CO_2 emissions (million tonnes)	1,456
CO_2 emissions per capita (tonnes)	9.9
CO_2 emissions/GDP (tonnes/$1,000)	3.3

Sources: IEA (1999), IMF (1999).

The implementation of reforms has been difficult politically and the short-term consequences painful. The economy contracted by a third over seven consecutive years to 1996. After rebounding modestly by 0.8% in

1997, GDP resumed its decline in 1998 amidst a calamitous financial crisis. The crisis resulted from a sharp drop in earnings from oil and gas exports due to lower prices, and from the impact of the Asian economic crisis, which undermined confidence among international portfolio investors in emerging markets generally. In August 1998, pressure on the Ruble led the Government to abandon efforts to maintain its stability, and the currency was allowed to float. The Government also imposed a 90-day moratorium on foreign-debt repayments without consulting the banking sector. The Ruble immediately lost almost half of its value. Inflation, which had fallen to 11% in 1997, surged to more than 50% in September 1998 alone. The private banking sector, which accounted for around a third of total deposits, was severely hit. The crisis undermined the fragile confidence in banks that had been achieved, disrupting transactions between businesses and exacerbating the effects of the devaluation.

Signs of economic stabilisation are now emerging. Preliminary official statistics show a drop of around 4% in real GDP in the first quarter of 1999, after more than 7% in the second half of 1998. Industrial production has increased month-on-month since October 1998, although output remaining below the level of a year earlier. The Ruble devaluation has helped exports and domestic industry. The recovery in oil prices since the spring has also boosted export earnings and lent support to the Ruble.

Energy Sector Overview

Energy has traditionally played a central role in the Russian economy. During the Soviet era, the energy sector was developed to provide resources for heavy industry and national defence, as well as to earn foreign exchange to finance imports. The immediate impact of the transition to a free market economy was a slump both in demand for energy from the industrial sector and in investment and maintenance in the energy sector, which has led to declines in energy production, particularly of crude oil.

Russia nonetheless remains the world's second largest energy producer after the United States, accounting for over 10% of global primary energy supply. In 1997 Russia exported 333 Mtoe of energy (including exports to other FSU countries), of which 176 Mtoe was oil, second on both counts to Saudi Arabia. Russia is the world's largest exporter of natural gas (151 Mtoe in 1997).

Table 13: **Russian Energy Balance, 1997 (Mtoe)**

	Coal	Oil	Gas	Nuclear	Hydro	Electricity	Other	Total
Indigenous production	101.1	305.5	461.1	28.8	13.5	0.0	17.3	927.3
TPES	97.2	127.4	309.7	28.8	13.5	-1.7	17.1	592.0
TFC	27.5	81.3	90.8	0.0	0.0	50.4	139.0	389.0
Industry	12.1	13.5	34.4	0.0	0.0	22.7	53.1	135.8
Transport	0.3	32.3	14.4	0.0	0.0	5.5	0.0	52.5
Residential/ commercial	13.0	26.3	42.0	0.0	0.0	22.2	86.1	189.6
Non-energy	2.0	9.1	0.0	0.0	0.0	0.0	0.0	11.1

Source: IEA (1999), Energy Balances of Non-OECD Countries, 1996-1997.

Demand Trends

Total energy supply has declined progressively throughout the 1990s, most sharply in 1990-94. In 1997, TPES stood at 592 Mtoe, a fall of 35% from 1990 (Table 13). Primary energy supply fell only modestly in 1996 (by 2.2%) and 1997 (by 3.1%), but is thought to have fallen much faster in 1998 in response to the economic and financial crisis. Since 1990, final energy use has fallen even more dramatically than TPES, by 45% to 389 Mtoe in 1997. Coal use has declined most sharply: primary coal supply fell by 42% over the same period, due to reduced demand from power stations and heavy industry largely caused by sharp increases in rail transportation tariffs. Primary supply of natural gas has also dropped heavily, due almost entirely to a nearly two-thirds fall in gas use in industry, notably as feedstock for the petrochemical sector. However, the share of natural gas in TPES increased from 46% in 1990 to 52% in 1997. From 1990 to 1996, primary energy decreased by around 15%, with the drop in economic activity caused by restructuring outstripping the fall in energy use.

Energy Efficiency

Russian energy efficiency is poor compared to other countries. Consumption for space heating and domestic hot water, for example, is about 50% higher in Russia than in IEA countries, while manufacturing energy use per tonne of output is up to twice the level in western European countries. Economic restructuring, combined with the economic downturn, has exacerbated the problem and led to even lower energy efficiency than in the Soviet era. The 1994 Energy Strategy outlined the Government's main policy objectives for enhancing energy efficiency in the energy sector, including the introduction of energy-efficient technology in production processes and power generation, improvements in oil refining, increased use of natural gas and greater exploitation of hydropower and non-traditional technologies. The Strategy estimated potential savings at 40% to 45% of primary energy consumption; 33% of these savings would occur in the energy sector, 33% in industry, 16% in the residential sector and 10% in the transport sector. A 1998 federal programme dubbed Energy Conservation in Russia, called for the implementation of this strategy. It aimed at reducing GDP energy intensity by 13.4% in the period 1997-2005 and conserving 260 to 310 Mtoe per year through market mechanisms, government regulations, reduced energy subsidies and appropriate energy prices and tariffs.

The objectives of the various policies and laws concerning energy efficiency have not yet been reached. Limitations on the Russian's ability to replace obsolete resource-intensive industry and to finance environmental improvements in the energy sector are increasingly evident. Potential investments are affected by the general decline in fixed capital formation. Barriers to investment include continued subsidies to residential electricity and heating prices, the non-enforceability of contracts, an unstable investment environment, and the non-payment of energy bills estimated at US$85 billion in 1997. On the micro-economic level, barriers include the small size of energy efficiency projects which render the fixed costs of arranging loans prohibitive, a lack of trained and skilled experts to develop project proposals, the antiquated structure of building and district heating supply systems and the lack of responsibility on the part of homeowners and housing associations.

Coal

Coal meets 16% of Russia's primary energy needs. A small amount, around six million tonnes in 1997, is exported. Much of the country's coal output is sub-bituminous, brown coal or lignite. Coal production dropped by 38% from 1990 to 1997, due largely to the closure of uneconomic mines in the face of declining domestic demand and investment. Strikes caused by of mining companies, failure to pay wages, itself the result of 80% non-payment by coal consumers, contributed to a 5% drop in output in

1997. Strikes also disrupted production in 1998. Reserves are estimated at over 200 billion tonnes.

The restructuring of the coal industry is aimed at shutting all uneconomic mines, removing all subsidies and privatising viable mining operations. The Government has set aside some of the money saved by the closure of loss-making mines to upgrade potentially profitable ones and provide transitional support to communities hit by mine closures. The World Bank has also contributed funding under the Coal Sector Adjustment Loan programme. In addition, the Export-Import Bank of Japan signed an agreement in July 1998 for up to $800 million in loans to the Russian coal industry. Worsening payment problems with coal consumers, and alleged misappropriation and misspending of money allocated to the industry have undermined these efforts.

Oil

Proven oil reserves are put at around 49 billion barrels, or 5% of total world reserves. Russian oil production has dropped steadily since 1988, when it peaked at 11.4 million b/d. Output averaged 6.1 mb/d in 1997 and an estimated 5.9 mb/d in 1998. This decline in output has resulted from a number of factors, including reservoir depletion, due to overproduction and poor field management; under-investment (due to an unpredictable fiscal system, as well as unclear and sometimes conflicting laws and regulations; and slow progress in implementing tax reforms and production-sharing agreements). Production concentrates in a small number of large fields, located mainly in West Siberia which account for two-thirds of total output; and the Volga-Ural region, which contributes a quarter. A drop in output from the super-giant Samotlor field in West Siberia was responsible for a third of the total decline in Russian oil production since 1988. The Ministry of Fuel and Energy foresees a continuation of this trend with West Siberian production declining by as much as100 million tonnes per year or one-third of Russian production, over the next seven to ten years.

In 1992 the Duma passed the Subsoil Law establishing a general legal framework for the oil sector. The industry was reorganised in 1993 into a dozen large, vertically integrated companies, combining exploration, production, refining and distribution, as well as a number of regional independent producers. Lukoil is the largest integrated company, with 1997 crude output of 1.1 million b/d. Most of the companies have been privatised, with foreign investors taking minor stakes. Several companies have formed joint ventures with foreign firms to gain access to capital and technical and management expertise. These joint ventures accounted for around 6% of total Russian output in 1997, up from around 5% in 1996. Investors' interest in setting up joint ventures has diminished since then, due to fiscal and legal uncertainty.

In February 1999 an important step was taken in establishing a stable legal and fiscal regime to attract long-term investments in Russia's natural resource sector. Passage of an "Enabling Law" brought the 1996 Production Sharing Law into compliance with existing Russian legislation, thereby bringing the latter Law into full effect[1]. The "Law on Amendments" amended the original law to include various control mechanisms, including the requirement for Duma approval to develop fields with significant reserves under a PSA. It set domestic-content limits and helped gather support for acceptance of PSAs. By May 1999, the Duma had approved eight new fields to be developed as PSAs in addition to three grand-fathered PSAs and the Sakhalin III field, which was approved by the Duma and the Federation Council and signed by the President earlier in 1999. A tax code — a key component in strengthening market reforms generally — is also being prepared.

The Federal Government continues to control crude oil exports through a quota system, despite its commitments to the IMF and the World Bank to liberalise exports. Exports are generally more attractive to producers and traders than are sales to domestic customers, because export prices are higher and there are fewer problems with obtaining payment for export sales. The devaluation of the Ruble in 1998 and the recent recovery in world oil prices have made exports even more attractive. As a result, they have surged to more than 3 million b/d in 1999 — the highest level since the mid-1980s. Most export pipelines, all of which are operated by Transneft, have operated at full capacity in recent months. The Government has recently withheld some export permits, to divert oil to domestic markets and to put pressure on companies with tax arrears.

1. Experience in many countries has shown that investors regard Production Sharing Agreements (PSAs) as an alternative mechanism on which to base major long term investments, especially while a new tax regime is being drafted and put into place. PSAs are agreements between the Government (as owner of the natural resource) and the investor. They govern the terms on which investments are made and how the results of the investment are to be shared over the life of the project. Within the terms of the agreement, the investor pays all investment and operating costs, pays specified taxes and royalties and meets all other obligations towards the Government. In return, the Investor receives the agreed share of production, which it can export, exempt from other federal taxes. In addition to taxes and royalties, the Government also receives its share of production, which increases with the profitability of the project.

Russian refineries currently operate at well below their rated aggregate capacity of 6.9 mb/d. Throughput in 1997 is estimated at around 3.7 mb/d. Most of the country's 28 refineries are relatively unsophisticated, producing predominantly fuel oil. Some modernisation is taking place, including a $400 million upgrade of the 400,000 barrels per day Yaroslaval refinery and a $350 million upgrade at the 440 kb/d Norsi-Oil refinery. More than 1.23 mb/d or 57 Mtoe of oil products were exported in 1997, mostly diesel oil and heavy fuel oil. Physical and government limitations on crude exports, hard currency requirements and higher prices than on domestic markets have encouraged product exports. The reintroduction of export duties on products in early 1999, which was intended to encourage sales to domestic markets and to raise budget revenues, appears to have had little impact on export volumes or profitability.

Natural Gas

Russia has one of the most gas-intensive economies in the world and is the world's largest gas exporter. Production has nonetheless been declining gradually in recent years, from a peak of 590 Mtoe or 643 billion cubic metres, in 1991 to 461 Mtoe or 572 bcm in 1997, because of declining domestic demand and gas field depletion. Three fields — Urengoy, Yamburg and Orenburg — account for roughly 80% of total production. Yamburg is the only field not yet in decline. Exports amounted to 151 Mtoe in 1997, down from an all-time peak of 156 Mtoe in 1996, due to a weather-related fall in demand from Western Europe, the principal export market. Proven gas reserves amount to 48 trillion cubic metres, equivalent to a third of total world reserves. Power generation is the largest consuming sector of gas in Russia, accounting for close to two-thirds of demand.

Gazprom, the national gas company, accounts for 95% of Russia's gas production, oversees eight production associations, owns and operates the country's entire 140,000 km high-pressure pipeline network, markets all of the gas on domestic and export markets and participates in joint ventures for marketing in several Western European countries. Gazprom was created out of the Soviet Ministry of the Gas Industry in 1989 and transformed into a joint stock company in 1992. In 1994, 60% of its equity was sold to employees and individual investors in regions where Gazprom is active. The German gas utility Ruhrgas has since acquired 4% — 2.5% in an auction in December 1998 — and other foreign investors around 2% of the company, with the Russian state's stake dipping to 38%. Gas distribution is carried out by a large number of regional, territorial and municipal gas companies that operate under the umbrella of the former distribution monopoly, Rosgaz, of which the majority share is still state-owned.

Since 1997, the Government has introduced some reforms to improve efficiency and promote competition in the gas industry, primarily to meet World Bank conditions for additional lending. In 1997, the President issued a decree that removed Gazprom's monopoly rights to develop new gas deposits, opened up access for independent producers to at least 15% of the company's pipeline capacity and mandated detailed annual financial reports to improve transparency. In 1998, agreement was reached on unbundling Gazprom's production, transmission and distribution activities to ensure that Gazprom charges third parties the same transportation rates that it charges itself, with the aim of increasing access to the network by independent producers. Despite these moves, little progress has yet occurred in promoting third-party access and unbundling Gazprom's accounts. In addition, rates are being reviewed and wellhead price controls for independent producers will be removed. Gazprom is pursuing a $45 billion-project to construct a 4,000 km pipeline from gas fields in the Yamal peninsula to Europe, although its economics are questionable.

Gazprom's underpayment of taxes to the Federal Government is a major, long-standing issue. Gazprom accounted for 25% of all Government tax revenues in 1997. It has been unable to meet all its tax liabilities because its customers — including state-owned enterprises — do not pay their bills on time; only around 15% of its domestic customers pay their bills promptly and in cash. Foreign customers have also run up large debts, particularly the Ukraine, Belarus and Moldova. In July 1999 the Ukraine Government and private Ukranian trading companies owed Gazprom around $1.8 billion. Gazprom responded to domestic payments problems by threatening to cut off customers. It was forced to back down in July 1998 under pressure from the Government, after threatening to stop supplying gas to power stations. Gazprom and the Government subsequently negotiated an agreement, under which Gazprom would pay $500 million per month in back taxes in exchange for government pressure on domestic customers to pay their bills. Gazprom also reached an agreement with the Ukrainian Government in July 1999, whereby some debts will be repaid through barter deals involving food, other goods and participation in industrial projects.

Electricity

Power production has declined steadily since the beginning of the 1990s in response to the weak economy. Output totalled 833 TWh in

1997, down 23% from 1990. Natural gas accounts for 45% of the total, hydropower 19%, coal 17% and nuclear 13%. Generating capacity stands at 205 GW, down slightly from 213 GW in 1990. Much of this capacity is in the form of combined heat-and-power plants. Construction of new capacity has virtually halted. Exports of power to Western Europe are being considered to take advantage of idle generation and transmission capacity and to provide cash flow.

United Energy Systems (UES), the 52% state-owned national utility, dominates the electricity supply industry. It owns and operates several large thermal and hydro plants with a total capacity of over 70 GW and owns nearly all transmission lines over 330kV. The regional distribution companies, known as energos, own most of the smaller thermal and hydro plants. UES, in turn, owns between 49% and 100% of the energos as well as a range of affiliated companies, including research and design institutes and construction businesses. Foreign investors hold around 28% of the shares of UES.

Moves to restructure the electricity sector have stalled as a result of political upheavals. In 1997, President Yeltsin issued a decree giving power stations access to the network and the right to sell power directly to end-users. The regional power companies have largely ignored it, however, and continue to block third-party sales. In addition, little headway has been made in shutting inefficient power stations and reducing the bloated work force. Some progress has come, however, in establishing financial controls, rationalising investment programmes and improving collections. The Government plans to set up a new body to develop an effective wholesale market to encourage competition among power producers. Major challenges to liberalising and restructuring the industry include:

- the regional structure of the industry and the energos' resistance to the creation of a competitive market;
- transmission constraints;
- the high proportion of combined heat-and-power plants and the lack of true local markets for heat;
- concerns over nuclear plant safety, reliability and costs; and
- non-payments by customers.

Nuclear

Russia has 29 nuclear reactors with a total capacity of around 21 GW. Almost all are owned and operated by Rosenergoatom, a 100% state-owned holding company under the Ministry of Atomic Energy (Minatom).

Rosnergoatom sells most of its output to UES, which in turn sells it to the energos.

Safety is a continuing concern, particularly with respect for the 16 old reactors of the design used at Chernobyl. Reactor maintenance and repairs have been delayed in recent years due to lack of funds, exacerbated by economy-wide payments problems, which have caused UES to withhold some payments to Rosenergoatom. The lack of demand and the recent economic crisis have disrupted plans to build new nuclear plants.

District Heat

Heat supplied through district and local heating networks accounts for an unusually large proportion — around a third — of total final energy consumption in Russia. This is another legacy of central planning. More than half the heat is produced in heat-only boilers instead of more efficient combined heat and power plants. Heat is generally produced by the regional electricity companies (energos); they supply both industry and municipal district heating companies, which in turn supply households. Industry accounts for almost 40% of the heat consumed in Russia. In general, district heating systems provide limited operational flexibility, are poorly insulated which leads to significant heat losses, and have very little metering. Incentives to reduce heat use or to use heat more efficiently are poor because of lack of control technology, metering and low prices.

Energy Subsidies

Overview

Despite Russia's considerable progress in establishing cost-based and market-related prices in the energy sector, sizeable subsidies remain. Perhaps the largest form of energy subsidy in Russia is non-payment, which effectively means a zero price to the consumer. In general, non-payment and payment arrears are most prevalent among industrial and commercial customers, where non-payment of bills along the entire production and supply chain is common. The collection rate among households tends to be much higher. Barter, which is prevalent throughout the Russian economy, may also contain some price subsidies and it is certainly a possible means of tax avoidance. Although some headway appears to have been made in the last year or so in recover payments, this remains a major problem in the electricity, gas and coal industries.

Consumption subsidies revealed by the price-gap approach are also significant, especially in the gas and electricity sectors (Table 14).[2] The rate of subsidisation[3] has been greatly reduced in the oil sector, although the devaluation of the Ruble in 1998 and government moves to restrain domestic price increases through export restrictions have recently led to an *increase* in subsidies.

Table 14: **Russian Energy Subsidies: Summary of Results**

	Estimated Rate of Subsidy (% of reference price)[1]	**Potential Primary Energy Savings from Subsidy Removal (%)[2]**	**Estimated Economic-Efficiency Cost (million rubles)**	**Estimated Budget Cost (million rubles)**
Gasoline	9.3	2.4	40.4	3,344.0
Auto diesel	0.0	0.0	0.0	0.0
LPG	0.0	0.0	0.0	0.0
Kerosene	0.0	0.0	0.0	0.0
Light fuel oil	1.5	0.7	1.3	283.6
Heavy fuel oil	0.0	0.0	0.0	0.0
Electricity	42.0	24.3	8,689.4	62,847.0
Natural gas	46.1	36.6	30,674.1	121,908.7
Steam coal	0.0	0.0	0.0	0.0
Coking coal	0.0	0.0	0.0	0.0
Total[2]	**32.5**	**25.7 (18.0)[3]**	**39,405.2**	**188,383.3**

Notes: Calculations are based on 1997 prices and quantities. 1. Weighted average. 2. TPES saved/TPES for the sectors covered in the study. 3. Figure in parentheses is calculated using TPES for all sectors and fuels, including those not covered in the study.

Box 15: **Non-payment and Barter**

Payment problems have become widespread in recent years in many countries, notable those of the FSU. The non-payment of an energy bill constitutes a form of subsidy, as the monetary price is effectively zero. Late payment also represents a subsidy to the extent

2. There are significant price differences across regions for individual fuels. The price-gap analysis here is based on average national prices.
3. The difference between the actual price and the notional reference price based on full supply costs expressed as a proportion of the reference price.

that the price eventually paid does not fully reflect borrowing costs over the period of the debt.

Economy-wide payment problems developed quickly at the beginning of the 1990s after dramatic price increases resulting from price liberalisation. Non-payment often goes unpunished because of the potential social implications of the closure of large enterprises. In Russia, outstanding bills owed to the national gas company, Gazprom, have reached Rbs 115 billion, equivalent to more than a year of turnover. The current collection rate is estimated at around 60%; cash payments represent only 17% of total bills paid. The electricity and coal industries have also low collection rates. State-owned companies and organisations are among the worst offenders. In Kazakhstan, the average collection rate in the electricity sector is estimated at between 50% and 60%.

Barter is often used as an alternative to cash payment. In Russia, the majority of bills to businesses for electricity, gas and coal are settled by barter, typically with the customer's output. The tax system and a failure to punish companies that do not settle bills in cash have tended to encourage the development of barter arrangements. Other forms of non-monetary payment have also emerged, including money surrogates or promissory notes issued by enterprises, banks or governments, with specified maturities and discount rates, and debt swaps.

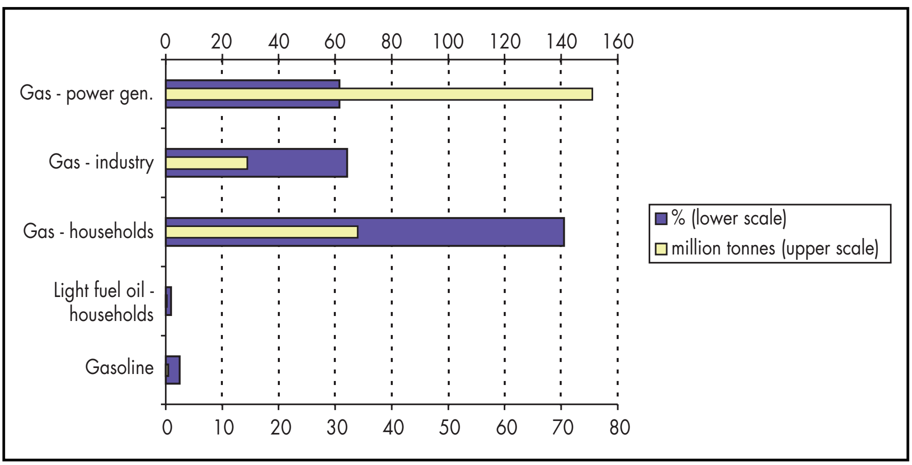
Non-payment and barter impose large costs on the economy. Chains of payment arrears induce financial paralysis and undermine production and investment. Barter reduces economic efficiency. When a company earns its revenues in goods, it must sell or barter those superfluous to its own needs, a situation, which lends to increased informational and transactional costs. Barter also inhibits the functioning of credit and capital markets, distorting prices, reducing flexibility in marketing and procurement, impeding competition, and encouraging the development of the "informal" economy, since avoiding transactions through the banking system makes it easier to evade taxes.

