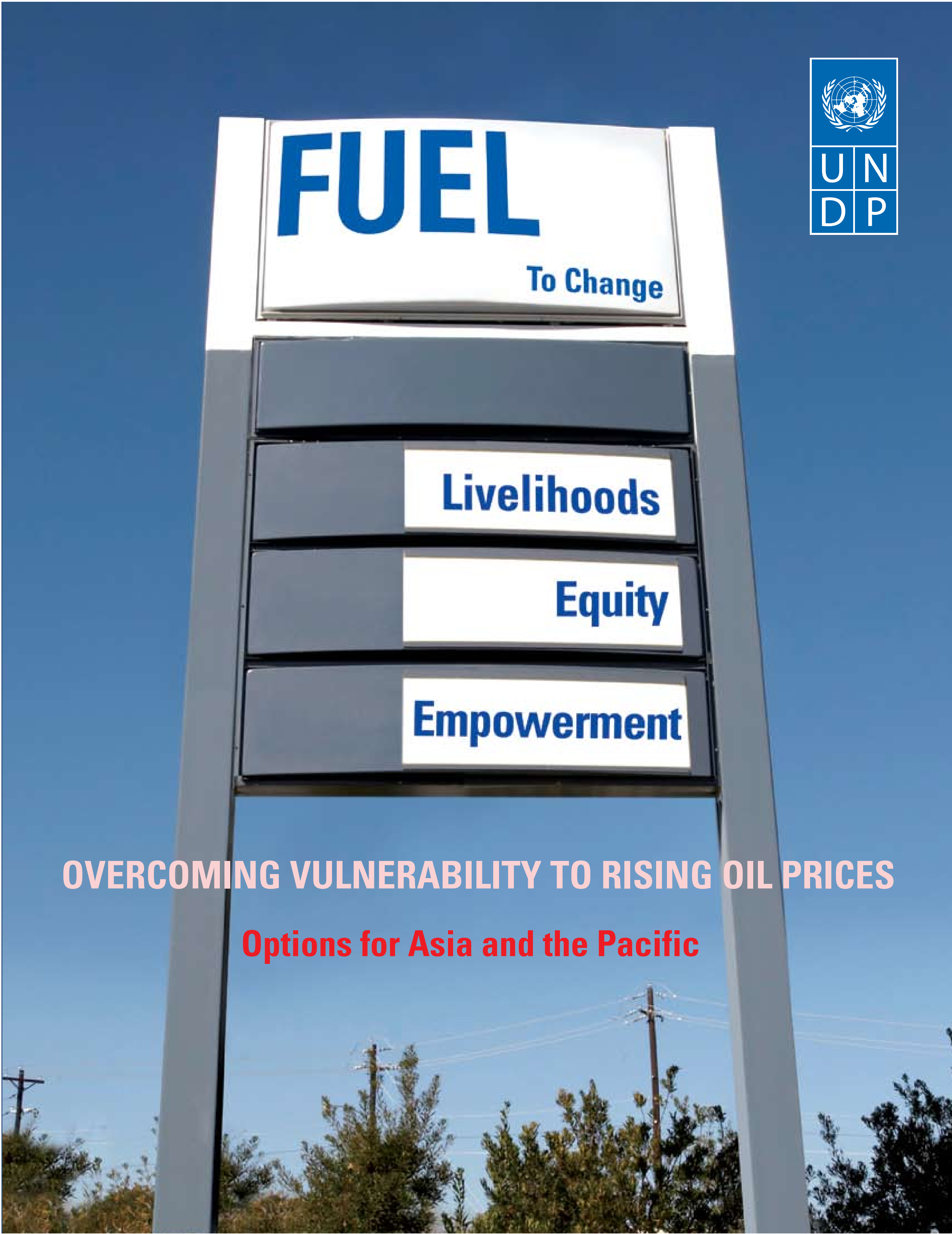

OVERCOMING VULNERABILITY TO RISING OIL PRICES

Options for Asia and the Pacific

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Regional Energy Programme for Poverty Reduction

UNDP Regional Centre in Bangkok

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Foreword

Global oil prices have been rising steadily and now have hit an all-time high of US$84 per barrel. UNDP commissioned this Report because there is evidence that these rising oil prices are starting to bite, most severely at the incomes and lives of the region's poor. Governments have been trying to protect the vulnerable – either by providing subsidies, or by obliging public oil companies not to pass on the full international price increases to local consumers. However, these policies are becoming difficult to sustain. The political and social consequences are severe. Over the past few years, people across the region have taken to the streets in various Asian countries in reaction to significant fuel price hikes.