Effects and Costs

Underpricing of energy alone results in major distortions in energy consumption and significant economic costs. The price-gap analysis implies that primary energy consumption would get reduced by 18%, or 107 Mtoe, were those price subsidies to be removed. Natural gas and electricity use would fall the most. CO_2 emissions would also drop by about 20%. This analysis takes no account of the practicalities of price reform or of the structural and economic barriers to investment in Russia.

The annual economic-efficiency cost is estimated at Rbs 39 billion (around $7 billion). The pure financial cost that is borne by energy producers and suppliers (in that the prices they receive are below market value), and the Federal Government (in that it directly subsidises energy) amount to an estimated Rbs 190 billion (over $30 billion). Trading of CO_2 permits based on an assumed carbon value of $27/tonne would yield almost Rbs 11 billion ($1.9 billion) in revenues.

Figure 10: **Reduction in Russian CO_2 Emissions Through Subsidy Removal**



Source: IEA.

Coal

Although subsidies to coal consumption do not show up in the price-gap approach, end-use prices that are above reference prices may reflect subsidies to production. The state subsidises production through direct grants, which make up the difference between sales revenues and production costs. Direct subsidies amounted to an estimated $2 billion in 1994, making coal mining at that time the third most heavily subsidised sector in the country behind defence and agriculture. Subsidies have since shrunk considerably, to less than $500 million[4]. Direct state funding

4. *International Coal Report* (Issue 466), 25 January 1999.

accounted for 13% of total industry revenue in 1998, compared to 77% in 1993.

Oil

Crude oil and product prices were progressively decontrolled from 1992 as the first major step placing the oil industry on a commercial footing. Oil prices in the Soviet era were set well below world market levels. Liberalisation led to dramatic increases in crude oil prices, from only 1% of world prices in 1991 to almost half by the end of 1993. Changes in government export controls, export capacity availability, the level of domestic demand and the ability of domestic customers to pay have caused crude prices to fluctuate significantly in relation to world levels in recent years. In July 1999, Ural blend crude was priced at around $7/barrel to domestic refiners compared to over $18 delivered to refiners in Northwest Europe. At present, the Government does not directly control crude oil prices, but influences them through export restrictions and directives to producers to ensure that domestic refineries receive minimum volumes of oil. With no export capacity constraints and quota restrictions, domestic crude oil prices would probably still remain below world levels because of export capacity limitations, poor refinery yields and relatively low domestic product prices.

Oil product prices are not formally controlled, although this year the Government exerted pressure on retailers and refiners to restrain price increases during the harvest season. In 1997, most end-user oil prices were at or slightly below world market levels: gasoline, the most heavily subsidised product, was priced on average about 90% of the true market value or reference price. Since 1998, domestic product prices have tended to lag behind increases and falls in prices on international markets. Payment problems with retailers and the attractiveness of hard currency sales for exports have tended to discourage refiners from selling to the domestic market over the past year or so. This has led to shortages. Small, private retailers have exploited these shortages by charging prices above those on world markets. In August 1999, the Government negotiated a plan with the largest oil companies that would make the granting of product export quotas conditional on their supplying minimum volumes of diesel and gasoline to the domestic market, and limiting price increases.

Natural Gas

Russian gas prices to domestic customers lie well below levels those in Western Europe and the prices Gazprom charges its export customers. They are also structured differently, with prices to industry and power stations much higher than to households, which is contrary to the structure of supply costs. On average, gas prices were set at only half their true market prices in 1997. Households paid less than 9% of the reference price, while power stations were charged an estimated 64%.

Between 1992 and 1997, the Government adopted a hands-off approach to the gas industry, exerting little direct control over prices. In general, Gazprom set prices to its direct end-use customers and to the regional distribution companies. This ensured profits for all its production and transportation subsidiaries, taking account of export earnings. Periodic price adjustments were nonetheless subject to formal approval by a special government committee appointed by the Prime Minister. In 1997, the Government assigned responsibility for tariff setting to the Federal Energy Commission (FEC). In December of that year, the FEC introduced new tariffs for six zones, depending on their distance from producing areas. Since then, however, increases in tariffs for household customers have failed to keep pace with inflation, and the gap between industrial and household tariffs has tended to widen. In mid-1997, a 15% discount was introduced on gas sales to power plants supplying electricity to the wholesale market. The FEC is currently drawing up a new tariff methodology, which is expected to pave the way for a more cost-reflective pricing structure.

Non-payment is the main problem facing Gazprom and the regional gas distribution companies, and a major source of subsidy in the gas industry (see Box 15). Gazprom and the distributors have, in some cases, responded by cutting customers off. In 1997, the Government narrowed the list of protected customer categories that cannot be disconnected under any circumstances. The new list includes strategic state entities, such as the military, but excludes households and power stations. Some customer categories are entitled to special discounts. Gazprom also offers large discounts to big customers that pay in cash. The company is thought to have made some progress since 1999 in improving collection and increasing the share of cash payments; the share of cash in total payments is expected to rise from less than 30% in 1998 to between 40% and 50% in 1999. Collection measures include bankruptcy procedures, negotiated settlements with local authorities and incentive schemes for customers paying in cash.

Electricity

Despite dramatic increases in tariffs in 1993, electricity prices remain well below cost. In 1997, the average rate of price subsidy expressed as a proportion of the reference price across all sectors was 42%. As in the case of gas, the rate of subsidy is considerably higher for the household sector than for industry, producing an inverted pricing structure. Household prices were only two-thirds of industrial prices, even though true supply costs are thought to be at least twice as high for household customers. Another source of cross-subsidy was removed in 1995, when the policy of uniform tariffs for households across Russia was abandoned, allowing tariffs more accurately to reflect differences in supply costs among regions.

Wholesale electricity tariffs are regulated by the FEC, while the regional energy commissions (RECs) regulate retail tariffs. The RECs are in principle required to follow the same pricing principles as the FEC, but in practice policy divergences and disputes emerge. A 1997 Federal Government decree attempted to increase FEC authority over regional tariff setting. Two-part wholesale tariffs, incorporating a fixed capacity charge and a variable commodity or demand charge, were also introduced in 1997 to ensure that electricity was supplied on the basis of short-run marginal cost. The FEC has announced plans to bring household prices up to 80% of industrial prices as a first step toward a rational pricing structure.

As with gas, non-payment and the widespread use of barter deals to settle debt present a major problem and a source of subsidy in the electricity supply industry. In 1998, UES revenues amounted to around $20 billion, only 21% of which were in the form of cash payments. Barter and other types of non-cash payment have undermined efficiency and increased costs. The lack of cash payments has put at risk the financial viability of many power companies, and hampered their ability to maintain and improve operating efficiency and respond to changing market conditions. UES has stated that up to 62% of its equipment requires replacement and has confirmed World Bank estimates of UES capital investment needs of up to $60 billion to 2005.

Conclusions

Russia has made some progress in moving the energy industry onto a more commercial and market-based footing, including establishing more rational prices. Still, large subsidies remain. Non-payment remains a pressing, economy-wide problem, despite signs that the situation may be improving. Consumption subsidies resulting from underpricing are most prevalent in the natural gas and electricity sectors. Oil prices have been largely decontrolled, but have periodically moved out of line with Western markets because of informal government intervention in pricing decisions, pipeline capacity constraints, government controls and payment problems. The coal sector continues to be characterised by production subsidies, although these have fallen greatly in recent years with the closure of many uneconomic mines.

The removal of the consumption subsidies identified in this study would reduce electricity use by a quarter and gas use by more than a third. It would bring substantial financial benefits to producers and suppliers and would improve resource allocation. CO_2 emissions would fall by almost a quarter. This could provide a lucrative source of revenue for Russia, if an international permit-trading programme was established. Subsidies in the district-heating sector, not covered in this study, are also thought to be very large. In order to assure the political feasibility and social acceptability of price reform, any subsidy removal would have to be accompanied by efforts to ease the transition, as domestic consumers particularly would face significantly larger energy bills. In particular, there is a need to facilitate investments that improve the end-use efficiency of energy use.

Pricing reform will have to be pursued as part of the overall restructuring process, including the establishment of the rule of law, the security of contracts and the full monetisation of the economy. Initial steps toward establishing a coherent and rational regulatory framework have been taken in both the gas and electricity sectors, but much remains to be done. The cost of supply must be better reflected in electricity and gas prices to specific customer categories and locations. The introduction of competitive elements into both sectors based on third party access to the network should also remain a key long-term policy objective. Political stability and recognition of the necessity for reform will be important prerequisites for rapid progress in this regard.

CHAPTER 7
INDIA

High domestic coal consumption dominates the conventional energy sector, but India also faces high oil import dependency. Subsidies to energy consumption are substantial. The price-gap analysis revealed significant differences between end-use prices and reference prices for coal, kerosene for domestic use, LPG and electricity for domestic and agricultural use. The removal of these subsidies and the freeing of prices would reduce both budget outlays and costs to public-sector enterprises. It would slim demand for energy inputs and electricity, and improve energy security. Until recently, all energy prices were administered under policies aimed at social and political goals, but the rationalisation of energy subsidies has now become a central element in the Indian government's overall plans to reform the energy sector.

Economic and Political Overview

The Republic of India is a democracy of 26 states and six union territories. Its constitution lists powers assigned exclusively to the central government, those reserved for the states and those that are shared "concurrent". In this federal system, devolution to the states plays a crucial and growing role, with important implications for the depth and pace of economic reforms. The main impetus for economic reform remains with the central government. The 1990s were a decade of ruling coalitions, often based on fragile alliances. In mid-April 1999, the government lost a vote of confidence after only thirteen months in power. At the time of writing, India has a "caretaker" government, pending new elections. While the need for reform has not been questioned in principle at any government level, significant political resistance to liberalisation of the economy persists in practice and slows the pace of reform.

The 1990s have nevertheless brought rapid economic change to India. Table 15 gives a snapshot of current key indicators. After several decades of protectionist "import substitution" trade policies and severe limitations on foreign investment, India began opening to foreign trade and investment. The state has gradually withdrawn from direct capital ownership and put into practice market regulations aimed at an improved allocation of resources. This trend began in the late 1980s but picked up speed after 1991, when a balance-of-payments crisis led India to implement a structural adjustment programme with the help of the IMF.

Table 15: **Key Economic and Energy Indicators, 1997**

Population (midyear, millions)	971.3
GDP (1998, current rupees, billion)	14,714.1
GDP (current US$, billion)	380.5
Real GDP growth rate over 1997 (%)	4.9
Government Budget (current rupees, billion)	2,331.5
TPES (Mtoe)	461.0
TPES per capita (toe)	0.47
TPES/GDP (toe /$1,000, at 1990 values)	1.04
CO_2 emissions (million tonnes)	880.7
CO_2 emissions per capita (tonnes)	0.91
CO_2 emissions/GDP (t /$1,000 at 1990 values)	1.98

Sources: IEA (1999).

From 1980 to 1996, the Indian population grew at an annual rate of 2% while GDP grew at 5.8%. Per capita income reached S367 in 1998, with GDP at $357 billion.[1] If population growth decreases as projected in the coming decade to below 1.6% per year[2], per capita income should continue to grow faster than GDP, even if GDP growth slows in the next three to five years from an average of 6.9% between 1992 and 1997.[3] GDP growth in the first half of the 1990s reflected the positive effects of the first generation of economic reforms, which aimed at increasing the tax base, streamline expenditures, reducing the public deficit, stimulating private investment and decentralising decision making. Although reforms had positive results in economic growth and the balance of payments, the effects on public-deficit reduction remain unrealised. The gross fiscal deficit

1. The text data differ somewhat from figures in Table 12 because they refer to fiscal years ending in March. Using purchasing-power parities, per capita GDP reached $1,580 in 1996-97.
2. Data on GDP and population stem from World Bank (1998d) and IMF (1999).
3. Government of India (1998).

reached 5.7% of GDP in fiscal year1997-98 and increased to 6.3% in 1999. The slowdown in economic growth since 1996-97, aggravated by the Asian economic crisis, has brought the government to consider "second-generation reforms".

Energy Sector Overview

India must provide energy to some 970 million inhabitants, of whom 36% live below the poverty line. Its total primary energy supply reached 461 Mtoe in 1997 (Table 16). The energy mix consists mostly of fossil fuels. Coal, oil and oil products represent more than 52% of the primary energy supply, with coal accounting for a third of that. The share of gas is low but growing quickly, from 2.8% in 1990 to almost 4% in 1997. Non-conventional and largely non-commercial energy, mostly the combustible renewables and wastes known as essentially biomass, account for more than 40% of the total primary energy supply. Nuclear and hydroelectricity have marginal shares, with hydro accounting for only 1.4% of TPES, down from 1.7% in 1990.

Table 16: **Indian Energy Balance, 1997 (Mtoe)**

	Coal	Oil	Gas	Electricity	Other	Total
Domestic Production	147.2	37.6	17.8		201.9	404.5
TPES	153.3	87.9	17.8	0.1	201.9	461.0
TFC	42.6	79.9	9.4	30.0	192.8	354.7
Industry	42.5	18.0	9.0	13.7	22.0	105.2
Transport	-	40.9	0.0	0.6	0.0	41.5
Residential/commercial	-	16.4	0.2	4.9	170.8	192.4
Non-energy	-	4.1	-	-	-	4.1

Source: IEA (1999).

India is an oil-dependent country. Increases in the international price of oil, and bad monsoons are been two important factors behind the economic crises it has had to face since independence. The oil crisis of 1973/1974 worsened India's terms of trade by 40% and caused the current-account deficit to double. The second oil shock, in combination with a disastrous drought in 1979, caused a 15% plunge in agricultural production, while the doubling of world oil prices worsened the terms of trade by 33% between 1979 and 1980. Recession and sharply accelerated inflation ensued.

The energy intensity of India's GDP reflects significant inefficiencies in economic activity. In 1997, at 1.04 toe per $1,000 (at 1990 prices) of GDP, it was more than double the world average. Even subtracting the large part of the energy supply from the use of combustible renewables and wastes, energy intensity remains high, at 0.60 toe. With its large and relatively poor population India has low energy consumption *per capita*, at 0.5 toe in 1997 (of which 0.3 toe came from conventional energy). Similarly, India stands among the world's highest CO_2 emitters relative to economic activity (2.57 tonnes/$1,000 US$ of GDP in 1997), yet one of the lowest per person (0.9 tonnes). The carbon intensity of the economy is more than twice the world average, the result of high coal use and inefficiencies in the transport sector, whereas the per-capita figure is one-twelfth the average for OECD countries

The average annual growth rate of total primary supply, which was 5.9% between 1971 and 1995, accelerated to 6.2% in 1990-1995 after economic reforms began. Transport demand has increased considerably, putting pressure on final oil demand and pushing up CO_2 emissions. Electricity has grown fastest, however, at an average rate of 7.9% in 1990-1995 and with 5% expected in 1995-2020. The intensity of electricity in GDP terms has decreased, but the acceleration of economic growth keeps final electricity demand growing.[4]

Oil and Gas

In 1996/97, oil and gas represented 22.9% of India's total primary energy supply, with crude oil accounting for 19.1%. Consumption of petroleum products amounted to 80.7mt in 1997. Diesel oil accounted for 43.4% of this, a high figure compared to other countries. Two of them had a share of almost 12% and LPG, 5.2%. Public sector companies dominate India's oil and gas sector. The Oil and Natural Gas Corporation Ltd. (ONGC) and Oil India Ltd. (OIL) carry out most oil and gas exploration and production activities. Several private companies also operate under production-sharing contracts. Pipeline gas transportation is the responsibility of the publicly owned Gas Authority of India Ltd. (GAIL).

Although the country has significant coal and hydroelectricity resources, it is poor in oil and gas. Most oil reserves are found on the West

4. The elasticity of electricity consumption with respect to GDP is falling but remains high. It is 1.58 for 1980-1995, but appears provisionally to have fallen to 1.22 in 1992-1997 (Government of India (1999)).

coast and in the Northeast region. Domestic production of crude oil was 33mt and gas production amounted to 22.7bcm in 1998 final year. All of it was consumed locally. With low and stagnant crude oil production, India will remain a heavy oil importer. It imported 38mt of crude oil and 25.5mt of oil products in 1997.[5] Petroleum and its products have represented 20% of total imports in the 1990s, and oil dependency has increased steadily, from 29.6% in 1984 to 57.3% in 1997, with expectations of 64% by 2002 due to increasing demand, particularly in the transport sector. The two most important end-uses for natural gas are fertiliser production and power generation; demand for both expected to increase in coming years.

Because refining capacity should double in the next two to three years, imports of crude oil could reach 52mt in 2000 and imports of oil products could almost disappear. The total annual capacity of the 14 refineries in the country, 61.55mt in March 1998, will rise to a planned 131mt in 2002. Capacity additions will come through public-sector investment and public-private joint ventures. Once additional capacity comes on stream, the remaining product imports will be mostly of kerosene and LPG.

Market Reform in the Oil Sector

Reforms in the oil sector began to stimulate production in 1991 by opening onshore exploration and production to private and foreign firms *via* production-sharing contracts. The importing and marketing of LPG, kerosene, low-sulphur heavy fuel and lubricants were also opened to the private sector. Plans are moving ahead for a partial privatisation of ONGC, IOC and GAIL, and to open the refining sector to private firms. In 1996, a second, three-stage phase of reform began. The government planned to withdraw first from refining (1996-1998), then from the upstream sector (1998-2000) and finally from marketing (2000-2002). The second phase includes dismantling the Administered Pricing Mechanism (APM) and the implementation of a free, market-determined pricing mechanism (MDPM) in the oil sector. In February 1997, the Government also endorsed a New Exploration Licensing Policy (NELP) to provide a framework to private newcomers in oil exploration and to allow public companies to diversify and integrate vertically. It advertised the sale of 48 oil and gas blocks 26 of them offshore, 10 onshore and 12 deep-sea).

Private companies play a growing role in Indian oil and gas. Major oil companies such as Shell, Occidental, Amoco, Chevron, BHP and Enron have bid for exploration blocks. While state firms still control retail gasoline

5. Most products are middle distillates such as kerosene and diesel oil.

sales, multinationals (Shell, Exxon, and Caltex) hold over a third of the lubricants market. Foreign companies, including British Gas, Enron and Total, are looking at prospects for LNG imports. Currently announced plans include 10-20 LNG terminals. Enron will start importing LNG from Oman in 2001 for its Dhabol power plant.

Coal

India is the world's third largest coal producer behind China and the United States. Its coal has high ash and low sulphur content. Resources in 1998 are estimated at 206 billion tonnes, with proven reserves of 75 billion tonnes or 7% of the world total.[6] Indian coalfields are mostly in the eastern part of the country. Domestic production stagnated around 290mt in 1998. Despite its large reserves India is not self-sufficient; it ranked as the tenth world importer of hard coal in 1998. Coal imports will come to 15mt in 1999.

Coal accounts for more than half of India's total conventional energy supply. Along with oil, it will continue to dominate the primary fuel mix. Coal's share of final energy demand will decrease slightly as the use of gas and oil increases. In 1998, thermal power plants took 72% of coal output. Cement and steel-making consumed the rest.

Coal India Ltd. (CIL), a centrally owned public-sector firm, produces 87% of domestic coal output. Singareni Collieries Co. Ltd. (SCCL), a joint public-sector undertaking between the Government of Andhra Pradesh and the Government of India accounts for another 10%. The fragile financial situations of both companies require restructuring, which has been delayed by political resistance, based mainly on fear of massive lay-offs.

Many of the problems that the Indian coal industry now faces arose from past pricing policies that led to an inefficient allocation of resources. The industry could not generate adequate investment for expansion, or for quality improvements such as washeries. Low-quality, unwashed coal dominate domestic supply. Demand for higher-quality grades cannot be satisfied except through imports, to which Indian coal is losing market share.

These problems prompted the start of reform in the coal sector in 1993, but reform has progressed slowly. Private-sector participation was permitted at first only in captive coal mining, which did not allow investors to sell surpluses on the market and was not well received. Import restrictions were lifted, and import duties were reduced. In 1996 prices of coking and superior grades of non-coking coal were liberalised. In February 1997, the

6. TERI (1999).

Minister of Coal announced a deregulation plan to open coal mining further to private investors — including foreign companies — and to end price and distribution controls by 2000.

Electricity

India had 92 229 MW of generating capacity in 1998. Electricity generated in fiscal year 1998 amounted to 448.6 TWh. Growth in power generation has slowed since 1996/97, but power shortages have also declined. The overall demand-supply gap decreased from 8.1% in 1997 to 5.9% in 1998. Peak power shortages nevertheless increased from 11.3% to 13.9%). In 1998 the availability of power increased for the first time in nearly a decade as the economy slowed. The share of hydroelectricity declined from 27.1% in 1991 to 18.6% in FY 1998.

Additions to overall generating capacity amounted to 4,242 MW in 1998, exceeding the target for the first time ever by almost 1,000 MW, although additions by the private sector, at 1,575 MW, fell short of the targeted 1 830 MW. In 1998, state governments through their State Electricity Boards owned 63.3% of generation capacity; the central government through National Corporations, 30.7%; and the private sector, 6%. The Power Grid Corporation (PGC) has exclusive responsibility for high-voltage bulk transmission. Most distribution rests in the hands of the State Electricity Boards (SEBs).

Reforms of the electricity sector in 1991 opened up supply and facilitated new private investment in generation. States received responsibility to attract independent power producers. Despite a large number of projects, very few plants actually got built due to procedural delays, changes in project-selection rules and other problems. To remedy these, the central government implemented a number of institutional changes in 1998. It set up a Central Electricity Regulatory Commission (CERC) to determine interstate power tariffs and to regulate tariffs for power plants belonging to the National Power Corporations. The States promised to create State Electricity Regulatory Commissions (SERC) to set tariffs and promote competition.

The government set up the Power Trading Company to buy power from large independents or from public plants and sell it to the SEBs or to large consumers. This will reduce the financial risk for private investors, who were hitherto reluctant to invest because of the generally poor financial situations of SEBs. These were in turn the result mainly of high subsidies, especially to farmers. The government aims to increase the share of hydropower to 25%, mainly by encouraging private investment. Future development of the power sector depends crucially on the SEBs' financial viability, operating efficiency and ability to attract private investors.

Combustible Renewables

Renewable energy other than biomass has growing importance in India, even if its share in the total primary energy supply remains small. The Indian government actively promotes non-conventional energy sources, including wind, hydro and photovoltaics. India was the world's fourth-largest wind-power producer in 1998, with a capacity of 1,024 MW, and third-largest in photovoltaics, with 47 MW.

Biomass, a huge and well-established part of the Indian energy supply, is used especially in poorer households. Its market flows and prices are difficult to monitor. This creates great uncertainty on how its share in total primary energy supply will evolve with pricing reforms in the energy sector. A removal of subsidies and the subsequent increase in commercial energy prices could have a substitution effect in the short run. It might increase biomass consumption, exacerbating environmental degradation, mainly through deforestation. On the other hand, environmentally friendly renewables might become more competitive.

Energy Subsidies

Overview

Most fuels still have administered prices in India, many of them subsidised and some taxed within a system of cross-subsidies that seldom balances. State intervention also affects energy prices through measures such as capital ownership in energy companies and railway freight rates that artificially lower the transport cost of coal over long distances.

In 1998, the weighted average price in the energy sector was around 14.2% below its reference price (Table 17). The energy use on which these estimations have been calculated represents 15.4% of the total conventional energy supply. The highest subsidy rate (52.6%) applies to kerosene used for cooking. LPG also enjoys heavy subsidies (31.6%). Coal, the most important product in overall energy use, sells at prices around 13.1% below the reference value for steam coal and 42.3% for coking coal.[7] Still, progress

7. These estimates might require adjustment in light of new information about transportation costs.

has been made. A similar analysis carried out at the beginning of the 1990s would have shown higher rates of subsidy than does Table 17. Several products that had subsidised prices until very recently, such as light and heavy fuel oils, are no longer receiving subsidies.

Table 17: **Indian Energy Subsidies: Summary of Results**

	Estimated Rate of Subsidy (% of reference price)[1]	**Potential Primary Energy Savings from Removal Subsidy (%)[2]**	**Estimated Economic-Efficiency Cost (billion rupees)**	**Estimated Budget Cost (billion rupees)**
Gasoline	0.0	0.0	0.0	0.0
Auto diesel	0.0	0.0	0.0	0.0
LPG	31.6	17.3	1.8	20.6
Kerosene	52.6	32.9	12.9	64.3
Light fuel oil	0.0	0.0	0.0	0.0
Heavy fuel oil	0.0	0.0	0.0	0.0
Electricity	24.2	0.0	27.2	187.3
Natural gas	22.5	16.6	2.0	22.4
Steam coal	13.1	16.5	4.6	50.4
Coking coal	42.3	24.1	1.3	11.1
Total[2]	**14.2**	**14.0 (7.2)[3]**	**60.6**	**356.2**

Notes: Calculations are based on 1998 prices and quantities. 1. Weighted average. 2. TPES saved/TPES for the sectors covered in the study. 3. Figure in parentheses is calculated using TPES for all sectors and fuels, including those not covered in the study.

Energy subsidies in India are regressive because only consumers with access to commercial energy can benefit from them. About half of all the states have yet to achieve full village electrification. Yet social equity once provided the rationale behind most of them. The subsidies on kerosene and LPG, for example, were designed to give the poor access to more advanced forms of energy than fuel wood. This approach may work for kerosene, but it remains highly questionable whether the poorest part of the population has access to fuels such as LPG or is connected to the electricity grid. For these reasons, a number of voices in India are asking for a larger debate to appraise the legitimacy of subsidies and their costs. A *Discussion Paper on*

Government Subsidies, tabled in Parliament in May 1997, called for a phased overall reduction of subsidies through an increase in user charges. It also recommended that subsidies apply exclusively to "merit" goods and services that have well-established positive externalities. The nation's fragile fiscal situation also provides a policy impetus to reduce subsidies. A large part of public expenditure goes toward them, rather than into more productive uses such as infrastructure investment.

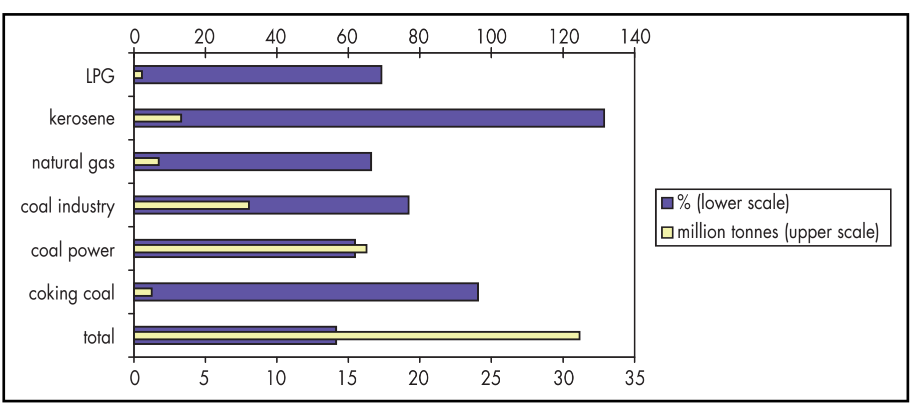
Impacts and Costs

Despite the declining overall rate of subsidy, the existing level still imposes a heavy cost on the Indian economy. The welfare (or efficiency) loss is estimated at Rupees 60.6 billion ($1.21 billion), or 0.3% of the GDP. It is highest in the electricity sector.

Subsidy elimination would reduce energy consumption, with potential positive effects for energy security and for CO_2 emissions. Estimates put energy savings from removing subsidies at 14% for the portion of primary energy supply taken into account here. The magnitude relative to total primary energy supply would be 7.2%. The 33 Mtoe of energy thus saved would come mostly from a reduction in steam-coal consumption by industry and in kerosene consumption by households, representing respectively 21.3% and 13.3% of the total reductions in gross calorific value (GCV).

Removing subsidies would bring a 14.1% drop in CO_2 emissions. The potential 124.6 Mt of CO_2 emission abatement (Figure 11) would arise from decreases in consumption of kerosene (kerosene emissions would decrease by 32.9%), LPG a 17.3% decrease and coal, used mainly in power generation. Steam-coal emissions would decrease by 16.5%, mainly from a 19.2% reduction in industry, and coking-coal emissions by 24.1 %.

Figure 11: **Potential Reductions in CO_2 Emissions through Subsidy Removal**



If all Indian subsidies were paid out of central government expenditure (which is not the case), the sum would amount to Rupees 356.2 billion ($8.6 billion), or about 15% of central government outlays.

Oil Products

Subsidies on oil and gas are very important in India, and the country depends heavily on imported oil products. In 1997/98 India imported 1.1 million tonnes of LPG, or 23.6 % of consumption and 3.8 million tonnes of kerosene (38.6%). Lowering subsidies on these products would improve energy security by reducing consumption. It would also ameliorate the financial situation of those public enterprises currently paying the subsidies. Kerosene and LPG have the highest subsidies, at 52.6% and 31.6% respectively. Gasoline and automotive diesel oil, on the other hand, are now priced at roughly their opportunity cost. These more realistic prices are among the first positive effects of the oil-price reforms that began in 1998. The subsidies on kerosene and LPG will go down gradually until 2002. At the end of January 1999, the subsidy on LPG fell by 14 Rupees per cylinder. According to official plans, LPG prices in 2002 will reach a subsidy level of 15% of the import-parity price, and the kerosene subsidy will reach 33.3% of import parity.[8] Because of the effects of cross subsidies and the policy of subsidy removal, the Oil Pool Account had amassed a surplus of approximately 79 billion Rupees at the end of 1998.

Coal

The subsidy on steam coal amounts to 13.1% and that on coking coal to 42.3%. Both subsidies have delayed the needed restructuring of the coal industry. Coal prices have often fallen below production costs, because official price revisions followed increases in input costs only with long lags and even then did not fully cover them. Heavy financial losses for the coal industry ensued. Subsidised railway freight rates for domestic coal increased demand, especially for low quality coal even from remote locations.

Reforms in the coal sector proceed gradually. Prices for coking-coal and higher-grade coal were freed in 1996 and 1997. Lower grades will be freed in January 2000. This last step is politically sensitive, because lower-grade production is very labour intensive. Prices adequately reflecting costs will facilitate both the location of new thermal plants near pitheads, to

8. C.M.I.E. (1999).

avoid high transportation costs, and near washeries, to make transportation more efficient.[9]

Electricity

The subsidy to electricity for household use is 63.8%.[10] Electricity rates generally fall far below costs. In 1997/98 the average tariff amounted to 1.8 Rupees/kWh; 0.3 Rupees/kWh for agriculture; 1.3 Rupees/kWh for the domestic sector; and 2.9 Rupees/kWh for industry. But average costs were 2.3 Rupees/kWh unit. Moreover, transmission and distribution losses amounted to 20.6 % in 1997/98 with some states recording losses of over 40%. Some 40%-50% of these losses came from inadequate metering. This meant poor financial performance for the SEBs — they had a negative 18% rate of return in 1998 — and reduced their ability to invest in new infrastructure and generating capacity.

The high subsidy rates also induce low consumption efficiency in households and obviously create vested interests. Furthermore, they produce low-quality service. The cross-subsidisation that the SEBs use to recover part of the subsidies to agriculture and households, encourage auto-production in those sectors, which must bear the costs. Auto-production touches about 20,000 mW, implying a loss of business for SEBs, the public power suppliers. The auto-producers are mainly industrial users, which prefer to produce their own more reliable, even if more expensive supply.

Reforms have been the slowest in the electricity sector. The central government has limited its action to authorising the states to continue subsidising the price of power for domestic and agricultural consumers, provided that they increasingly account for these subsidies in their budgets. Recent changes show that the government is finally moving ahead, however, as the budgetary costs of subsidies, estimated at 187.3 billion Rupees, not counting the agricultural sector, begin to place heavy weight on public finances. The creation of the CERC and the SERCs is one sign of progress. Future plans include allowing for frequency-linked tariffs and raising prices for all consumer categories to at least 50% of the average cost of supply. For agriculture, a minimum tariff of 50 paise/kWh has been agreed; it would improve the situation slightly but still leave a substantial gap between revenues and costs. Only a few states have implemented it: Haryana,

9. This has also been recommended by the Planning Commission, see Government of India (1996).
10. The calculation does not include electricity consumed by agriculture, where the subsidy level is even higher. Electricity consumption in agriculture amounted to 98.1 TWh in 1998, or 22% of total electricity generated.

Himachal Pradesh and Orissa.[11] The process of reforming the SEBs has started in some states. Orissa is the first to restructure its SEB, set up an SERC and plan for the privatisation of distribution and supply. It is expected that other states will follow this model and review their tariff schemes to reduce the strain on public finances and encourage private investment.

Conclusions

Energy subsidies remain significant in India. Originally legitimised by social policy, they nevertheless are far from progressive, and often even regressive. The more affluent benefit disproportionately from them, a situation identified in the government paper on subsidies of May 1997.

The government is aware of the need to reform and reduce subsidies and has in fact started reforms in all sectors, but at different speeds. The main factors favouring reforms, are the high public deficit, the low efficiency of public energy production, and a price structure that does not provide sufficient incentive for investment in oil and gas exploration, gas infrastructure, coal production and electricity production and distribution.

Political resistance slows subsidy removal. Yet consumers are increasingly aware of the low quality of service they receive, and some price increases would probably prove acceptable after subsidies are removed, so long as service quality improves. The government has started to implement plans to free the administered pricing schemes in the oil, gas and coal sectors, and is determined to reduce the subsidies on electricity and petroleum products. These reforms go in the right direction but they need to be carried further.

11. Government of India (1999).

CHAPTER 8
INDONESIA[1]

Indonesia is the world's largest exporter of liquefied natural gas (LNG) and an important oil producer. Its oil reserves are limited, however, and Indonesia will probably become a net oil importer in the next five to ten years, partly because of high subsidies on petroleum products that encourage domestic consumption. The recent decline in domestic demand and in demand from neighbouring Asian countries', in conjunction with recently agreed OPEC production quotas, may increase Indonesia's reserve/production ratio somewhat. Indonesia is arguably the country hit hardest by the Asian financial and economic crisis, with a decline in the economy of 13.7% in 1998. The economic crisis and the resulting IMF adjustment programme have given an impetus to energy market liberalisation and subsidy removal. First steps to remove the subsidies on kerosene and diesel oil, however, met with widespread protests and have been partly withdrawn.

Economic and Political Overview

The Indonesian archipelago has five main islands, 30 medium-sized islands and over 10,000 smaller ones. From 1967 to 1998, Indonesia was ruled by President Suharto, all executive powers being concentrated in the presidency. Until the onset of the Asian economic crisis in the middle of 1997, the economy grew by an annual average rate of 7%. The share of manufacturing in GDP increased from 8% to about 25% over those 30 years. Despite such robust growth, frequent criticism pointed to an over-concentration of wealth and economic activity among a privileged group in society, dubbed "cronies" and "conglomerates".

The share of the oil and gas sectors in GDP decreased from 10% in 1993 to 7.9 per cent in 1997, but oil and gas still accounted for 21.7% of the country's exports in 1997, $5.5 billion for crude petroleum, $4.8 billion

1. General references used for this chapter include: IEA (1998c), BP AMOCO (1999), Economist Intelligence Unit (1999b), World Bank (1999).

Table 18: **Key Economic and Energy Indicators, 1997**

Population (midyear, millions)	199.87
GDP (billion current Rupiahs)	625,506
GDP (billion current US$)[1]	214.99
Real GDP growth rate 1997 (1998) (per cent)	4.6 (-13.7)
GDP per capita (current US$)	1,076
TPES (Mtoe)	138.8
TPES per capita (toe)	0.69
TPES/GDP (toe/$1,000)	0.65
CO_2 emissions (1,000 tonnes)	256,515
CO_2 emissions per capita (tonnes)	1.28
CO_2 emissions/GDP (tonnes/$1,000)	1.19

Note: GDP has been converted into current US dollars at an average 1997 exchange rate of 2,909.4. The Rupiah fell from a pre-crisis level of about 2,340 Rupiahs per dollar to 14,900 in spring 1998. It has somewhat stabilised since then, at between 8,000 and 9,000 Rupiahs to the dollar. The wide currency swings since 1998, which rendered the calculation of reference prices meaningless, was the main reason why 1997 was chosen as the base year for the quantitative subsidy analysis of Indonesia.
Sources: IMF (1999), IEA (1999).

for gas and $1.3 billion for petroleum products. Japan has been the largest importer of Indonesian crude oil and LNG.

Rapid economic growth produced ballooning current-account deficits and large-scale short-term foreign borrowing by corporations and banks. The need to finance the deficits and meet debt-service obligations distorted the domestic interest-rate structure. Rising domestic interest rates and the peg of the Rupiah to the US dollar led to an appreciation of the Rupiah's real exchange rate in the first half of 1996. By early 1997, however, fears that the country's economy was overheating reinforced concerns about Indonesia's political stability. This made the Rupiah vulnerable to contagion by the currency crisis that began in Thailand in July 1997. The defence of the Rupiah was eventually abandoned and it was allowed to float in August 1997. The Rupiah's decline surpassed that of other Asian currencies; it fell at one point to less than 20% of its pre-crisis value.

With 75 per cent of Indonesia businesses in technical bankruptcy, the government turned to the IMF. In January 1998, the government announced a budget that markets believed was based on unrealistic assumptions about the economy, and the economy further deteriorated. In May 1998, following another agreement with the IMF, the government announced fuel price increases, which set off serious nation-wide protest. Suharto resigned as president on 21 May and Vice President Habibie succeeded him. Three IMF support packages added up to $43 billion.

Several measures were taken to open the political system. In November 1998, the People's Consultative Assembly passed a decree limiting the president's terms to ten years. The Parliament and the Assembly are expected to become more independent from executive control. The regions have been promised increased autonomy. Parliamentary elections took place in June 1999 and a presidential election will be held by the end of 1999.

Macroeconomic stabilisation and structural reform remain the keys to a revival of the Indonesian economy. The tight monetary policy prescribed by the IMF has been adopted. The real annual GDP growth rate was minus 13.7% in 1998 and the Asian Development Bank (ADB) predicts that the economy will be flat in 1999. Although the IMF's recommendations have sometimes been criticised as inappropriate, improvements have occurred in some macroeconomic indicators such as inflation and the foreign-exchange rate.

The agenda for structural reforms includes restructuring the banking sector, resolving the issue of external private debt and privatisation of state-owned enterprises. In order to attract foreign private capital once again, a step-wise reform of the legal framework for foreign investment is under way. The old framework was vague and gave a large amount of discretion to implementing officials. While the previous situation impeded long-term capital investment, short-term funds could enter and leave the country without any controls. As part of the return process, the role of the once all-powerful Capital Investment Coordinating Board (BKPM) is gradually being reduced.

Energy Sector Overview

Total primary energy supply (TPES) in Indonesia amounted to 139 Mtoe in 1997 (see Table 19). Oil and gas, of which Indonesia is a major producer, account for almost 60% of its TPES. Per capita energy use is low compared to OECD countries.

Oil and Gas

Indonesia, Asia's second-largest oil producing country after China, has been an OPEC member since 1962. Its annual oil production, most of it in Central Sumatra, was 1.5 mb/d in 1997, unchanged from 1996

Table 19: **Indonesian Energy Balance, 1997 (Mtoe)**

	Coal	Oil	Gas	Electricity	Other	Total
Indigenous production	33.9	77.3	63.0	0.0	47.3	221.5
TPES	9.5	50.5	31.5	0.0	47.2	138.8
TFC	2.7	42.6	9.9	5.7	44.4	105.2
Industry	2.7	10.7	7.9	2.7	0.0	24.0
Transport	0.0	19.9	0.0	0.0	0.0	19.9
Residential/commercial	0.0	11.0	2.0	3.0	44.4	60.3
Non-energy	0.0	1.1	0.0	0.0	0.0	1.1

Source: IEA (1999).

production, but was reduced in June 1998 to 1.28 mb/d in line with Indonesia's OPEC quota. Proven oil reserves were five billion barrels at the end of 1998 (14% cent lower than in 1994), equivalent to 9.2 years of production at current levels and to 0.5% of world proven reserves. Primary oil consumption came to around 0.9 mb/d in 1998, with the remainder exported. Oil meets about 36% of Indonesia's total primary energy requirements. Because indigenous oil production will probably decline as domestic consumption rises, Indonesia may well become a net oil importer by the early years of the new century. Export earnings from crude oil, gas and petroleum products declined from $11.7 billion in 1996/97 to $10.3 billion in fiscal year 1997/98.

Indonesia is the largest LNG exporter in the world. Gas production totalled 63 Mtoe in 1997, with about half of it exported in the form of LNG. About 18% per cent of Indonesia's primary gas supply went into power generation and 25% to industry. Proven gas reserves were 2.05 trillion cubic metres (tcm) at the end of 1998, equivalent to 29.9 years of production at current levels and to 1.4% of world proven reserves. Despite the size of the gas reserves, gas accounted for only 23% of Indonesia's total primary energy supply in 1997, compared to over 35% for crude oil and oil products.

Pertamina, the Indonesian national oil and gas company, has exported LNG to Japan since 1977, to Korea since 1986 and to Chinese Taipei since 1990; Indonesian LNG makes up for more than a third of Japan's LNG imports. The Natuna gas field in the South China Sea is believed to contain 1.3 tcm of recoverable gas reserves, but its high CO_2 content (approximately 71%) raises its development costs. The forecast decline in Asian LNG caused by the economic crisis has led to strong competition.

Following the Indonesian government's pledge to accelerate political and economic reforms, it ordered Pertamina to review contracts with politically-connected companies. Several contracts with companies linked to the Suharto family were cancelled. At present Pertamina is trying to restructure itself to become more efficient and competitive. It has split its exploration and production, transport and processing, and marketing divisions into business units. These units will eventually become separate companies, which will have to compete with other domestic and foreign companies, while Pertamina will function as a holding company.

The revision of oil and gas law has offered a major challenge. The government submitted a reform bill to the parliament, but in August 1999, it is still under debate. The bill would terminate Pertamina's monopoly on the processing, transportation, storage and marketing of oil and natural gas. It would transfer to the government Pertamina's role in guiding and supervising contractors in exploration and exploitation activities, and would allow for more flexible contract arrangements for foreign participation in exploration. The bill would also liberalise the downstream sector. Refining, with a total capacity of slightly less than one million barrels per day, was particularly hard hit by the crisis. Attempts to attract foreign investors into it have failed so far, despite far-reaching incentive schemes.

Coal

Indonesian coal reserves amount to 5,220 million tonnes: 770 million tonnes for anthracite and bituminous, and 4,450 million tonnes for sub-bituminous and lignite. Production has grown steadily in recent years, from 6.5 Mtoe in 1990 to 33.9 Mtoe in 1997. Similarly, exports increased from 3 Mtoe in 1990 to 25.5 Mtoe in 1997. In 1997, 64% of domestically used coal was used in power generation and the rest in non-metallic industry.

Electricity

Of the 74,832 GWh of electricity generated in Indonesia in 1997, coal contributed 31%, oil 30%, gas 28%, hydro 8% and geothermal 3%. Before the crisis, power output surged by 11% annually between 1990 and 1997 — and gas-fired power generation soared, from a low base, by over 45% a year. Of the installed capacity of 21 GW, 82% is thermal, 15% hydro and 3% geothermal. The state-owned, vertically integrated utility, PLN (*Perusahaanumum Listrik Negara*), dominates the electricity sector. It has two subsidiary generating companies, GENCO 1 and GENCO 2. Some independent power producers (IPPs) also operate. The economic crisis hit PLN hard. Due to a number of previously agreed power-purchase agreements (PQAs), it had to continue to purchase electricity from IPPs, mostly in US dollars, while its customers paid in rapidly developing Rupiahs. In September 1998, the government announced plans to separate PLN from the system and allow foreign companies to sell electricity directly to customers, but no substantial progress in this direction has occurred to date.

Hydro, Nuclear and Renewables

In 1997, renewables contributed about 47.3 Mtoe, or about one-third, to the total primary energy supply. Most of this 44.5 Mtoe took the form of combustible renewables and waste used as non-conventional energy in rural households. Biomass holds a high share in energy supply because 115 million Indonesians, almost 60% of the total population, remained unconnected to the electricity grid in 1997. This reflects partly a still low level of economic development and partly the technical difficulties of establishing universal access in a country composed of a multitude of islands.[2]

Indonesia has a small but active niche market for renewable energy. The American company Unocal, for instance, started operating a geothermal power plant with a capacity of 55 MW in October 1997, in collaboration with local companies. Capacity is projected to expand eventually to 330 MW, which over a projected lifetime of 30 years would substitute for 100 million barrels of oil.[3] In January 1997, the World Bank financed through the Global Environment Facility a project installing home-sized photovoltaic systems to produce electricity for a million rural households. Finally, Indonesia has three small nuclear research reactors. Plans for twelve nuclear power plants with a combined capacity of 7 GW were cancelled in the wake of the economic crisis.[4]

Energy Subsidies in Indonesia

Energy subsidies have played a major role in the economics and politics of Indonesia. The estimated difference between reference prices (international market value) and domestic consumer prices amounted in 1997, to 40.2% for automotive diesel, 55.2% for kerosene, 45.5% for light fuel oil and 28.4% for natural gas. Weighted by the gross calorific value of all energy used, this amounts to an average subsidisation of 27.5%.

2. Versak (1997), p.1.
3. UNOCAL (1997).
4. US Energy Information Administration (1999b), p. 4.

Table 20: **Indonesian Energy Subsidies: Summary of Results**

	Rate of Subsidy (per cent of reference price)[1]	**Energy Saved by Subsidy Removal (per cent)[2]**	**Economic Efficiency Cost (billion Rupiahs)**	**Budget Cost (billion Rupiahs)**
Gasoline	0.0	0.0	0.0	0.0
Auto diesel	40.2	12.1	175.9	2,918.7
LPG	0.0	0.0	0.00	0.0
Kerosene	55.2	31.3	706.0	4,288,4
Light fuel oil	45.5	23.4	310.4	2,467.5
Heavy fuel oil	7.8	3.6	2.6	141.5
Electricity	0.0	0	0.0	0.0
Natural gas	28.4	16.9	318.0	1,863.4
Coking coal	0.0	0.0	0.0	0.0
Steam coal	0.35	0.0	0.0	4.7
Total	**27.5**	**13.9 (7.1)[3]**	**1,512.9**	**11,684.3**

Notes: Calculations are based on 1998 prices and quantities. 1. Weighted average. 2. TPES saved/TPES for the sectors covered in the study. 3. Figure in parentheses is calculated using TPES for all sectors and fuels, including those not covered in the study.

The funds needed to maintain such high degrees of subsidisation are staggering. For the 1998/99-budget period, Pertamina estimated subsidies to be 54.2 trillion Rupiahs ($3.6 billion at the exchange rate of 1/15 000, which was used to compute the subsidy amount).[5] This amounts to over half of the government budget in 1997.[6] According to a different source, actual government outlays for fuel subsidies in fiscal year 1997/98 amounted to a still enormous but more probable 15.8 trillion Rupiahs, more than 15% of the 100 trillion Rupiah budget.[7] This number comes close to the 10% estimate, which was arrived at in this study, exclusively on the basis of price and cost data, without prior knowledge of the Indonesian government budget.[8]

5. US Embassy Jakarta (1998a), p. 1.
6. The reported Pertamina estimate was based on unrealistic assumptions on the exchange rate and internal demand. Also, the 1998/99 budget, which is not yet available, may be larger.
7. US Embassy Jakarta (1998b), p. 3.
8. Calculated on the basis of energy content. That the vast majority of energy subsidies in Indonesia actually *do* show up in the government budget is an exception among the countries studied here. It results from the very explicit policy goal to subsidise domestic consumption and the very transparent manner in which this subsidisation was administered. In other countries, the link between effective subsidies (end-use price lower than reference price) and government budgets is less direct.

Whatever their exact size, fuel subsidies in Indonesia constitute an enormous drain on government finances. Unsurprisingly, plans existed in early 1999 to ask for an additional $10 billion in external funds to help finance the budget deficit for fiscal 1999/2000.[9, 10]

While they are an important fiscal issue, energy subsidies in Indonesia are also an eminently political matter. When the economic reform process began in spring 1998, the IMF demanded a phase-out of fuel subsidies by the end of 1999 as one of the conditions for its support package. In May 1998, subsidies for a range of petroleum products were reduced and prices rose by over two-thirds. The population reacted with widespread and violent protests, and the government had to revise the reductions several days later.[11] The issue is far from resolved. In January 1999, the government pledged not to increase the prices of most fuel products during the fiscal year 1999/2000.[12] Fuel subsidies provide one of the main contentious points in the new energy bill currently under debate in parliament, with widespread concern amongst lawmakers that subsidies would be discontinued in a liberalised market.[13]

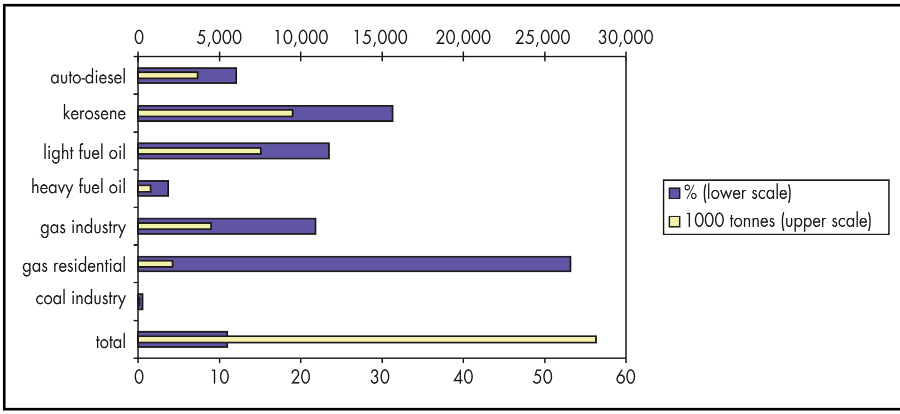
CO_2 emissions savings, like energy savings, due to subsidy removal are comparatively small (about 11%) due to the fact that the main subsidies accrue to petroleum products with comparatively low elasticities of demand. Figure 12 provides the details on those savings.

Conclusions and the Way Forward

Indonesia currently faces extraordinary challenges after the major financial, economic and political upheaval of the last two years. Given the importance of the energy sector for its current-account position and the value of its currency, as well as the size of its energy subsidies, energy questions loom large in Indonesian policy debates. Moreover, Indonesia will have to face in only a few years the transition from net-exporter to net-importer status in oil. It is more than usually difficult to draw firm conclusions about Indonesia's future and to provide unambiguous policy

9. US EIA (1999b), p. 1.
10. Equally unsurprisingly, Pertamina, which is also the main importer of crudes and refined products, experienced cash flow problems due to the failure of the government to transfer the full amount of fuel subsidies. In order to resolve the cash flow problem, the government chose to back Pertamina's letters of credit through Bank Indonesia to make them acceptable to Indonesia's foreign trading partners.
11. US Embassy Jakarta (1998b), p. 3.
12. US EIA (1999b), p. 2.
13. OPEC (1999), p. 17".

Figure 12: **Reductions in CO_2 Emissions through Subsidy Removal**



proposals. Clearly, energy subsidies are a major drain on the government budget, when funds are extremely scarce and demands for government support very high. Equally clearly, however, energy subsidies are an extremely sensitive issue for a population that finds itself suddenly impoverished and of which a large part has to struggle for survival.[14]

Any government will have to tread a difficult path between the economically desirable and the politically feasible. In the long run, the subsidisation of fuel use becomes a costly and ineffective substitute for a social safety net, especially for a country which faces the depletion of its oil reserves sometime during the next decade. Currently, fuel subsidies accrue to the whole population and less than proportionately to the most disadvantaged two-fifths of it. It is plainly imperative to provide the minimum requirements for existence to the needy parts of the population. At the same time, efforts to attract foreign investment to the exploration and production of energy resources — through increased transparency and flexibility, as well as the liberalisation of the downstream sector — clearly need to continue. Adoption of the proposed energy law would provide an important signal in this respect.

Given Indonesia's precarious reserve position, oil's more than one-third share in primary energy supply seems unsustainably large. The use of gas, where the reserve situation is somewhat better, should be accelerated. Increased use of coal for power generation might also be considered, even

14. The World Bank estimated that at the end of 1998, the number of Indonesians living below the poverty line reached nearly 40% of the population. (US Energy Information Administration, 1999, p. 1).

if it could imply a further increase in the carbon intensity of the economy.[15] The net effect of a reduction of fuel subsidies would in any event reduce CO_2 emissions, even if some substitution towards coal took place. Indonesia also has some room at the margin for renewables. Together with hydro and geothermal resources, off-grid solutions such as photovoltaic power might find a role, given the technical difficulties of providing universal grid access in this thousand-island state.

15. Indonesia's carbon intensity per $1,000 of GDP of 1.19 tonnes of CO_2 (1997) is rather low, compared with the average for non-OECD countries of 1.85 tonnes per $1,000.

CHAPTER 9
IRAN

Iran has among the largest oil and gas reserves in the world, and arguably the lowest energy prices. The government now wants to reduce direct oil subsidies to improve its fiscal position and to prevent rising domestic oil consumption from crowding out important oil export revenues. Although the administration understands the benefits of reducing oil subsidies, political obstacles hinder reform. In addition, the government continues to subsidise natural gas as part of an ambitious plan to substitute gas for domestically consumed oil, thereby freeing up more oil for export. Overall, removing subsidies could give Iran 48% savings in energy and a 49% reduction in CO_2 emissions.

Economic and Political Overview

The Islamic Republic of Iran, as its name implies, has a dual structure. It is a theocracy under Ayatollah Ali Khamenei and a constitutional republic headed by President Seyyed Mohammed Khatami. President Khatami has moved gradually to open the political process, with the support of a young population, two-thirds under the age of 25. The President has also received backing from Ayatollah Khamenei, at the apex of the formal power structure as Chief of State and head of the Judiciary. A popularly-elected 270-seat unicameral Islamic Consultative Assembly, or *majlis*, develops and passes legislation and a Council of Guardians approves all laws to ensure that they are in accord with Islamic principles. Until August 1999, when Khatami's government encouraged the formation of the Islamic Labour Party, Iran had no political parties.

Iran's economy is a mixture of central planning, state ownership of oil resources and other large enterprises, village agriculture, and small-scale private trading and service ventures. More than 80% of business and industry is owned by the government. Oil is the backbone of the economy, so Iran passes through boom and bust periods coinciding with fluctuations in oil prices. A sharp fall in oil revenue in 1998 caused the economy to contract by about 2% hard on the heels of record 5.2% growth in 1996.

Attempts to diversify the economy have met only limited success. Hydrocarbons contribute 16% to 20% of the country's GDP and roughly 80% of its foreign currency earnings (83% in the year ending March 1998), far less than the almost 100% of the mid-1970s. The non-oil portion of GDP has recently shown sporadic growth. It increased by 5% overall in 1996/97 compared to 1.5% for oil, then rebounded from a 2% decline in 1997/98 to rise by over 40%, to $817 million, between March and June 1999. One of the largest non-oil exports is carpets, followed by agricultural products.[1]

Table 21: **Key Economic Indicators for Iran, 1997**

Population	60.7
GDP (1997 rial)	280,731
GDP (1997 US$)	160.1
Real GDP growth rate 1997	3.3
GDP per capita (1997 US$)	2,638.7
Inflation (% change in consumer price index)	17.1

Source: IMF (1999).

The collapse in crude oil prices in 1998 drove total export revenue down nearly 20% to $8.4 billion, with a $3.8 billion drop in revenue from crude oil. The effect on the current account has been dramatic, with the balance falling from a surplus of $930 million in early 1998 to a $1.7 billion deficit in early 1999. Iran has asked the IMF for a $500 million credit line to make up for shortages of hard currency earnings in early 1998, although Iranian finances have improved with rising oil prices.[2] Pushed by the fall in oil prices, the government deficit rose to IR17,712 billion in the year ending March 1999 from IR2,869 in the year ending March 1998. As the primary recipient of crude-oil revenue, and with government expenditure comprising 29% of GDP, the government is the dominant economic force in the country. In 1997, earnings from oil and gas made up more than 60% of total government revenues, while taxes made up about 20%. The government has taken steps to improve tax collection and tax revenue more than doubled in 1998/99, accounting for over 30% of the total budget, while the oil and gas share has been halved to 31%.[3]

1. *Middle East Economic Digest (MEED),* 16 July 1999, 2 April 1999.
2. *MEED*, 25 June 1999.
3. *Middle East Economic Survey (MEES)*, 2 August 1999.

The Iranian oil industry has to some extent replaced U.S. firms such as Exxon and Texaco with Asian companies, particularly from Korea and Japan, after the US implemented comprehensive sanctions against Iran in 1995. Japanese companies are the largest foreign lifters in Iranian fields, with French companies making significant strides. Japan has become Iran's largest market, taking 15.1% of total exports in 1998, and the third largest exporter to Iran, behind Germany and Italy. In the early 1990s, the United States was the second largest market for Iranian exports. Notwithstanding the political profile of US sanctions, however, the main impediments to foreign investment have so far been the commercial and political conditions on offer for potential investors.

Non-oil export growth is also constrained by a dual exchange-rate regime, introduced in May 1994. The first "official" rate is IR1,750 to the US dollar. It applies to oil and gas export receipts, imports of essential goods and services, and imports related to large projects. The second export rate of IR3,000 to the dollar applies to non-oil export receipts.[4] Since 1995 the government has sought to unify the exchange rates; it is believed to be considering declaring a single exchange rate in 2000.

Energy Sector Overview

Although Iran is the second largest oil producer after Saudi Arabia and holds the world's fourth-largest pool of proven oil reserves, its production has dropped by more than a third from a peak of over 6 million b/d in 1974 to about 3.6 million b/d today. Years of political isolation, recurring war and US sanctions have deprived the oil sector of needed investment. Iran's share of total world oil trade peaked at 17.2% in 1972, then declined to 2.6 % in 1980, but has since recouped to roughly 6%.

In the first six months of 1999, Iran exported an average of 2.25 mb/d, but burgeoning domestic demand for refined products, encouraged by subsidies, is jeopardising oil export growth.[5] Iran has turned to natural gas as a substitute for the domestic consumption of petroleum products. In 1997, petroleum products accounted for 62% of primary energy supply, compared to over 80% thirty years ago; natural gas made up more than the difference, increasing its share from 1% to 35%. Coal, hydro, and nuclear each account for less than 1% of indigenous production and primary energy supply (Table 22).[6]

4. All calculations in this chapter are based on the "official" exchange rate unless otherwise specified.
5. *MEES*. 26 July 1999.
6. With a negligible share of energy demand attributed to coal and sparse coal price data, coal is assumed to be unsubsidized.

Table 22: **Energy Balance for Iran, 1997 (Mtoe)**

	Coal	Oil	Gas	Electricity	Other	Total
Indigenous production	0.6	184.6	38.4	0.0	1.4	224.9
Total primary energy supply	0.9	67.6	38.3	0.0	1.4	108.3
Total final consumption	0.6	50.7	28.7	6.1	0.7	86.8
Industry	0.6	7.5	17.1	1.9	0.2	27.2
Transport	0.0	20.1	0.0	0.0	0.0	20.1
Residental/commercial	0.0	16.0	11.6	3.4	0.0	31.0
Non-energy	0.0	2.9	0.0	0.0	0.0	2.9

Source: IEA (1999).

Energy intensity (Table 23) is high in Iran compared to OECD countries. Iran's overall energy intensity, measured as the ratio of TPES to 1,000 of GDP (in 1990 US dollar), was 0.68 toe in 1997, compared to 0.21 toe for OECD and 0.80 toe for non-OECD countries. The multitude of exchange rates, however, renders it difficult to calculate a reliable value for the energy intensity of GDP. Using the 1997 black market rate of about IR4,600 to the dollar, energy intensity more than triples to 1.8 toe per 1,000 dollar of GDP from the 0.68 toe obtained with the "official" rate. The "export" rate yields an energy intensity of 1.2. A measure of energy intensity less dependent on the specific exchange rate chosen is the ratio of energy demand to population. In 1997, this measure was 1.8 toe *per capita* per year. That is high compared to other non-OECD countries (0.95 toe) but lower than the OECD value of 4.6 toe.

Table 23: **Key Energy Indicators for Iran, 1997**

TPES (Mtoe)	108.3
TPES per capita (toe)	1.8
TPES/GDP (toe per 1,000 current US$)	0.7

Source: IEA databases.

The National Iranian Oil Company (NIOC) controls all the country's oil operations. The National Iranian Gas Company manages collection, treatment, processing, transmission, distribution and exports of natural gas and gas liquids. Oil and gas company budgets are part of the national budget, and there is little distinction between the companies and the oil ministry. The Oil Minister serves as chairman of NIOC and of the gas and petrochemical companies.

Foreign Investment

Limited access to foreign investment in the recent past has generated both financial and technical constraints on the state-run energy industry. The administration of President Khatami has, however, opened nearly all aspects of economic activity to foreign investors, calling for the modernisation of the oil industry especially, including comprehensive restructuring and decentralisation. He has also called for renewed major exploration efforts, something Iran has not seen in nearly three decades.

In 1998, the *majlis* approved a plan to seek $9.5 billion in foreign investment, primarily in the energy sector. The Ministry of Petroleum then announced bidding through a "buy-back" program for 43 petroleum projects worth $8 billion. This is the largest investment opportunity in Iran since the 1979 revolution. Under the buy-back program, a foreign partner arranges the financing, carries out the development work, and receives a fixed return of 15% to 20% once the field is producing. By early 1999, NIOC had invited tenders for some 50 projects under the buy-back model. Arco (US) tendered one such in hopes that by the time the contract is agreed upon US sanctions will be relaxed. Other US firms have followed, establishing preliminary contacts with NIOC.

Government officials have tried to open up the energy sector and other areas of the economy even further. The head of the *majlis* oil committee announced a proposal in July to amend the constitution to allow direct foreign ownership of energy resources in remote or economically depressed regions.[7] To boost investor confidence, the government has established an IR385 billion fund to pay compensation for some of the factories seized after the 1979 revolution. State holding companies are preparing over 3,000 factories for privatisation in 2000. Iran has also expressed interest in joining the World Trade Organisation. While the need to open the economy and to improve the conditions for foreign investment is clearly understood, decisive policy steps, however, still depend on the outcome of difficult negotiations between the different factions dominating Iranian politics.

Oil

Iran holds the world's fourth-largest proven oil reserves, over 90 billion barrels, or 9% of the world total. After the 1980-1988 Iran-Iraq War,

7. *MEED*, 16 July 1999.

NIOC launched a reconstruction program to restore damaged fields. Output recovered from 2.5 million b/d in 1988 to 3.4 mb/d in 1994. Since 1994 production has averaged 3.6 mb/d, still half that in 1974 levels; Iran is the second-largest OPEC producer. The government expects that foreign finance and technology will help raise Iran's output to seven million b/d by 2020. The one-million km^2 exploration area that is now open for tender is expected to boost Iran's reserves by more than 20 billion barrels. Enhanced Recovery Technology, which uses gas or water injection to improve the yield of an oilfield, has proved effective in increasing the long-term recovery rates of Iran's mature fields.

Iran imported nearly 20% of its oil supply in 1997 to meet burgeoning domestic demand for middle and light distillates. Although the country has achieved self-sufficiency in fuel oil and lubricants, it continues to import diesel oil and kerosene, which together account for roughly 60% of domestic fuel use. According to NIOC, Iran will need to build a new 200,000 b/d refinery every two to three years just to keep pace with domestic demand growth.

Natural Gas

Iran's natural gas reserves are estimated at over 23 trillion cubic metres, the second largest in the world after Russia's, and roughly 15% of total world reserves. The largest field, South Pars, is estimated to contain 6.8 trillion cubic metres. NIOC estimates that South Pars has a gas production potential of up to 226 million cubic metres per day. The field is expected to produce \$35 billion to \$40 billion worth of gas over a 40-year period. In 1997, the French company Total, Russia's Gazprom and Malaysia's Petronas signed a \$2 billion buy-back contract to develop the South Pars field during Phases 2 and 3. Two Korean firms, Samsung and Daelim, won contracts for development work in Phase 1.[8] The largest external investment in Iran in recent years has been in gas production, as Iran hopes to switch domestic industrial customers to gas, freeing crude oil for export. By mid-1999, over \$1 billion had been invested in South Pars alone.

Gross production of natural gas increased to 38.4 mtoe in 1997, more than doubling in ten years as total final consumption increased by two-thirds. Almost all gas is domestically consumed; no gas exports have been recorded since 1995. Nevertheless, Iran continues to promote export markets for its natural gas, with NIOC planning to export 12.7 million

8. *MEES*, 2 August 1999.

cubic metres per day by 2000 *via* three gas export pipelines to Turkey, Armenia, and Nakhichevan. Pipelines to Europe and Asia are also planned.

Electricity

In the year ending March 1998, Iran produced 97 billion kWh of electricity, over two-thirds from oil, one-fifth from gas, and 7% from hydropower. The fuel composition of electricity has stayed steady in recent years, at between 60% and 70% from oil and 15% to 20% from gas. While the share from gas has increased, hydro has accounted for an increasingly smaller share, 7% in 1997/98 compared to 13% in 1993/94. More than eight GW of hydroelectric generation capacity is under construction, however, with a dozen new dams to go up during the next several years. Currently Iran has five small nuclear reactors, which perform a negligible portion of electricity generation.[9]

Iran's annual electricity consumption is growing at an annual rate of 7.5%. According to the Ministry of Energy, $500 million per year in foreign investment will be required to keep up with demand. Output growth slowed to 5.4% in 1997, down from 7% in 1996 and 11% ten years ago. The Ministry of Energy is encouraging foreign investment in the electricity industry on a Build, Operate and Transfer (BOT) basis. Under this model, private investors construct the power station, sell power to the electricity industry for an agreed price, and then transfer the station to the electricity industry. The government retains control over electricity generation and distribution.

Energy Subsidies

Overview

The average overall subsidy rate is 80.4%, reflecting an average of 83.3% for refined oil products, 77.8% for natural gas and 48.1% for electricity (Table 24).[10] Automotive diesel oil and natural gas for power generation and households are among the most heavily subsidised fuels, with 93.9%, 93.8% and 92.5% subsidy rates respectively.

9. Iran is a signatory to the Nuclear Non-Proliferation Treaty.
10. Petroleum weighted by gross calorific value.

Table 24: **Energy Subsidies of Iran: Summary of Results**

	Estimated Rate of Subsidy (% of reference price)[1]	Potential Primary Energy Savings from Subsidy Removal (%)[2]	Estimated Economic-Efficiency Cost (billion rial)	Estimated Budget Cost (billion rial)
Gasoline	59.4	20.2	214.5	2,128
Auto diesel	93.9	50.4	817.2	3,246
LPG	89.7	67.9	237.4	699.6
Kerosene	89.5	66.0	895.5	2,696.8
Light fuel oil	82.3	57.7	557.6	1,903.8
Heavy fuel oil	88.1	63.4	465.0	1,466.0
Electricity	48.1	28.0	242.2	1,734.6
Natural gas	77.8	55.1	2,814.5	9,168.1
Steam coal	0.0	0.0	0.0	0.0
Coking coal	0.0	0.0	0.0	0.0
Total[2]	**80.4**	**53.5** **(47.5)[3]**	**6,244.0**	**23,042.8**

Notes: Calculations are based on 1998 prices and quantities. 1. Weighted average. 2. TPES saved/TPES for the sectors covered in the study. 3. Figure in parentheses is calculated using TPES for all sectors and fuels, including those not covered in the study.

Impacts and Costs

The economic-efficiency costs of subsidies are estimated at IR6.2 trillion ($3.5 billion), or 2.2% of 1997 GDP, the bulk of it is arising from by natural gas subsidies. If all subsidies were directly paid by the government, they would have amounted to an estimated IR23 trillion or $13.2 billion in 1997, close to 10% of GDP and over 30% of government expenditures. In contrast, the IMF documented IR5.9 trillion ($3.4 billion) in total budgetary subsidies in 1996/97, with wheat subsidies accounting for two-thirds of that total.[11] In addition, according to the IMF, government expenditures for petroleum, fuel, and power, totalled IR7 trillion ($4 billion) in 1997 or 8% of the budget. Reconciling these estimates means that other factors besides direct government payments are lowering prices. In fact, the IMF estimates implicit subsidies from the

11. IMF (1998a).

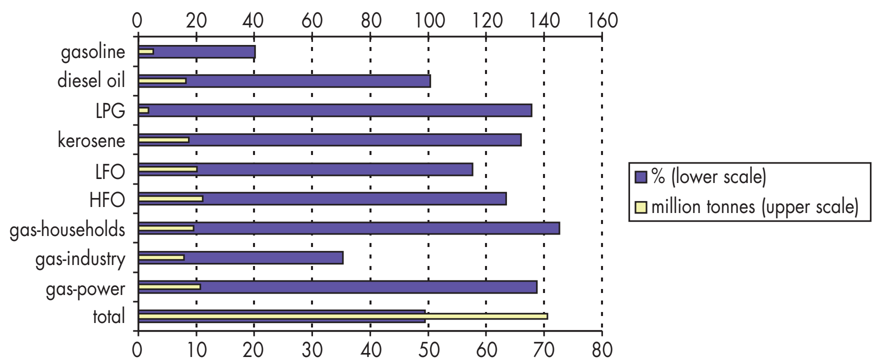
underpricing of petroleum products in comparison to international price levels at about IR30 trillion ($17.1 billion) alone for 1997/98.[12]

Table 25: **CO_2 Emissions Data for Iran, 1996**

CO_2 emissions (million tonnes)	285.3
CO_2 emissions per capita	4.7
CO_2 emissions/GDP (tonnes/1000 1996 US$)	1.78

Source: IEA databases.

Figure 13: **Reduction in CO_2 Emissions through Subsidy Removal, 1997**



Removing subsidies would lead to an estimated 47.5% reduction in energy use, or 51 Mtoe, and a 49.5% reduction from 1997 CO_2 emissions (see Table 25 and Figure 13). Reduced consumption of oil products would make up for the majority of total CO_2 emissions reductions, or 85 million tonnes. Iran is the second largest emitter of CO_2 in the Middle East, with slightly more than 1% of world emissions in 1997, just behind Saudi Arabia.

Subsidies throughout the Energy Sector

Buy-Back Programs. Buy-back contracts that guarantee risk-free returns between 15% and 20% could constitute subsidies to oil exploration and production. The unfavourable oil price environment in early 1998 sparked interest among international companies. Although returns are

12. According to the IMF, underpricing of diesel oil represents the largest implicit subsidy for petroleum products.

limited, many oil companies have voiced satisfaction with the buy-back agreements on offer.[13] If oil prices drop, the government is obliged to supply more oil to meet the agreed money figure; the company and the government set a price per barrel before monthly crude volume is assigned to a foreign firm. The buy-back method is vulnerable to criticism, in that the fixed return effectively subsidises exploration as the government bears the risk, and in that monthly price setting is inefficient. Nevertheless, Iran, unlike other countries with low-cost oil fields such as Saudi Arabia, Kuwait, and Iraq, has taken the lead in opening up the oil sector to foreign investment.

OPEC Compliance. In December 1998, Iran's actual compliance was only 8% of its targeted compliance, the lowest of OPEC countries.[14] In July 1999, however, Iran announced that it was fully complying with the oil output cuts it agreed at the March OPEC meeting, reducing its oil output to 3.359 million b/d. Non-compliance has two effects: (1) it could lower domestic and international prices (partially offsetting increases from other countries' compliance), and (2) it allows a country to benefit from price increases without shouldering its portion of the cost burden. Lower prices and the increased supply that result from non-compliance could also stimulate domestic consumption.

Transport Subsidies

The number of registered vehicles in Iran grew hundred-fold between 1990 and 1996, to 2,900,000. The primary source of the increase is a domestic auto industry that receives government subsidies, is shielded from competition and is helped by subsidised petrol prices. The government hopes that Iran will develop into a major regional centre for car production, and encourages investment in the industry. The goals of reducing domestic consumption of petrol and subsidising a fledgling car industry work against each other. The expansion of car use has inevitably led to further in domestic petrol use, especially as the most common vehicle on the roads, the locally produced Paykan, is highly fuel-inefficient.

Oil

Prices for oil products in Iran are among the lowest in the world. Automotive diesel oil, which receives the greatest subsidies of any petroleum

13. *Wall Street Journal*, 5 March 1999: Bahree, Bhushan, "Fields of Dreams: Big Oil is Gushing About Big Bucks to be Made in Iran."
14. EIU (1999c).

product, cost one-sixteenth the international price in 1997; diesel oil also holds the largest share of domestically consumed petroleum products. Until they doubled in March 1995, domestic prices of refined products had changed little since 1960 meaning there were large declines in real terms. In the context of Iranian inflation, which has ranged from the high teens to nearly 50% in 1995, dropping back to 19.3% in 1998, nominal yearly price increases for domestic fuel products, in lace since 1950 as part of the country's Second Five Year Development Plan, have had a negligible impact on relative prices.

The government estimates the average annual volume increase in domestic fuel consumption at 5.5% in 1998, well above the real economic growth rate. In an effort to curb demand, the *majlis* approved a 75% increase in domestic gasoline prices in January, raising them from IR200 per litre to IR350, considerably less than the 275% increase advocated by the government. As of March 1999, when the price hikes were implemented, consumers could purchase 50 litres of petrol per month at a subsidised price, subject to annual increases; they pay a multiple of this price for additional fuel.

The crowding out of oil exports by domestic consumption served as the impetus for the price increases. The continuing rise in domestic fuel consumption has also siphoned off potential export revenue. Imports of refined products grew by 60% between 1995 and 1997, while exports of crude and refined products increased by just 0.25%. Smuggling of Iranian fuel to neighbouring states, where oil products cost up to five times as much, poses another problem. Because Iran imports oil products to meet domestic demand, their low prices translate into large subsidies. The government sells imported products cheaply, although they are imported at high world prices. The estimated IR23 trillion-budget cost of subsidies in 1997 roughly equalled to total oil export revenues in 1995/96.

Natural Gas

With the hope of boosting oil exports to between 3 and 3.75 million b/d by 2000, the government has instituted programs to substitute gas for oil. The First Five-Year Development Plan (1989-1994) did not use price adjustments to control the consumption of refined products, relying instead on the substitution of natural gas. During the Plan period, production of natural gas increased by 88%, from 18.1 Mtoe in 1989 to 34.2 Mtoe in 1994; in addition, the number of houses connected to the network rose from 1.3 million to 4 million. The government continues to encourage the substitution of natural gas, actively promoting it as a motor fuel, for example. Between 1989 and 1997, gas consumed by the transport sector increased by 60%, while residential use doubled and industrial use nearly tripled. In 1997/98, the Ministry of Petroleum earmarked some $570 million for the domestic gas sector to increase production capacity, build high-pressure gas delivery systems and connect additional cities to the gas network.

Government has actively subsidised natural gas to bring parity between gas and petroleum products. In 1997, it offered a direct subsidy of IR122 per cubic metre of gas consumed or 32% of the reference price for households, 57% for industry and 77% for power generators.[15] Even if natural gas and petroleum products do reach price parity in terms of calorific value, it might not be profitable to switch fuels, given the cost of equipment change. Thus, Iran may end up offering special incentives for capital investment, or could even subsidise gas infrastructure development directly. In addition, oil companies may receive favourable rates for natural gas used for oil recovery.

Electricity

The Ministry of Energy receives subsidies in the following forms: favourable exchange rates, access to state-owned banking facilities, low taxes, exemptions from some commercial rules and low fuel prices for electricity generation.[16] The subsidy paid by the Ministry to generators and distributors is the amount by which costs exceed tariffs. To increase electricity generation and transmission efficiency, where losses amount to an estimated $4 billion a year, the government has proposed breaking up Tavanir, the state power-generation monopoly, into competing private companies.

Conclusions

Fundamental pricing reform is central to the efficient functioning of the energy sector in Iran. In the second Five-Year Development Plan, the government has taken necessary steps in this regard, adopting the goals of reducing reliance on oil revenues, unifying the exchange rate and reducing subsidies while making them more transparent in the budget. These reforms

15. IMF (1998a).
16. Power plants are the fastest-growing sector of natural gas consumers, with a 19% increase in 1997/98 over 1996/97. Government subsidies to natural gas are ultimately passed through into cheaper electricity.

should continue with the country's third five-year plan due to begin in March 2000. The government appears to value the potential economic benefits of removing subsidies, particularly for oil consumption:

- an improved fiscal position for the government;
- greater availability of oil for export;
- a reduction in Iran's vulnerability to oil price fluctuations, as subsidies to oil products would no longer crowd out domestic consumption of non-oil goods; and
- increased energy security as the time-line for reserves is lengthened.

Applying similar analysis to policies that affect the consumption of natural gas has not been a government priority. As with oil, subsidising natural gas may place added strain on the government budget and threaten energy security and future gas export revenue. The government appears ambivalent with regard to energy subsidies. It aims to abolish subsidies for oil but increase them for natural gas. With regard to foreign investment, though, most government officials agree that it is a key ingredient to growth, and Iran is taking bold steps to open its economy. The government's move to decentralise the electricity industry is an important step in encouraging investment, which could lead to increased technical efficiency. In addition, the Iranian buy-back model, though subject to some criticism, is one of the first moves by a country in the Middle East to open its low-cost oil fields to foreign investment.

Although the government recognises subsidy removal as good policy, especially for oil products, political obstacles as well as concerns over its distributional effects hinder reform. Per capita, Iran is among the poorest nations in the Middle East. Annual GDP per person is about $2,500 using the "official" exchange rate, but using the black-market rate could push it down substantially, to just over $600 per head. To improve the situation for the most vulnerable segments of the population, the government is considering a comprehensive anti-poverty program with expanded provision of food, clothing, health care, education, social security and bank credits. The government also aims to raise the amount of subsidies targeted to vulnerable groups and in pilgrimage centres. As overall subsidies are phased out, the government may obtain discretionary funds to institute such a specialised and more effective income-distribution policy. However, Iran faces the difficult task of convincing vulnerable segments of the population that any short-term dislocations caused by subsidy removal will be outweighed by long-term benefits.

CHAPTER 10
SOUTH AFRICA

Subsidies on energy consumption in South Africa are small and limited mainly to electricity sales. Liquid-fuel production subsidies, not revealed by the price-gap analysis, appear less significant in terms of price impacts and cost. The removal of current subsidies on electricity and a subsequent adjustment in the price of coal to power stations would choke off some demand for electricity and therefore demand for inputs to power generation. The economic costs of the subsidies to households inherent in the electrification scheme, a key element of the Government's Reconstruction and Development Programme, must be weighed against the potentially large social and political benefits from long-term economic development of poor townships and rural communities. Larger subsidies to industry are much harder to justify and would probably be politically easier to remove.

Economic and Political Overview

The Republic of South Africa is a federal state, consisting of a central government and nine provincial governments. The Head of State is the President, elected by the National Assembly. Historic all-races elections in 1994 led to the formation of a multi-ethnic, multiparty central government led by the African National Congress. Following elections in May 1999, President Thabo Mbeki took over from Nelson Mandela, the first black African president of the country, who retired. South Africa's international relations were normalised after the 1994 elections, which brought an end to the policy of racial separation called apartheid.

The South African economy is reasonably developed but has enormous income disparities. The average income among the white population is close to that of Western Europe, while the black community, the bulk of the population, is little richer than the rest of sub-Saharan Africa. Mining and manufacturing together account for around a third of the formal economy. Foreign trade is relatively large, with a quarter of GNP going to exports, of which minerals, notably gold and coal, normally constitute more than 40% and commodities as a group about two-thirds. Table 26 provides some key economic and energy indicators for the country.

Table 26: **Key Economic and Energy Indicators in South Africa, 1997**

Population (mid-year, millions)	43.3
GDP (current rand, billion)	594.9
GDP (current US$, billion)	129.2
Real GDP growth rate over 1996 (%)	1.7
GDP per capita (current US$)	2,981
Inflation (annual % change in consumer price index)	8.5
TPES (mtoe)	107.2
TPES per capita (toe)	2.47
TPES/GDP (toe/$ million)	829
Energy production/TPES	1.33
CO_2 emissions (million tonnes)	345.3
CO_2 emissions per capita (tonnes)	8.0
CO_2 emissions/GDP (tonnes/$1,000 of GDP)	2.7

Sources: IEA databases, IMF (1999).

Since 1994, the Reconstruction and Development Programme (RDP) has formed the centrepiece of the Government's economic policy. It aims to extend the economic benefits enjoyed previously by a minority to the majority of the population, through improved education, health-care and housing, infrastructure development, welfare and affirmative actions to promote the interests of disadvantaged ethnic groups. Energy, through an ambitious electrification plan, plays a key role in this process. The energy sector is also explicitly targeted by liberalisation policies intended to roll back the system of protectionism and state intervention that had developed under the apartheid regime. Partly in response to disappointing early results of the RDP, the Government launched a new economic strategy, Growth, Employment and Reconstruction (GEAR) in June 1996.

The economy grew at an average annual rate of just over 3% from the middle of 1993 to early 1997, following the country's worst recession since the war at the beginning of the 1990s. Economic growth has since faltered, due partly to the impact of the Asian financial crisis on export demand.

GDP grew by only 1.7% in 1997 and by an estimated 0.1% in 1998.[1] Despite a 20% drop in the value of the rand against the dollar, exports actually fell in 1998 by 8%. Gold exports, in particular, have dropped sharply, due both to lower production and a fall in the world price. By contrast, consumer-price inflation has fallen from 8% on average in 1994-1997 to 6.5% in 1998.

Energy Sector Overview

South Africa is extremely well endowed with natural resources, including energy. Coal, the main fuel produced meets three-quarters of the country's primary energy needs. The relative abundance of coal and low production costs has encouraged the development of energy-intensive industries, including the mining of non-energy minerals and heavy manufacturing. South Africa consequently has one of the most energy-intensive and, since most of the coal is burnt in power stations, electricity-intensive economies in the world. In December 1998, the Government issued the final draft of an energy White Paper, which proposes the deregulation of the liquid-fuels sector and a restructuring of the electricity sector to pave the way for competition in generation.

Demand Trends

Total primary energy supply has grown steadily since 1993, in line with economic recovery, at an average annual rate of 4.4% to 1997. Energy use had fallen slightly from 1988 to 1992 as a result of the recession. Demand for solid fuels has grown most rapidly over the past 15 years,

Table 27: **South African Energy Balance, 1997 (Mtoe)**

	Coal	Oil	Gas	Nuclear	Electricity	Other	Total
Indigenous production	124.7	0.4	1.5	3.3	0.0	12.2	142.1
TPES	80.5	10.4	1.5	3.3	-0.6	12.0	107.2
TFC	16.4	16.9	0.6	0.0	13.3	8.7	56.0
Industry	13.9	1.5	0.6	0.0	7.9	1.6	25.4
Transport	0.0	12.7	0.0	0.0	0.4	0.0	13.1
Residental/commercial	2.5	2.0	0.0	0.0	5.0	7.2	16.7
Non-energy	0.0	0.7	0.0	0.0	0.0	0.0	0.7

Source: IEA (1999).

1. EIU (1999d).

driven by steadily rising electricity use. Primary supply of oil has been virtually stable since the 1970s. The increase in demand for oil products, especially gasoline, has been met mostly with synthetic fuels derived from indigenous coal and natural gas. Table 27 provides data on energy balances.

Coal

South Africa is a major coal producer and the world's third largest coal exporter. Recoverable coal reserves, most of them bituminous with relatively high ash and low sulphur content, are estimated at 55 billion tonnes, equivalent to 250 years of production at the 1997 level of 220 million tonnes. Three fields — Waterberg, Witbank and Highveld — hold 70% of recoverable reserves. Domestic consumption amounted to 154 Mt and net exports 64 Mt in 1997. The national power utility, Eskom, is the largest single consumer of steam coal. Sasol, a coal-mining and synthetic-fuels company, is the second largest. In 1995, Sasol's coal liquefaction plants processed nearly 40 million tonnes, of which 28 million tonnes were for liquid fuels production. Its own mines met 95% of these requirements. Other large end-users include the steel, cement and brick and tile industries.

Several privately owned companies mine coal, including Ingwe (the largest), Duiker, Sasol, Amcoal and Anglovaal. Most producers are planning mine expansions or new mine developments to boost production. The mining companies own and operate for their own use the Richards Bay Coal Terminal, through which most coal exports are handled. In principle, shareholders may individually and collectively agree to allow non-shareholders to export coal through the terminal, but entry terms are restrictive, particularly for small exporters. Construction of a new terminal at Richards Bay, the South Dunes project, is under discussion.

Sasol is the world's largest producer of synthetic oil derived from coal, with two liquefaction plants at Secunda, for producing finished oil products, and at Sasolburg, for making petrochemicals. Total production capacity amounts to 150 thousand barrels per day. The plants also produce around 1.6 billion cubic metres of synthetic gas, distributed mainly to industrial end-users. The company was set up by the Government in the 1950s to help reduce the country's dependence on imported oil in the face of the UN-led embargo on oil exports to South Africa. It was privatised in 1979.[2] The company is investing 860 million rand in upgrading and expanding the Secunda plant.

2. The embargo was lifted in 1993.

Oil and Natural Gas

South Africa has limited oil and gas reserves. Proven oil reserves amounted to 29 million barrels at the beginning of 1999. Crude oil production averaged a mere 11,000 b/d in 1998, far short of what is needed to meet refined product needs, which averaged 460,000 b/d. Oil imports, almost entirely as crude, meet around 60% of the deficit, with synthetic fuels from coal and gas meeting the rest. Indigenous and imported crude is processed at four refineries with a total distillation capacity of 470,000 b/d, supplying both domestic and regional markets.

Proven natural gas reserves total 22 bcm. The entire present annual production of 1.8 bcm comes from the F-A offshore field in Mossel Bay in Cape Province and is processed in a gas-to-liquids (GTL) plant, producing a range of synthetic petroleum products. The state-owned company, Mossgas, is responsible for both the production and the transportation to shore of gas and condensate, as well as processing. The project began operation in 1993. A second field, E-M, located 49 km west of F-A, is due to be commissioned in 2000, when F-A reserves are expected to start to run out. The E-M field, costing R2.2 billion to develop, is expected to produce sufficient gas for the GTL plant to run at capacity until 2006.

A key element in the government's energy White Paper is the deregulation of the liquid-fuels industry. From exploration to retailing, the industry has become enveloped in a complicated web of interdependent protectionist policies, including market-sharing agreements, trading restrictions and price controls. These policies reflect the energy-security priorities of the embargo era. The White Paper proposes the removal of:

- controls on oil prices and on wholesale and retail margins;
- restrictions on trade, including limitations on opening service stations and self-service points (known as the rationalisation plan);
- a ban on vertical integration in the downstream sector; and
- subsidies on synthetic fuels production by Sasol and Mossgas.

Price controls would fall away over a three-to-five year period, to protect service station operators and soften the impact on jobs, while subsidies would end within a year. The paper also recommends continuing the obligation on oil companies to buy Sasol's liquid fuels output (including conventional products from its interest in the Natref refinery) until Sasol has established its own retail network. At present, a government-brokered "upliftment" agreement effectively prevents Sasol from engaging in retail activities. In the context of the general policy to promote the participation of black people, the Government has suggested that it would be desirable that deregulation go hand in hand with a higher level of participation by black people in the oil industry.

Soeker, the state-owned oil and gas exploration and production company, is being restructured to separate its operational and regulatory functions, but there are no immediate plans to privatise it. The Government decided in 1995 to privatise Mossgas, but reversed its decision in 1996 after rejecting the bids received as unacceptable.

Electricity

State-owned Eskom produces around 95% of South Africa's electricity, which represents over half the total for Africa. Eskom's 32 GW of capacity is mostly coal-fired, with one nuclear plant at Koeberg providing 1.8 GW. Hydropower capacity is 0.6 GW and pumped storage 1.4 GW. The utility also owns and operates the national transmission system and is a major distributor and retailer of electricity. It exports power to five southern African countries. Around 400 municipal authorities, some of which also generate part of their own requirements, also carry out local distribution, accounting for around 40% of sales to end-users.

The Reconstruction and Development Programme includes an aggressive plan to expand household electrification. At the end of 1997, only 59% of homes were supplied with electricity, although this figure was up from 43% in 1993. The Government has set a goal of 75% of electrification by 2000, equivalent to adding 1.75 million extra homes from 1994. In most cases electrification involves connection to the national grid, but solar applications are now being promoted in remote areas. Eskom carries out and finances most connections. Connection rates have been lower in regions where distribution is the responsibility of local authorities, which often do not have sufficient funds to finance grid extensions. Low electricity use by most newly connected homes means that income from them is insufficient even to cover running costs. The Government has taken steps, including setting up an electrification fund, to boost connections through direct and indirect subsidies.

The energy White Paper sets out the principles of how the Government intends to restructure the electricity-supply industry. Eskom's generation, transmission and distribution activities will be unbundled, with the aim of introducing competition into generation through the sale of Eskom-owned, mothballed stations and the development of new independent power projects. In addition, the White Paper envisages that Eskom will form joint ventures with local authorities to create five regional electricity companies. The Government has not yet reached a decision on the exact method of restructuring.

Energy Subsidies

Overview

Consumption subsidies in South Africa are generally small and limited primarily to electricity (Table 28). Domestic coal prices appear to fall slightly below reference prices, although this may reflect quality factors. There are also some production subsidies, mostly for oil. These subsidies are not quantified by the price-gap analysis. Overall, the estimated weighted average rate of energy-price subsidy, expressed as a proportion of the reference price, lies around 6%. The subsidy on electricity due to underpricing amounts to about 20%.

Table 28: **South African Energy Subsidies: Summary of Results**

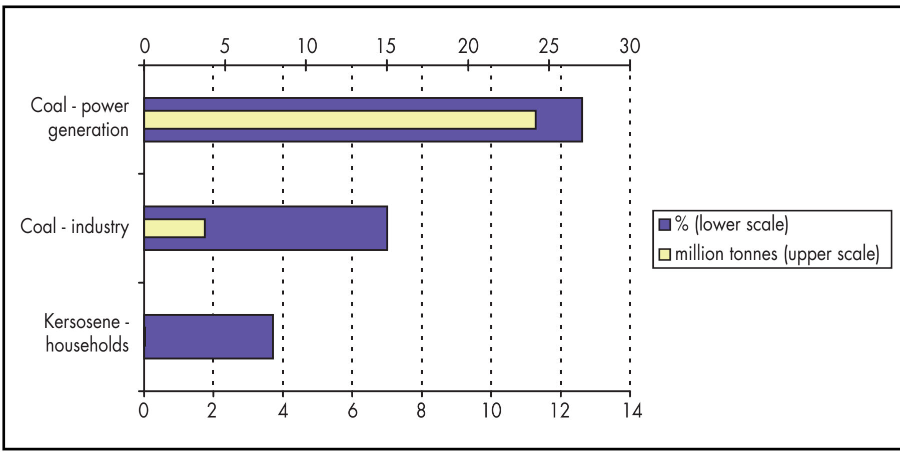
	Estimated Rate of Subsidy (% of reference price)[1]	Potential Primary Energy Savings from Subsidy Removal (%)[2]	Estimated Economic-Efficiency cost (million rand)	Estimated Budget Cost (million rand)
Gasoline	0.0	0.0	0.0	0.0
Auto diesel	0.0	0.0	0.0	0.0
LPG	0.0	0.0	0.0	0.0
Kerosene	2.0	1.0	1.0	53.5
Light fuel oil	0.0	0.0	0.0	0.0
Heavy fuel oil	0.0	0.0	0.0	0.0
Electricity	20.3	10.8	351.6	6,102.7
Natural gas	0.0	0.0	0.0	0.0
Steam coal	8.1	11.1	8.3	237.1
Coking coal	0.0	0.1	0.0	0.0
Total[2]	**6.4**	**8.8** (6.4)[3]	**360.9**	**6,393.3**

Notes: Calculations are based on 1998 prices and quantities. 1. Weighted average. 2. TPES saved/TPES for the sectors covered in the study. 3. Figure in parentheses is calculated using TPES for all sectors and fuels, including those not covered in the study.

Impacts and Costs

Consumption subsidies have a relatively modest impact on energy consumption and related emissions. The removal of these subsidies would reduce primary energy use by 6.4% and energy-related CO_2 emissions in those sectors covered by the study by an estimated 8.1%. Coal accounts for almost all of the 6.8 Mtoe of primary energy that would be saved each year. Virtually all of the reduction in CO_2 emissions from subsidy removal would come from lower coal use in power generation, due mainly to lower demand for electricity (Figure 14).

Figure 14: **Reduction in South African CO_2 Emissions through Subsidy Removal**



Source: IEA.

The economic-efficiency cost is estimated at R360 million and the notional budget cost (were all subsidies to be paid out of government funds) at around R6.4 billion. The potential revenue from CO_2 permit trading, based on an assumed carbon value of \$27 per tonne of carbon dioxide, comes to around R1 billion. The costs of electricity subsidies are borne directly by Eskom and the municipal distributors, since they could be charging higher prices. To the extent that Eskom pays coal prices below the true market level, the mining companies bear the cost.

Coal

An analysis of coal prices to domestic markets suggests that current prices may be slightly below the true market value, based on the netback value of exported coal adjusted for differences in calorific value and indicative transportation costs. The price difference for coal sold to Eskom for power generation is around R2.8/tonne or 7% of the estimated market value. In practice, this difference may be explained by differences in quality other than calorific value, such as ash or sulphur content, by contractual factors and by statistical discrepancies.[3] Coal prices were deregulated in 1988. The Government does not directly intervene in negotiations between the coal mining companies and buyers. Eskom, as the single buyer, may be able to exert a degree of bargaining power to lower prices. Nonetheless, the main reasons for extremely low coal prices (equivalent to around $8 per tonne for Eskom and $15 per tonne for industry) are low production costs, because most coal comes from surface mines, and low transportation costs, because markets generally lie close to the mines. Domestic prices may also be depressed slightly by restrictions on access to the Richards Bay Coal Terminal for non-shareholders.

Oil and Natural Gas

All subsidies in the oil and gas sectors go to producers, result in higher prices to end-users, and thus do not show up in the price-gap analysis. They are both direct, through explicit payments to the synthetic fuel producers, Sasol and Mossgas, and indirect, through price and margin controls and trading restrictions, including market-sharing agreements.

The total economic-efficiency cost of all the producer subsidies is difficult to quantify but probably significant. One indicator of efficiency is pre-tax final selling prices, which are typically higher than in most OECD countries.[4] In addition, the Government imposes a levy specifically to cover the cost of subsidy payments to Sasol and Mossgas. It determines these payments by the difference between the cost of importing crude oil to produce the same products and a reference crude-oil price.[5] Wholesale prices, which apply to both conventional and synthetic products, are set in accordance with international markets. The subsidy payments, which effectively guarantee prices of Sasol and Mossgas products, come from the Equalisation Fund (EF), which is financed by a levy on fuel sales. The fall in world oil prices in 1998 led to higher payments from the EF and a corresponding hike in EF levies. Gasoline and diesel levies were raised in

3. Differences of contract length and pricing formulas between domestic supply and export contracts can also result in divergences between prices effective under current contracts.
4. See IEA (1996).
5. $18 per barrel in 1997, $17 in 1998 and $16 in 1999.

October 1998 from one SA cent/litre to eight SA cents/litre. In total, current EF levies generate around R1.5 billion annually. Higher prices in 1999 should mostly remove the need for further payments, once the deficit in the EF, which ballooned in 1998, has been made good.

Electricity

Electricity sales in South Africa are generally subsidised through the underpricing of power sales and connections, as well as the non-payment of bills. The estimated average rate of subsidisation (the price subsidy as a proportion of the reference price) runs somewhat higher for industry at 24%, than for households at 10%, despite the high costs of the campaign to extend electrification to poor urban and remote rural areas. This may reflect how some municipal distributors mark up electricity rates to household customers to help finance other municipal services. State-owned Eskom handles most electricity sales to industry. Any under-charging by Eskom contributes to maintaining the competitiveness of South African industrial products traded in international markets.

The issue of non-payment has grown in recent years: outstanding bills, caused by ordinary debt problems and deliberate non-payment, reached about R1 billion (compared to total Eskom revenues of R15 billion) by 1996. Cross-subsidies caused by inconsistencies in setting national and regional transmission tariffs also present a concern.[6]

Conclusions

The price-gap analysis does not reveal many of the energy subsidies in South Africa, because they go to producers and suppliers in a form that results in higher, not lower, prices to end-users. Subsidies on the production of liquid fuels, especially those derived from coal and natural gas, are most significant. Significant consumption subsidies apply to electricity sales, particularly to industry. Although our analysis suggests that coal prices to Eskom and industry fall slightly short of the full market value based on export sales, quality and/or contractual differences may explain the gaps.

In practice, the removal of current subsidies on electricity and/or any upward adjustment in the price of coal to power stations would have no impact on the fuel mix in power generation. This is the case because of the limited potential for substitution of coal with other energy sources, due to its exceptionally low cost and the lack of competitively priced local

6. This issue was raised in the IEA's 1996 review. See IEA (1996), pp.139-140.

alternatives. Any increase in coal and electricity prices would, however, choke off some demand for electricity and therefore demand for inputs to power generation. This would result in a disproportionately larger reduction in CO_2 emissions because of the dominance of coal in power generation.

The economic costs of the subsidies to households inherent in the electrification programme must be weighed against the potentially large social and political benefits from the long-term economic development of poor townships and rural communities. Concerns exist nonetheless about a lack of transparency in current financing arrangements and about differences in the level of subsidy among supply areas. The higher subsidies for industry, which entail much larger economic costs, are much harder to justify and would probably be politically easier to remove. Cross-subsidies in the electricity-supply industry will also need attention. Unbundling of Eskom's generation, transmission and distribution businesses, as proposed in the 1998 White Paper, would pave the way for the establishment of a coherent, transparent and cost-reflective pricing methodology.

CHAPTER 11
VENEZUELA

Venezuela heavily subsidises most energy sources and fuels, reflecting the historical significance of petroleum production and exports to the economy. In most cases, price controls hold prices down below true supply costs. Subsidies have a significant impact on energy consumption and related emissions, and engender sizeable economic costs. Primary energy use in the sectors covered here is estimated to be 25% higher, and energy-related CO_2 emissions to be 26% higher, than they would be if no subsidies existed. Almost half of the more than 14 mtoe of primary energy that would be saved annually by removing those subsidies would result from lower natural gas use in industry and a further third from lower gas use in power generation. The government has committed itself to energy-sector restructuring, including the opening up of the sector to private investment and the modernisation of the regulatory regimes governing oil, gas and electricity. Price reform remains critical to the overall success of this process. Political instability and the likelihood of social unrest that would result from raising energy prices, notably gasoline and electricity, make the process of subsidy removal difficult.

Economic and Political Overview

Venezuela is a federal republic with a congressional system. President Hugo Chavez, whose party, *Movimiento Qunita Republica* (MVR), forms part of a three-party ruling coalition, took office in February 1999 on a platform of constitutional, political and economic reform.

Petroleum has provided the backbone of the Venezuelan economy since the late 1920s. Despite attempts to diversify the economy through investment in agriculture, iron and steel, and tourism, oil still accounts for between 70% and 80% of the country's export earnings, 25% to 35% of GDP and around half of government revenues. (Table 29 provides basic economic and energy information.) The dependency on oil makes the economy highly vulnerable to price fluctuations in international markets. Previous governments tended to pursue expansionary economic policies during times of high oil prices, such as during the 1970s and early 1980s, but encountered fiscal and balance-of-payments difficulties when oil prices weakened, for example in 1986. Boom-and-bust economic cycles, exacerbated by the use of oil and gas resources as a means of political patronage, have tended to promote political instability and social unrest.

Table 29: **Key Economic and Energy Indicators, 1997**

Population (midyear, millions)	22.8
GDP (current bolivares, billion	43,212
GDP (current US$, billion)	88.4
Real GDP growth rate over 1996 (%)	-0.7%
GDP per capita (current US$)	3,881
Inflation (annual % change in consumer price index)	50
TPES (mtoe)	57.5
TPES per capita (toe)	2.4
TPES/GDP (toe/US$ million)	650
Energy production/TPES	3.55
CO_2 emissions (million tonnes)	144.4
CO_2 emissions per capita (tonnes)	6.3
CO_2 emissions/GDP (tonnes/$1,000)	1.6

Sources: IEA databases, IMF (1999).

Venezuela's recent economic performance has mirrored the volatility of oil prices. After a year of strong economic growth of almost 6% in 1997, the Venezuelan economy contracted by an estimated 0.7% in 1998 with the collapse in world oil prices. Although interest rates have risen sharply, inflation remains high at 36% in 1998. The federal fiscal deficit has risen to more than 4% of GDP, more than 6.5% if the states' debts are included, and unemployment increased to around 11.5% by late 1998. The recent recovery in world oil prices is expected to lead to improved business and economic conditions from the second half of 1999.

The new government is addressing acute short-term fiscal difficulties largely through increased taxation and better tax collection. Efforts to reduce spending have been only partly successful. Debt-service payments account for between 30% and 40% of the federal budget.

Increased lending has been negotiated with the Inter-American Development Bank, and the government is keen to obtain additional credit from the World Bank as well as renegotiate the terms of its external debt. The government plans to privatise some state industries, including electricity companies and aluminium plants, to bolster revenues. Congress passed an Enabling Bill in April 1999 granting the President the right to rule by decree in most areas for up to six months, which gives him the power to issue new debt without congressional approval. Authority over oil legislation remains with Congress.

Energy Sector Overview

Total primary energy use in Venezuela amounted to 57.5 Mtoe in 1997 (Table 30). Oil and gas, of which Venezuela is a major producer, account for over 90% of requirements. Per capita energy use and energy intensity, *i.e.* energy use per unit of GDP, are low compared to OECD countries, but high relative to the rest of Latin America. Carbon intensity and per capita emissions are even lower relative to the OECD area, due to reliance on gas and hydropower and the very limited use of coal.

Table 30: **Venezuelan Energy Balance, 1997 (Mtoe)**

	Coal	Oil	Gas	Electricity	Other	Total
Indigenous production	3.4	166.1	29.0	0.0	5.5	204.0
TPES	0.3	22.9	29.0	0.0	5.3	57.5
TFC	0.3	19.7	11.1	4.9	0.4	36.4
Industry	0.3	3.0	10.3	2.3	0.2	16.1
Transport	0.0	12.6	0.0	0.0	0.0	12.6
Residental/commercial	0.0	2.7	0.8	2.5	0.1	6.3
Non-energy	0.0	1.4	0.0	0.0	0.0	1.4

Source: IEA (1999).

Demand Trends

Venezuelan energy demand has risen rapidly in recent years, driven by economic growth and low prices. Total primary energy supply (TPES) grew at an average annual rate of around 4% over the ten years to 1997, although growth rates have fluctuated enormously from year to year according to international oil prices and macroeconomic performance. Electricity consumption grew by 45% over 1986-1997, an average of just under 4%

per year. Net oil exports have also risen sharply in recent years, from 79 million tonnes in 1986 to 141 million tonnes in 1997.

Oil and Gas

Venezuela is the world's sixth largest oil producer, with output averaging 3.1 million b/d in 1998. Proven oil reserves amounted to 72 billion barrels at the beginning of 1998, equivalent to 63 years of production at current levels and 7% of world proven reserves. Most of the reserves are heavy or extra heavy oil. The government agreed in March 1999 to limit its oil production to 2.7 million b/d under an agreement negotiated by OPEC, of which Venezuela is a founding member. The national oil company, *Petroleos de Venezuela* SA (PdVSA), agreed to absorb all the cutbacks. Primary oil consumption amounted to around 475,000 b/d in 1998, with the remaining 2.6 million b/d exported. Of these exports, around 0.7 million b/d were shipped as refined products. Local consumption and exports include orimulsion, a boiler fuel composed of pulverised natural bitumen suspended in water and used mainly in power generation. Refinery capacity amounts to 1.2 million b/d. Oil meets around 40% of the country's total primary energy requirements.

Venezuela holds most of the natural gas reserves in Latin America. Proven reserves, mostly associated with oil, were estimated at 4 trillion cubic metres, or 143 trillion cubic feet, at the beginning of 1998. Gas production totalled 29 million toe (around 30 bcm) in 1997, all of which was consumed locally. About 60% of Venezuela's gas is used by the oil industry as on-site fuel or for re-injection — or is flared, because output exceeds domestic needs and exporting the gas as LNG is not economic. About a quarter of total production is used in power generation, 6% in the petrochemical sector and the rest in industry, notably aluminium and steel, and in the commercial sector. Gas in compressed form has increasing use as transport fuel. The government promotes it as an alternative to gasoline and diesel, to exploit its abundant reserves and to offset the effect of possible oil-price increases in the future. Natural gas accounts for about 50% of the country's primary energy supply.

PdVSA was created as a state-owned company in 1976, upon the nationalisation of the oil and gas industry. When it encountered difficulties in financing programmes to bolster production capacity, the government opened the oil sector to private investors in 1992. PdVSA has signed a number of joint-venture agreements with international oil companies, including projects to develop heavy crude reserves using upgrading technology. PdVSA auctioned off the operating rights to a number of mature fields to private Venezuelan and foreign companies in two rounds in 1996 and 1997. A new hydrocarbons bill, aimed at improving the coherence and transparency of the legal framework and reducing taxes and royalties to encourage investment in the upstream and downstream oil sectors, is expected to be presented to Congress in the second half of 1999.

The impact of the oil price collapse in 1997/8 led the new government to reduce PdVSA's investment programme sharply and to increase cash remittances by the company through higher corporate taxes. PdVSA's investments in the Venezuelan oil sector will probably total less than half the $11.2 billion originally planned for 1999. In February, the budget office estimated that PdVSA would have to borrow $2.33 billion to finance operations and investments in 1999.

The new President has announced plans to tighten control over the operation of PdVSA because of complaints of poor management — although the company is considered by many analysts as one of the most efficient and better-run state oil companies — and a lack of accountability. Senior management has been replaced and there are plans to set up a special tax office to monitor the company's spending. The President has ruled out privatisation of PdVSA, which had been proposed as part of the solution to the government's budgetary difficulties. He has suggested that the company could be restructured to create a separate entity handling non-associated natural gas production and distribution activities, and that this offshoot could be sold to private investors. The government is drawing up a new Gas Bill, which is expected to include the establishment of an independent regulatory authority and an opening of the gas sector to increased private-sector participation. The government also signed a protocol with Brazil in June 1999, to establish a joint-venture oil company, Petroamerica, to be jointly managed by PdVSA and Petrobras, the state-owned Brazilian oil company. Petroamerica will pursue projects in upstream and downstream oil.

Coal

Coal reserves estimated at over nine billion tonnes are largely unexplored and under-exploited. Recoverable reserves are estimated at 900 million tonnes from open-cast mines and 600 million tonnes from underground mining. Production has grown steadily in recent years, reaching 3.4 Mtoe in 1997, of which 3.2 Mtoe were exported. The rest was consumed mainly in the Venezuelan cement industry. Coal mining is carried out by the state-owned company, *Carbozulia*, and by private companies.

Electricity

Venezuela has around 20 GW of generating capacity, of which about three-quarters is hydropower. In 1997, production was 77 TWh, half of which was supplied to industry. Per capita electricity consumption is roughly a third that of OECD countries but is among the highest in Latin America. Peak demand nonetheless remains well below capacity, partly because of an imbalance between investment in generation and in distribution. A 400 km transmission line is being built to export 200 MW of surplus power to Brazil, under a 1997 agreement between Venezuela's largest utility, EDELCA, and the Brazilian company *Electrenorte*. In order to meet an expected increase in domestic requirements, construction of the Caruachi hydropower project started in 1998. The facility will provide 2,200 MW of power when commissioned in 2002.

The electricity industry includes both publicly owned and private companies. EDELCA, which is state-owned, operates the massive 10 GW Guri hydropower facility and a network of transmission lines to carry power to the northern coastal region. Most of the private utilities are involved mainly in distribution, but some have generation capacity. Rapid demand growth, partly due to the underpricing of electricity and under-investment in the grid, has led to power shortages and to problems with the reliability of supply. In 1997, 32 major power failures occurred, with one failure in August leaving 75% of the country without electricity. The government has launched a programme to restructure the electricity-supply industry, reform the regulatory regime and privatise some state-owned companies. The large hydropower plants and the interconnected network will remain under state control, while the thermal plants will be sold off. Concessions for small and medium-sized hydro plants will go to private investors. Under a bill in preparation, the government plans to establish an independent regulator, a competitive market in generation and a third-party access regime for the national and regional grids. Efforts to attract private capital have been hindered by low tariffs, excessive employment and weak management. Only one small distribution company, Margarita Island, has so far been sold, in late 1998 under the previous government. The new government hopes to raise $700 million from the sale of four regional utilities before the end of 1999.

Energy Subsidies

Overview

Most energy sources and fuels receive heavy subsidies in Venezuela, although to varying degrees. In most cases, subsidies work through price controls, which hold prices down to below international market levels or true supply costs. Estimated price subsidies expressed as a proportion of the reference price average 58% (Table 31). The rate is highest for coal (although the quantities of coal consumed are very small), natural gas and electricity. Oil products are subsidised to a lesser extent. Price subsidies on light fuel oil used by industry and power stations amount to only 7% while heavy fuel oil is subsidised by just under 40%. In addition, households buy LPG at a 30% discount to the international price.

Table 31: **Venezuelan Energy Subsidies: Summary of Results**

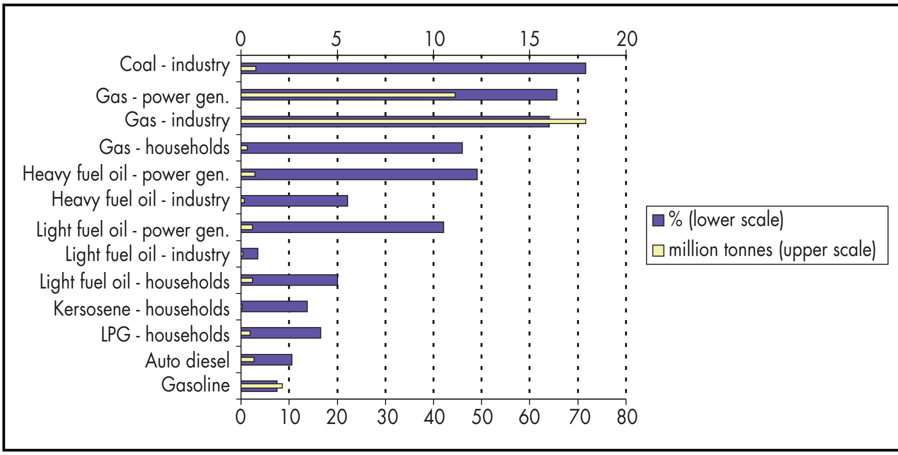
	Estimated Rate of Subsidy (% of reference price)[1]	**Potential Primary Energy Saved by Subsidy Removal (%)[2]**	**Estimated Economic-Efficiency Cost (billion bolivares)**	**Estimated Budget Cost (billion bolivares)**
Gasoline	26.6	7.5	10.1	272.2
Auto diesel	35.9	10.5	3.4	63.8
LPG	26.1	14.2	3.0	35.9
Kerosene	4.9	2.6	0.3	5.0
Light fuel oil	19.3	18.3	3.5	35.3
Heavy fuel oil	39.4	40.2	2.0	9.7
Electricity	63.0	40.8	213.9	943.4
Natural gas	85.6	64.4	369.1	1,152.4
Steam coal	91.9	71.6	2.1	5.8
Total[2]	**57.6**	**39.2 (24.9)[3]**	**607.3**	**2,523.6**

Notes: 1. Weighted average. 2. TPES saved/TPES for the sectors covered in the study. 3. Figure in parentheses is calculated using TPES for all sectors and fuels, including those not covered in the study.

Impacts and Costs

Subsidies have a significant impact on energy consumption and related emissions, and they engender sizeable economic costs. For the sectors and fuels covered in this study, primary energy use is estimated to be 25% higher and energy-related CO_2 emissions to be 26% higher than they would be if no subsidies existed. Almost half of the more than 14 Mtoe of primary energy that would be saved annually by removing those subsidies would result from lower natural gas use in industry, with a further third from lower gas use in power generation. Similarly, 82% of the reduction in CO_2 emissions from subsidy removal would come from lower natural gas use (Figure 15).[1]

Figure 15: **Reduction in CO_2 Emissions through Subsidy Removal**



The economic cost of subsidies is estimated at 607 billion bolivares or around $1.1 billion. This is equivalent to 1.2% of Venezuela's GDP. The hypothetical budget cost comes to 2,524 trillion Bolivares ($4.6 billion). These costs are borne directly by the producers and suppliers of energy, because they receive prices lower than full costs. As most of the costs relate to natural gas, the state bears much of them through its ownership of the national gas company, PdVSA.

Oil

Oil products are among the most subsidised fuels in Venezuela. The government controls the prices of all fuels except LPG and jet kerosene. Congress recently approved a bill reconfirming the current system of retail and ex-refinery price controls, which guarantees a margin to retailers. In early 1999, the Energy Minister announced that he would resist pressure

1. The fall in fuel oil use implicitly takes account of the large drop in natural gas use in power generation: the removal of price subsidies on gas, oil and electricity would lead to both fuel switching in favour of hydropower and, other things being equal, reduced demand for electricity.

from industry to raise gasoline pump prices to avoid worsening social and economic problems. The President has since ruled out any increase for gasoline prices in 1999, although PdVSA's latest business plan assumes a gradual increase in retail prices over four years. The government continues mindful of the enormous social unrest caused by gasoline price rises in 1989. A number of international oil companies, including Shell, BP Amoco, Texaco and Exxon, entered the retail market in 1998 in the expectation that the government would remove price controls. These outside companies are said to be making significant financial losses, as margins are insufficient to cover distribution and marketing costs. Leaded gasoline currently sells at around 11 cents/litre — some 27% below the reference price. The most heavily subsidised product is heavy fuel oil, which is priced almost 40% below its market value.

Natural Gas

Natural gas prices are significantly below true market levels, although the outgoing government raised tariffs to industry and power generators in 1998, as a condition for securing a loan from the Inter-American Development Bank to finance a hydropower project. The low value of gas reflects the fact that most gas produced in Venezuela is associated with oil, and that less than half of the gas produced is consumed as energy. Prices vary across the country reflecting to some extent the cost of pipeline transportation from the main producing fields in the east of the country.

In 1998, before tariffs increased, the rate of subsidy ran as high as 87% of market value for industry and 84% for the power sector. The main source of these enormous subsidies is the underpricing of transportation, which would normally constitute a significant proportion of the full cost of delivery to end-users. Plans are under way to develop natural gas projects, including the proposed Colon gas project, which would include participation by PdVSA, Shell, Exxon and Mitsubishi. The future of these plans will depend on the ability of investors to recover costs through tariffs as well as the establishment of a stable and coherent regulatory regime.

Electricity

Electricity is heavily subsidised through tariffs that fail to reflect full supply costs, which include the capital costs of building hydropower facilities, transmission lines and distribution networks. Household tariffs, which are held very low for social policy reasons, average only 16% of full costs. Industry pays a little under half of full supply costs. A rate-setting formula, introduced in 1989 as part of an IMF loan agreement, was designed to keep tariffs in line with long-run marginal costs and to provide sufficient cash flow to fund investment needs. This formula has not been fully applied, and tariffs have failed to keep pace with inflation. Household tariffs were frozen in April 1998, which amounted to a significant real cut, given an average inflation rate of around 36%. An agreement reached between the electricity industry and the government last year foresaw an average increase of 38% in household tariffs in 1999, but the new government has persuaded the industry to limit the rise to 20% on social grounds. The agreement provides for further increases in line with production costs and inflation.

The costs of underpricing electricity are high. The annual economic-efficiency loss to Venezuela is estimated at over 200 billion bolivares or $390 million. In practice, this is reflected in chronic under-investment in the industry, in deteriorating reliability of supply and in shortages. The Energy Minister estimated in early 1999 that $500 million of investment was urgently needed to avoid a virtual collapse in the system, plus a total of $5 billion in new capital over the next few years to maintain the existing system and meet the growth in demand. Industry estimates the investment needed for the five years to 2004 at $6 billion.

The government has committed itself to re-launching the privatisation programme started under the previous administration. The Chavez administration sees reform of the regulatory framework as critical to reassuring potential investors. Also vital is a tariff structure that reflects production costs as well as opportunity costs in international markets and ensures adequate financial returns.

Conclusions

There remains a pressing need for energy-sector reform in Venezuela. Restructuring and liberalisation of the energy sector, aimed at increasing investment and improving efficiency, has a number of key elements:

- reform of the legislative and regulatory regime governing the oil, gas and electricity sectors, with the aim of establishing a stable, transparent and coherent investment environment free of ad hoc political interference;
- opening the sector to private, foreign investment;
- a move towards more market-based pricing, including sound pricing methodologies for electricity and gas based on long-run marginal

costs, and the removal of price controls on oil to the extent that open competition is possible; and

- the establishment of arms-length relationships between the Government and the currently state-owned energy companies.

There are some encouraging signs that policy is moving in the right direction. Oil companies have entered the market in direct competition to, or in partnership with, PdVSA. One electricity distributor has been privatised and others have been identified for sale. Legislation aimed at modernising the regulatory regimes governing oil, gas and electricity is in preparation. Foreign investors have been encouraged by the apparent determination with which the new government of President Chavez is pursuing these reforms, although the plans to tighten control over PdVSA has raised fears that the company may be undermined by short-term political expediency.

Reform of the pricing system remains critical to the overall success of energy-sector restructuring. Successive Venezuelan governments have sought to ensure that the population shares the benefits of the country's resources through artificially low prices and implicit cross-subsidisation of the domestic oil and gas sector by oil exports. These policies have incurred heavy costs and led to uneconomically high levels of energy use. In particular, the high levels of oil demand due to the under-pricing of domestic sales reduces the amount of oil available for export and deprives the country of additional oil revenues. In the long run, subsidised energy prices should not be used to support social policy objectives. A gradual move to direct financing of social programmes would impose lower costs on the economy.

Political instability and the likelihood of social unrest that would result from raising energy prices, notably gasoline and electricity, make the process of subsidy removal extremely difficult. The government will need to persuade the electorate that the long-term rewards of eliminating subsidies - in higher investment, improved quality of service and enhanced economic performance - outweigh the short-term hardships and distributional effects.

CHAPTER 12
KAZAKHSTAN

Estimated end-use prices for coal, natural gas, and electricity average 18% below reference prices in Kazakhstan. Natural gas and electricity receive the highest per-unit subsidies. Coal, which is subsidised by 21%, accounts for more than half of energy demand, so the greatest energy savings and CO_2 emissions reductions may come from reduced coal consumption. Factors that contribute to inefficient pricing include price controls, non-payment, government ownership and cross-subsidisation. With continuation of market reforms that began in 1996 and the removal of price controls, profitability may increase, encouraging investment and stabilising the tax base. This could raise living standards, enhance energy security through modernisation and improve the government's fiscal position so that it could address its serious wage- and pension-arrears problem.

Economic and Political Overview

In December 1991, the Republic of Kazakhstan became the last of the former Soviet republics to declare independence. A new constitution, passed in a nation-wide referendum in 1995, concentrated power in the presidency and sidelined the legislature, which consists of a 67-seat lower house, the *Majilis*, and a 47-seat upper house, the Senate. The president, Nursultan Nazarbayev, first elected in December 1991 and re-elected in January 1999, is the central political figure.

Following 1996 and 1997, the first years in which the economy showed positive growth, Kazakhstan's economy contracted by 2.5% in 1998 and has continued to shrink in 1999. Industrial production fell 2.1% in 1998 and 4.1% year-on-year in the first quarter of 1999. Output also dropped in transport (by 10.9%) and agriculture (by 18.9%) bringing their respective shares of GDP to 10.8% and 8.8%, the latter representing agriculture's lowest contribution since Kazakhstan's independence. Although inflation was 7.3% in 1998 (Table 32), far below 1994's runaway 1,800%, it may well rise in the wake of the April 1999 devaluation of the Tenge.

Table 32: **Key Economic Indicators for Kazakhstan, 1998**

Population (mid-year, millions)	15.7
GDP (current Tenge, billion)	1,963
GDP (current US$, billion)	25.1
Real GDP growth rate 1997-1998 (%)	-2.5
GDP per capita (current US$)	1,595
Inflation (annual % change in consumer price index)	7.3

Source: World Bank (1999), EIU (1999) d.

The energy sector accounts for more than 30% of Kazakhstan's industrial output and employment. Crude oil and oil products, along with metals, made up more than 75% of exports in 1998. Principal imports included machinery and equipment, energy and metals. Gross energy exports in 1997 approximated 31 Mtoe, and net energy exports were 26.4 Mtoe. Kazakhstan both imports and exports fuels, largely because it lacks the infrastructure needed to transport oil from fields in the West to population and industrial centres in the East.

Main trading partners are Russia and China, both of which share borders with Kazakhstan, the world's largest land-locked country. In 1998, Russia supplied about a third of Kazakhstan's total imports and took about a quarter of its exports. Except for limited barge traffic across the Caspian Sea, Kazakhstan depends on transit through Russia for trade outlets to the rest of the world.

Energy Sector Overview

Kazakhstan's total primary energy supply in 1997 was 38.4 Mtoe, 14% lower than in 1996, reflecting declines of roughly 15% in both the industrial and transport sectors. Excluding 1992, when demand rose by 7%, demand for energy has fallen each year since independence. Energy demand in 1997 reached less than half 1992 levels, although production rose by 3.1%, the second consecutive increase, and the largest on a year-on-year basis since independence.

Energy consumption per capita is 2.4 toe, high relative to the overall level of 0.97 toe for non-OECD countries, but lower than the average 4.6 toe in the OECD in 1997. Energy intensity per US dollar of GDP is also high, at 1.53 toe compared to both the 0.80 toe for non-OECD countries and the 0.21 toe for the OECD. Contributing factors to

Table 33: **Key Energy Indicators for Kazakhstan, 1997**

TPES (million toe)	38.4
TPES per capita	2.4
TPES/GDP (toe/1,000 current US$)	1.5

Source: IEA databases.

Kazakhstan's high energy intensity are its low population density, extreme climatic conditions, low relative energy prices and an ageing energy infrastructure with significant distribution losses.

Although Kazakhstan is a substantial producer of oil and gas, coal dominates both energy production and consumption (Table 34). In 1997, Kazakhstan produced 32 Mtoe of coal, compared to 25.6 Mtoe of oil, and 6.6 Mtoe of natural gas. Coal made up 57% of primary energy supply, compared to 24% for oil, 16% for natural gas, and 1.5% for hydro. In contrast, coal accounts for roughly one-fifth of energy supply in OECD countries, with almost half the supply made up of oil and one-fifth of gas. Of the oil produced in Kazakhstan in 1997, Kazakhstan over 60% was exported.

Table 34: **Kazakstan's Energy Balance, 1997 (Mtoe)**

	Coal	Oil	Gas	Electricity	Other	Total
Indigenous production	32.0	25.6	6.6	0	0.6	64.8
TPES	21.9	9.1	6.2	0.6	1.2	38.4
TFC	6.1	7.0	3.6	3.5	0.1	20.2
Industry	6.1	0	0	1.6	0	7.7
Transport	0	2.4	0	0.3	0	2.6
Residental/commercial	0	0	0	0.5	0	0.5
Non-energy	0	0.1	0	0	0	0.1

Source: IEA (1999).

Privatisation of the Energy Sector

Efforts to privatise the energy sector began in 1996 as part of Kazakhstan's "third phase" of privatisation, when 180 large enterprises were identified for sale. (The first and the second phase had been limited to the privatisation of small businesses and medium-size enterprises.) In almost all cases, shares were bought by foreign investors. In mid-1997, energy privatisation slowed and showed signs of grinding to a halt. But fiscal difficulties, spurred in part by the Russian liquidity crisis and the Tenge devaluation, have compelled the government to resume oil and gas privatisation, although Kazakhoil, the state-owned oil and gas company, will probably remain under state control at least until 2001. Kazakhstan has received roughly $10 billion in overall foreign investment since its independence, and oil exploration holds the greatest potential for future investment. Outside private investment is higher in Kazakhstan than in any other former Soviet country.

Coal

Coal output centres in two basins, the Karaganda, which has 13 high-cost mines that produce high-quality, but high-ash, coking coal, and the Ekibastuz, with 3 strip mines that produce mainly sub-bituminous coal for power generation. The largest coal-producing area in Kazakhstan, Ekibastuz is the third largest coal basin in the former Soviet Union. Throughout the decade, coal has accounted for roughly half of Kazakhstan's primary energy supply and one-third of its final energy consumption. Between 1992 and 1997, however, domestic demand for coal declined by nearly half. Along with a two-thirds reduction in net coal exports to other FSU republics between 1991 and 1995, this decline weighed on production, which fell by 43%. Coal production in 1998 was 69.7 million tonnes, of which one-third was exported.[1]

Oil

Overview. While proven reserves range between 8 and 22 billion barrels, with the Tengiz oil field in the West accounting for 6-9 billion, estimates of total oil reserves vary between 95 billion and 117 billion barrels.[2] After Russia, Kazakhstan is the largest oil producer among FSU countries. Oil production rose from 20.3 million tonnes in 1994, its lowest point since independence, to 25.6 million tonnes in 1998, up by just half a percent from 1997. According to IEA estimates, annual output could reach 75-100 million tonnes by 2010.[3] Kazakhstan forecasts output of as much as 130 million tonnes by the same year.

Investment and Ownership. Cumulative foreign direct investment in the oil and gas sector has reached an estimated $3 billion. By 1999, over 20

1. *Eastern Block Energy*, June 1999.
2. US EIA (1999c).
3. IEA (1998a).

joint ventures worked in over 40 fields. Tengizchevroil (TCO), owned by the US firms Chevron (45%) and Mobil (25%), the country's own Kazakhoil (25%) and the Russian-American joint venture LUKArco (5%) is the largest foreign investment in Kazakhstan. Nine of the world's leading oil companies plan to invest $600 million in the Kashagan project as part of the Offshore Kazakhstan International Operating Company (OKIOC). Although the government has privatised a substantial portion of its oil enterprise, including a 60% stake in *Mangistaumunaigaz*, its largest oil producer (which was sold to Central Asia Petroleum of Indonesia) and half its share in the Tengiz oil field, Kazakhoil, the state's oil and gas holding company, still retains strong market influence.[4]

Transport. Until other pipelines are completed, Kazakhstan remains dependent on Russia's state-owned oil pipeline company, Transneft, for the transit of 75% of its oil exports. While oil from the main fields in the West of Kazakhstan is exported to Russian refineries and pipelines, the urban and industrial centres concentrated in the country's East must import oil *via* pipelines in Siberia, as there is no internal connecting pipeline.[5] Among the planned new pipelines, the most advanced is the $2 billion line being built by the Caspian Pipeline Consortium (CPC), connecting the Tengiz field to a new loading facility on the Russian coast of the Black Sea. The 1,440-km line is scheduled to be fully operational in October 2001 with an initial capacity of 28 Mt per year. Several other pipeline projects are under study, including a 2,900 km, $3.5 billion pipeline to China, which may also meet internal transport objectives, the 1,700 km Central Asia Oil Pipeline to Pakistan and the Arabian Sea, a $6.7 pipeline from Azerbaijan to Turkey across the Caspian Sea, and a pipeline via Turkmenistan to Iran.

Natural Gas

Natural gas reserves are estimated at around four trillion cubic metres, of which 1.5 to 2.35 trillion are proven. The Karachaganak field in Northwest Kazakhstan holds almost half of the country's proven gas reserves, and is expected to produce 24 bcm per year early in the next century. A production-sharing agreement worth $7 to 8 billion dollars to develop Karachaganak over the next 40 years was signed by a private foreign consortium in November 1997. However, a major impediment to the

4. In June, Kazakhoil increased its stake in the Atyrau refinery to 86% by buying out the 45% stake belonging to Telf AG (Switzerland). The other two of Kazakhstan's three refineries, the Pavlodar and Shymkent, have been partially privatised. Shymkent is the country's largest refinery.
5. Only half of the 20 Mt nominal throughput capacity of Kazakhstan's three major refineries has been used in recent years, with Kazakhstan's Pavlodar refinery processing mainly Siberian crude.

project has been difficulties in gaining access to gas processing and export facilities in Russia. The IEA projects Kazakh gas production to reach between 15 Mtoe and 29 Mtoe by 2010, growing at a faster rate than oil.[6]

As a legacy from its Soviet past, Kazakhstan currently has two separate gas-pipeline networks, one in the west and another in the Southeast, both managed by Intergaz Central Asia, a subsidiary of Tractebel, Belgium. Tractebel estimates the investment needs of the gas transmission system at $500 million, not including the construction of new pipelines. In 1997, physical gas losses in the western system were 11% compared to an average of 4.5% in OECD countries.[7] Integrating the pipelines could significantly reduce Kazakhstan's dependency on foreign gas, as the southern network is still dependent on imports from Uzbekistan. Turkmenistan and Uzbekistan supply much of Kazakhstan's gas imports, which accounted for 29% of primary gas supply in 1997, down from 70% in the early 1990s. Kazakhstan became a net exporter of natural gas for the first time in 1997 sending 2.2 Mtoe, mostly to Russia, and importing 1.8 Mtoe.

Electricity

In 1997 Kazakh electricity output totalled 52 TWh, 11% lower than in 1996 and 60% lower than in 1991, with industrial demand at only one-third of 1991 levels. Although Kazakhstan generates enough electricity to cover most of domestic demand (about 18.5 GW), the fragmented distribution network is one reason for its status as an importer (6.85 TWh in 1996).[8] In 1996, Kazakhstan spent 10% of its import expenditure on electricity from Russia. By June 1999 it owed Russia some $229 million. The composition of electricity generation has changed little since Kazakhstan's independence, varying by only one or two percent for each fuel. In 1997, coal-fired plants generated 72% of all electricity, oil 7% and gas 8%. Kazakhstan's four hydroelectric dams produced 12%, the same as in 1995 and 1996.

In part to increase efficiency, in part to raise money to pay off debts to Russia, all major generation stations have been privatised and 85% of generating capacity is now privately owned. The government has initiated the privatisation of distribution facilities as well, selling off management rights for a number of the 15 regional distribution networks.

6. IEA (1998).
7. IEA (1998).
8. Electricity imports from Russia and the Kyrgyz Republic account for about 14% of domestic consumption.

Energy Subsidies

While domestic oil prices *exceed* reference prices, end-use prices for natural gas, steam coal, and electricity average 18% below reference prices (Table 35). End-use prices for steam coal in power generation and industry are 17% and 48% below their reference prices. Coking coal, however, enjoys subsidies of less than 3%. Natural gas and electricity receive the highest subsidies as a proportion of their reference prices — more than half.

Table 35: **Energy Subsidies in Kazakhstan: Summary of Results**

	Estimated Rate of Subsidy (% of reference price)[1]	Potential Primary Energy Saving from Subsidy Removal (%)[2]	Estimated Economic Efficiency cost (million Tenge)	Estimated Budget Cost (million Tenge)
Gasoline	0.0	0.0	0.0	0.0
Auto diesel	0.0	0.0	0.0	0.0
LPG	0.0	0.0	0.0	0.0
Kerosene	0.0	0.0	0.0	0.0
Light fuel oil	0.0	0.0	0.0	0.0
Heavy fuel oil	0.0	0.0	0.0	0.0
Electricity	56.6	34.2	15,695.0	91,746.3
Natural gas	55.7	48.4	1,727.6	7,132.9
Steam coal	20.7	36.7	1,855.8	10,821.4
Coking coal	2.7	1.3	0.6	82.8
Total[2]	**18.2**	**28.8 (19.2)[3]**	**19,279.0**	**109,783.3**

Notes: Calculations are based on 1998 prices and quantities. 1. Weighted average. 2. TPES saved/TPES for the sectors covered in the study. 3. Figure in parentheses is calculated using TPES for all sectors and fuels, including those not covered in the study.

Impacts and Costs

The economic-efficiency costs of subsidies are estimated at 19.3 billion Tenge, $247 million, or 1% of 1998 GDP. If the government paid for all subsidies directly, they would have amounted to 26% of government expenditures, or 110 billion Tenge, $1.4 billion, in 1998.

Removing subsidies would yield an estimated 19.2% reduction in energy use, or 7.4 Mtoe, and a 22.8% reduction in 1997 CO_2 emissions, or

28.8 million tonnes. Approximately 93% of the CO_2 emissions saved from eliminating subsidies would come from reduced consumption of steam coal.[9] The government of Kazakhstan has expressed interest in assuming voluntary CO_2 commitments under the UNFCCC, the only non-Annex 1 country to do so besides Argentina.[10]

Figure 16: **Reduction in CO_2 Emissions through Subsidy Removal**

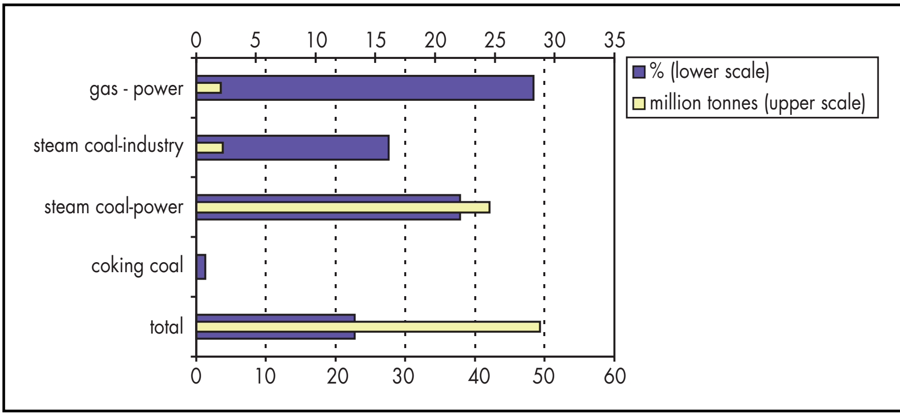


Table 36: **CO_2 Emissions Data for Kazakhstan, 1997**

CO_2 emissions (million tonnes)	126.6
CO_2 emissions per capita	8.1
CO_2 emissions/GDP (tonnes/1 000 currents US$)	5.1

Sources: IEA databases.

Coal

Most coking-coal mines have been privatised and receive no direct government subsidies. Steam-coal mines, however, are still mostly widely government owned, and price-gap estimates show for them average subsidies of 20.7%. In addition, non-payment is a serious problem for coal, as it is for natural gas and electricity. Although not a direct government

9. After Russia and Ukraine, Kazakhstan is the third-largest emitter of CO_2 in the FSU, producing 0.6% of world emissions.

10. Detailed calculations of potential revenues from such participation in a global carbon trading scheme can be found in the Annex to Part B "The Potential Benefits of Valuing CO_2 Emissions Reductions Through Global Emission Trading".

payment to consumers (and so not captured by the price-gap approach), non-payment resembles a subsidy because it essentially provides for free coal or free power. As of May 1999, *85% to 90%* of the bills for the Ekibastuz Bogatyr mine were unpaid. The mine consequently had to scale back 1999 production by 16.5%, to 15 Mt. Assuming that the price of coal is initially unsubsidised — a reasonable assumption for Ekibastuz sub-bituminous coal — non-payment could force an increase in prices to cover the power used by non-paying customers. This could crowd out consumers who can afford to buy the coal at the reference price, but it would not prevent non-paying customers from continued consumption. The Bogatyr mine plans to raise prices to keep pace with devaluation and to meet payments for equipment. These price hikes will most likely be higher than they would be with full payment.

Oil

That the price-gap approach does not capture subsidies for oil products does not necessarily mean that oil prices are undistorted. The high end-use prices relative to reference prices (twice the reference price for gasoline in 1998, for instance) may be partly explained by protectionist policies intended to stimulate the refining of domestic oil, which can be more expensive than imported oil, especially with inadequate pipelines necessitating costly transportation to refineries. Since the devaluation, a new rule requires exporters to surrender half of their hard-currency earnings to the state at the prevailing exchange rate. Kazakhstan also maintains an excise duty on petrol exports. In addition, the Ministry of Energy issued a protocol in June 1999 making it compulsory for many domestic oil companies, including TCO and Kazakhoil, to supply domestic refineries.

Despite these policies, distribution has been privatised and, since September 1995, prices largely liberalised, with foreign service stations now owned by Chevron, Mobil, and Lukoil, among others. The Kazakhstan Anti-Monopoly Agency, however, announced in July that it will probably set fixed prices for oil products, following market-driven price hikes of 14% to 39% in June.

Natural Gas

The non-payment problem is especially detrimental to the natural gas industry. Kazakhgaz was owed some 24 billion Tenge ($318 million) by large customers and distributors by the beginning of 1997. Uzbekistan suspended deliveries in 1998 because of unpaid bills, and in March 1997, Turkmenistan halted exports of gas through Kazakhstan. To cover debts from non-payment, Kazakhstan has had to resort to exporting natural resources at reduced rates or even gratis to its creditor countries; this have, in fact, returned to barter. Accounting for non-payment, the effective subsidy rate could be above the estimated 55.7%.

Along with non-payment, low retail tariffs for natural gas may explain why foreign investment in the gas industry has been minimal.[11] Beginning in 1997, gas prices were supposed to cover all costs, including transport and long-run development costs, plus profit, or "cost-plus profit". Due to a lack of residential meters, however, charges are determined by formulas based on the number of people in an apartment, floor space, and kind of use. These calculations tend to underestimate true natural gas use, so users are usually undercharged.[12] Liberalisation of tariffs and further privatisation may allow distributors and generators to address the non-payment problem with increased investment, notably in meters.

Electricity

Price ceilings. Kazakhstan has recently pursued a partial liberalisation policy. Wholesale electricity prices are determined by the market, transit prices by the State Committee for Price and Antimonopoly Policy and end-use prices by local government committees, in particular the Natural Monopolies Committee.[13] Inappropriate transmission tariffs hamper the efficient use of available generation, according to a report by National Economic Research Associates (NERA) commissioned by AES, a US company which owns and operates several power plants in Kazakhstan, including the largest generating plant in the country. The Kazakhstani Electricity Grid Operating Company (KEGOC), a government agency, manages the transmission network. In 1998, Tractebel, a Belgian firm, which manages one of Kazakhstan's 15 regional distribution companies, alleged that government price caps put long-term investment in jeopardy.

The 1998 "Law of the Republic of Kazakhstan on Natural Monopolies" determines the legal foundation for the prices and tariffs for the services of natural monopolies, which include, according to the law, oil and gas pipelines and transmission and distribution of electricity and heat. Although Article 5 of the law prohibits natural monopolies from charging prices above those established by authorised agencies, Article 18 says that "prices must not

11. As in the oil sector, foreign investment is limited by obligations to the domestic market, such as providing deep discounts for domestically consumed energy.
12. United Nations Development Programme and World Bank (1997).
13. IEA (1998).

be lower than the costs required for delivery". This provides for a return sufficient "to ensure efficient operation". It is uncertain whether current prices can achieve this objective, especially in light of the government's freeze on utility prices for six months following the devaluation.

Box 16: **The Near-Term Climate for Subsidy Removal in Kazakhstan**

Eliminating subsidies could help finance government wage arrears. In April 1999, the government owed 61.9 billion Tenge ($614 million) in unpaid wage and benefits payments. Revenue collection has been very difficult, despite the recent establishment of a ministry designed especially for that purpose. Tax arrears rose to 40% of the budget or 3.5% of GDP. In the first two months of 1999, revenue collection was at least 21% below target. Reducing fossil-fuel subsidies may provide some of the revenue needed to eliminate the government's wage and pension arrears to raise incomes and perhaps so help the government move toward stable tax collection. A steady stream of income could also help boost living standards, enabling citizens to pay for unsubsidised energy. The estimated budget cost of energy subsidies is 110 billion Tenge (assuming all subsidies captured by the price-gaps are paid from the government budget), or 6.3% of 1998 GDP, nearly double the government's wage and pension arrears.

The gradual removal of subsidies may minimise social turbulence. Because eliminating subsidies could cause household electricity prices to rise by as much as 90%, the risk of social unrest will be a factor in any decision to eliminate subsidies. Eliminating subsidies, especially for residential consumers, might succeed best as a gradual process, pursued in tandem with timely wage payments. This could cushion the shock to citizens used to artificially cheap, if not free, energy under the Soviet system. Some electricity companies, for example, have tried to solve the non-payment problem before raising tariffs, since increasing tariffs first might only exacerbate non-payment.

Cross-subsidies. Together with from price-ceilings, cross-subsidies between industrial and residential users of electricity are also prevalent, according to the World Bank, although end-use prices do not reflect this.[14] Cross-subsidies exist, when tariffs below the cost of production are charged

14. World Bank (1998a).

to one group of consumers, and the revenue short-fall is made up charging above-cost tariffs from another group of consumers. Other cross-subsidies might include the following:

- The present policy of common tariffs coupled with a wide diversity of supply costs means that consumers located in remote areas pay tariffs that are misaligned with true supply costs.
- For social reasons, as winter temperatures reach below negative 40°, combined heat and power plants redistribute costs, imposing higher electricity tariffs and significantly undercharging for heat.
- Power companies are forced to raise tariffs to cover losses from non-paying consumers.

Conclusions

Although subsidies for natural gas, steam coal, and electricity remain high, the government has taken the first steps toward privatisation and substantive reform in the energy sector. Kazakhstan should continue to build and enforce the transparent legal infrastructure necessary to provide energy at prices that reflect supply costs. This is no small feat, especially after Kazakhstan's history of arbitrarily fixed low prices and indifference to costs in the former planned economy.

Failure to establish well-defined policies and a sound regulatory framework could jeopardise the investment needed to secure a stable and efficient energy supply. Furthermore, revenue collection may increase, allowing the government to redistribute income directly, rather than to subsidise energy.

The government has used energy policy, especially price controls, to achieve social policy objectives. The challenge, now, is to institute cost-reflective pricing while dealing with social problems directly. By establishing independent regulatory agencies to separate oversight and control, lifting price controls, and furthering privatisation efforts, Kazakhstan might achieve these policy goals, ensuring a secure supply of energy while reducing costs in terms of efficiency, the budget and the environment.

ANNEX TO PART B
THE POTENTIAL BENEFITS OF VALUING CO_2 EMISSIONS REDUCTIONS THROUGH GLOBAL EMISSION TRADING

The present study has shown that the removal of energy subsidies brings large benefits for economic growth and environmental performance and generates ancillary benefits for government budgets and the trade balance. Concerning improved environmental performance, the reduction in the emissions of particulates, sulphur dioxide (SO_2) and nitrous oxides (NO_x) can lower the mortality and morbidity of local populations and reduce the damage to buildings and facilities. It is therefore a high priority in the eight countries under study.

Reduced energy consumption, however, also implies reduced carbon dioxide (CO_2) emissions. This reduction in CO_2 does not primarily benefit the country that achieves the emission reductions, but constitutes a contribution to global efforts to limit CO_2 emissions with the objective to prevent potentially large damage through a changing climate.[1] CO_2 emission reductions thus constitute a service to the global community by reducing the risk of damage from climate change for the world at large.

This service is valuable. In principle, it could be remunerated by the global community, or, more specifically, by those countries that have declared their willingness to shoulder the responsibility for limiting greenhouse gas emissions. These countries are, of course, those listed in Annex I in the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC) together with their contracted limitations or reductions of annual greenhouse gas emissions.[2]

1. If a country optimises only its own welfare only domestic concerns would count and global considerations would not be part of its objectives. CO_2 emissions would not normally be part of domestic concerns. Only countries with very large CO_2 emissions such as China, India or Russia could affect their own exposure to climate change risks in a perceptible way by changing their emissions. Even in their case, however, the domestically optimal adjustment would be much smaller than the globally optimal one.
2. The commitments under the Kyoto Protocol are formulated in terms of greenhouse gas emissions, whereby the global warming potentials of the six listed anthropogenic greenhouse gases are equalised in terms of carbon dioxide equivalent emissions. Of the six greenhouse gases, carbon dioxide is by far the most important one, contributing more than three-quarters of the total global warming potential.

This group of countries includes most industrialised countries, 24 of 27 Member countries of the OECD and several countries with economies in transition such as the Russian Federation and Ukraine

If these industrialised countries do indeed value reduced greenhouse gas emissions as much as their commitments indicate, they will have to incur high abatement costs. Domestic abatement costs are high in Annex I countries because their highly developed economies have low carbon emissions per unit of GDP. If carbon-emission reductions could be sold, countries with commitments under Annex I of the UNFCCC could also *buy* emission reductions from other countries to supplement domestic emissions reductions. If they follow economic logic, Annex I countries will buy emission rights or permits as long as they cost less than domestic abatement.

In fact, the costs of reducing emissions are frequently lower in countries without commitments than in Annex I countries. It is hence economically efficient to achieve at least some emission reductions in countries with no commitments, even if countries *with* commitments bear the costs.[3] This implies potential gains also for non-Annex I countries. The participation in a global flexibility mechanism could be particularly attractive for the countries under study since the emission reductions due to subsidy removal would accrue at no additional cost. They would simply be the by-products of the removal of energy subsidies, which were undertaken for their own benefits in terms of economic growth and domestic environmental performance.

In principle, tradable emission reductions accrue each time a country reduces its emissions below a prior established baseline of "business-as-usual". For the countries under study, tradable emission reductions would be determined by the difference between the emissions with subsidies (business-as-usual case) and the emissions without subsidies (subsidy removal case).

Two caveats apply: first, only countries willing to take on emission limitation commitment could participate in such an exchange. Such commitments would be set at or close to the emissions connected with a business-as-usual scenario. Second, no exchange system for emission right currently exists. Signatory countries to the Kyoto Protocol, however, are deliberating the implementation of such structures as the Clean Development Mechanism or generalised Carbon Permit Trading. At least one of the three

3. Achieving "economic efficiency" is understood here in the technical sense of moving from one given state of the world to another, the second being strongly Pareto-superior to the previous one. In other words, engaging in trading makes both parties, the country with the commitments and the country in which the reductions are made, unambiguously better off.

"flexibility mechanisms" under the Protocol, the Clean Development Mechanism, foresees the co-operation of non-Annex I countries.[4]

Two non-Annex I countries, Argentina and Kazakhstan, have taken steps such as the adoption of voluntary emission limitations to prepare for participation in carbon emission trading, once a scheme has been enacted. Participation of non-Annex I countries in the project-based Clean Development Mechanism instead does not require the establishment of *national* emission limitations, but only the definition of project-level baselines. For the time being, however, the specific arrangements for both flexibility mechanisms, the eventual participants and the exact revenue to be gained all remain unknown, as the precise rules are still being negotiated.

For illustrative purposes this study has nevertheless calculated the revenues to be gained if the emission reductions due to the removal of subsidies in the eight countries under study were sold on a market for carbon emission rights. This exercise — hypothetical, although based on the best information currently available, especially concerning the price per tonne of carbon dioxide abated — provides an indication of the order of magnitude of potential revenues from trading carbon that is not emitted due to subsidy removal.

The price of a tonne of carbon dioxide abated in a future trading scheme is unknown. In fact, a corollary benefit of a carbon-trading scheme (other than its least-cost achievement of emissions targets) is the information that it would provide about the true marginal cost of reducing carbon emissions. At the current stage of international discussions any quantitative indication of potential revenues from a carbon-trading scheme remains hypothetical.

While no certain numbers are available, a number of modelling efforts have been undertaken that try to determine the prospective price of a permit to emit an additional tonne of carbon in a trading scheme. This study has calculated the average value derived from the outcomes of seven different models from all over the world. All of them are well known and were presented at the OECD Workshop "Economic Modelling of Climate Change", held in Paris 17-18 September 1998. The marginal cost of abatement in full global trading, *i.e.* the price of a ton of carbon *not emitted*, emerges as follows from the seven models.[5]

4. For detailed information about flexibility mechanisms under the Kyoto Protocol see Mullins (1998).

5. Van der Mensbrugghe (1998); Richard Baron, International Energy Agency, established this overview. $26.6 per tonne of carbon correspond to $7.3 per tonne of carbon dioxide. The term 'hot air' refers to emission targets, which are *higher* than baseline emissions and which can be achieved at zero marginal cost. Their inclusion thus lowers the cost of abatement.

Table 37: **Modelling Results for the Price of Tonne of Carbon Dioxide Saved**

Model	**Marginal Cost/Price (1995 US$ per tonne of carbon)**
SGM without "hot air"	27
SGM with "hot air"	21
G-cubed	13
Poles	33
GREEN	25
AIM	43
EPPA	24
Average	**26.6**

Consequently, this study has taken a value of $27 as the price of a tonne of carbon dioxide saved. A country selling carbon credits could thus expect to receive this amount for each permit to emit one tonne of carbon. The study also assumes that the eight countries under study would sell at that price all the carbon dioxide not emitted after the abolition of energy subsidies. By multiplying the reductions in carbon dioxide emissions achieved through the removal of subsidies with the potential revenue per tonne of CO_2 of $27 (converted into domestic currencies), the following values were calculated for the eight countries under study.[6]

Always taking account of the indicative character of the calculations, the eight countries together could thus achieve revenues of $7.8 billion by selling the emission reductions achieved through the removal of energy subsidies at a price of $27 per tonne of CO_2 to countries with commitments under Annex I of the Kyoto Protocol. This sum corresponds to 1.85 per cent of their combined government budgets.

Such revenues from participation in a future permit market would constitute a windfall benefit over and above domestic economic gains from the removal of energy subsidies. The results for single countries are a function of their emission reductions due to subsidy removal and the relative size of their government budgets. Kazakhstan would have, by far, the most to gain from participation in global permit trading, with potential revenues of 3.95 per cent of its current government budget. Iran, China,

6. At a later stage the selling of emissions reductions generated with a positive, yet still comparatively low cost could be envisioned. In this exercise, however, only zero cost emission reductions have been considered.

Table 38: **The Potential Revenue from Carbon Emission Trading**

	China (million Yuan)	**Russian Federation (million Rubles)**	**India (billion Rupees)**	**Indonesia (billion Rupiahs)**	**Iran (billion Rial)**	**South Africa (million Rand)**	**Venezuela (billion Bolivares)**	**Kazakhstan (million Tenge)**
Gasoline	0.0	36.1	0.0	0	67.2	0.0	8.7	0.0
Auto diesel	0.0	0.0	0.0	78.3	211.1	0.0	2.7	0.0
LPG	0.0	0.0	0.7	0	45.4	0.0	1.9	0.0
Kerosene	0.0	0.0	4.0	203.4	224.5	2.2	0.3	0.0
LFO	0.0	15.1	0.0	161.8	261.7	0.0	5.2	0.0
HFO	0.0	0.0	0.0	16.5	286.6	0.0	3.6	0.0
Electricity	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0
Natural gas	287.0	10,559.2	2.1	141.5	724.6	0.0	118.4	1,186.7
Steam coal	20,214.5	0.0	29.5	1.4	0.0	948.8	3.1	15,404.3
Coking Coal	5,094.8	0.0	1.5	0	0.0	0.0		11.2
Total (local currency)	**25,596.3**	**10,610.4**	**37.8**	**602.9**	**1,821.1**	**951.0**	**143.9**	**16,602.3**
Total (million dollars)	**3,091.3**	**1,832.5**	**917.4**	**207.2**	**1,038.8**	**206.3**	**262.6**	**212.3**
Per cent of government budget	**2.40**	**1.90**	**1.62**	**0.60**	**2.54**	**0.50**	**1.62**	**3.95**

Russia, India and Venezuela would also gain substantially, as their benefits would be around 2 per cent of their governments' budgets. Indonesia and South Africa would find the gains, which lie below 1 per cent of their governments' budgets, relatively small.

In conclusion, the authors wish to re-emphasise two points. First, the calculations above have been made for illustrative purposes. Nobody knows today which form eventual global flexibility mechanisms under the Kyoto Protocol will take, which countries will participate, and what the price of a tonne of CO_2 will eventually be. It is nonetheless helpful to analyse the issue using plausible assumptions. The calculation of more precise numbers will only be possible with detailed information in the countries concerned themselves.

Second, the participation in a global flexibility mechanism in no way implies any kind of commitment to reduce or limit natural greenhouse gas emissions. It would, however, imply the establishment of a "business-as-usual" baseline, in order to be able to assess project-based emission reductions.[7] Any country without obligations under the Kyoto Protocol would only participate in a global flexibility mechanism if it were profitable according to its own domestic cost-benefit calculation. Emission trading helps to reduce the cost for countries with commitments. If countries without commitments contribute to that objective, they deserve remuneration. As subsidy removal would generate emissions reductions in addition to economic benefits, both sides could gain by engaging in mutually beneficial trades.

7. The baselines necessary to establish any accounting framework for carbon trading would likely to be so generous as not to constitute any burden on participating non-Annex I countries. In the parlance of the UNFCCC, they would be likely to have at least some amounts of "hot air" — tradable emission rights that they could dispose of without any further abatement efforts, because accepted baseline emission rights exceed actual emissions.

PART C

DATA SECTION:
END-USE AND REFERENCE PRICES IN

CHINA
RUSSIAN FEDERATION
INDIA
INDONESIA
IRAN
SOUTH AFRICA
VENEZUELA
KAZAKHSTAN

China: End-Use and Reference Prices

1998 Yuan per unit

	End-Use Price	Reference Price
Oil Products		
Leaded gasoline per litre	2.25	1.31
Automotive diesel oil per litre	2.15	1.29
Liquefied petroleum gas		
Households	2.03	1.17
Industry	2.03	0.93
Kerosene per litre		
Households	1.75	1.36
Industry/power generation	1.75	1.09
Light fuel oil per 1000 litres		
Households	1,900	1,292
Industry	1,538	1,034
power generation	1,538	1,034
Heavy fuel oil per tonne		
Industry	1,096	722
Power generation	1,096	722
Electricity per kWh		
Households	0.43	0.63
Industry	0.38	0.63
Natural gas per 1,000 cubic metres		
Households	1,333	2,138
Industry	1,006	1,156
Power generation	709	918
Steam coal per tonne		
Households	236	306
Industry	331	297
Power generation	174	206
Coking coal per tonne	129	480

Note: Prices are not reported where domestic consumption is zero.

Sources: Battelle Pacific Northwest National Laboratory, Advanced International Studies Unit (1998), *China's Electric Power Options.*

Ambassade de France en Chine (1999), *Le prix de l'éléctricité en Chine,* April 1999.

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India: End-Use and Reference Prices

1998 Rupees per unit

	End-Use Price	Reference Price
Oil Products		
Leaded gasoline per litre	24.95	6.30
Automotive diesel oil per litre	10.93	5.72
Liquefied petroleum gas		
Households	5.51	8.06
Industry	5.51	8.06
Kerosene per litre		
Households	2.75	7.66
Industry/power generation	16.78	7.66
Light fuel oil per 1000 litres		
Households	8,349	5,720
Industry	8,349	5,720
Power generation	8,349	5,720
Heavy fuel oil per tonne		
Industry	5,855	3,182
Power generation	5,855	3,182
Electricity per kWh		
Households	1.23	3.40
Industry	2.93	3.27
Natural gas per 1,000 cubic metres		
Households	4,046	10,836
Industry	4,046	5,698
Power generation	4,046	4,525
Steam coal per tonne		
Households	881	1,539
Industry	881	1,349
Power generation	1,041	1,090
Coking coal per tonne	1,367	2,371

Sources: Bhattacharyya, Subhes (1997), "Natural Gas in India: Market Prospects and Investment Opportunities".
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Iran: End-Use and Reference Prices

1997 Rials per unit

	End-Use Price	Reference Price
Oil products		
Leaded gasoline per litre	130	320
Automotive diesel oil per litre	17.5	288
Liquefied petroleum gas per litre		
Households	25	244
Industry	25	191
Kerosene per litre		
Households	30	291
Industry/power generation	30	228
Light fuel oil per 1000 litres		
Households	30,000	289,000
Industry	30,000	226,000
Power generation	30,000	226,000
Heavy fuel oil per tonne		
Industry	17,535	147,787
Power generation	17,535	147,787
Electricity per kWh		
Households	41	80
Industry	41	79
Natural gas per 1,000 cubic metres		
Households	30,000	399,298
Industry	90,000	214,660
Power generation	10,500	170,465
Coking coal per tonne	N.a.	N.a.

Sources: FACTS (1999), personal communication.
IEA (1998), Coal Information.
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Venezuela: End-Use and Reference Prices

1998 Bolivares per unit

	End-Use Price	Reference Price
Oil products		
Leaded gasoline per litre	60	82
Automotive diesel oil per litre	48	75
LPG per litre		
Households	48	69
Industry	48	48
Kerosene per litre		
Households	62	83
Industry/Power generation	74	74
Light fuel oil per 1000 litres		
Households	47,897	74,910
Industry	47,897	51,440
Power generation	47,897	51,440
Heavy fuel oil per tonne		
Industry	21,126	34,865
Power generation	21,126	34,865
Electricity per kWh		
Households	6.10	38
Industry	15.80	33
Natural gas per 1,000 cubic metres		
Households	48,543	166,493
Industry	10,119	78,355
Power generation	10,119	62,223
Steam coal per tonne		
Industry	1,192	14,780

Sources: IEA (1998), *Coal Information.*
IEA (1998), *Natural Gas Pricing in Competitive Markets.*
IEA (1998), *Oil Market Report Annual Statistical Supplement and User's Guide.*
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