This Report examines how oil price rises are affecting the region's poorest people. To capture this, it starts with a survey of day-to-day realities on the ground. The results are deeply disturbing. Over the last three years, households in the region are paying, on average, 171 percent more for cooking fuels, 120 percent more for transportation, 67 percent more for electricity and 55 percent more for lighting fuels.

This Report also develops an Oil Price Vulnerability Index (OPVI). This is a composite of selected indicators that reflects not just a country's economic performance and the resilience of its economy, but also the extent to which it depends on imported oil. For 24 countries for which the index has been calculated, 13 have been flagged as relatively vulnerable, with high OPVIs. However, macroeconomic consequences have not yet become fully visible in many countries, although rates of inflation have shown a tendency to rise.

The current price rises should, however, not be viewed simply as the source of an impending crisis. They also offer an opportunity to seek new and promising directions. Indeed, many countries have the chance to redesign policy to achieve not just national energy security, but also security at the household level.

The Report proposes the establishment of an Asia-Pacific Compensatory Oil Finance Facility for least developed countries and small island developing states with a two-fold purpose: first, to help tide poorer countries over the immediate balance of payments or fiscal deficits provoked by the oil price hike; second, to enable countries to invest in alternative forms of energy so that they become less dependent on imported oil.

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Contributors

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In taking on the subject of oil prices and the poor, we were humbled by the fact that no single mind or book can comprehensively address the issues under consideration. We hope that the analyses of ground-level realities and possible policy responses will prove useful to decision makers and other stakeholders in devising strategies aimed at mitigating the impacts of rising oil prices on poor people. We are hopeful that the Report will catalyze a constructive dialogue with development partners, and that the impacts on poor people will become an important consideration in the development of future policy responses.

Marcia V.J. Kran
Head of Policy and Programmes
UNDP Regional Centre in Bangkok

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Abbreviations

ACU	Asian Currency Unit
AP-COIL	Asia-Pacific Compensatory Oil Finance Facility
APERC	Asia Pacific Energy Research Centre
APL	Above Poverty Line
APSA	ASEAN Petroleum Security Agreement
APSP	Average Petroleum Spot Price
ASEAN	Association of Southeast Asian Nations
ATF	Aviation Turbine Fuel
BPL	Below Poverty Line
BRAC	Bangladesh Rural Advancement Committee
CDM	Clean Development Mechanism
CFB	Circulating Fluidized Bed
CFF	Compensatory Financing Facility
COCO	Cogeneration Public Company Limited
DFCC	Development Finance Corporation of Ceylon
ESMAP	Energy Sector Management Assistance Programme
ESF	Exogenous Shock Facility
EU	European Union
HIPC	Heavily Indebted Poor Countries
HSD	High Speed Diesel
GDP	Gross Domestic Product
GHG	Greenhouse gas
HDI	Human Development Index
IGCC	Integrated Gasification Combined Cycle
IMF	International Monetary Fund
IREDA	Indian Renewable Energy Development Agency
LDCs	Least Developed Countries
LICs	Low-Income Countries
LPG	Liquefied petroleum gas
MDRI	Multilateral Debt Relief Initiative
MDG	Millennium Development Goals
NGCC	Natural Gas Combined Cycle
NPR	Nepalese Rupees
NPK (fertilizer)	Nitrogen, phosphorus and potassium
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of Petroleum Exporting Countries
OPVI	Oil Price Vulnerability Index
Panchayat	Local self-governance unit
PCA	Principal Component Analysis
PDS	Public Distribution System
PPP	Purchasing Power Parity
PRGF	Poverty Reduction and Growth Facility
PV	Photovoltaic
R&D	Research and Development
REP-PoR	Regional Energy Programme for Poverty Reduction
RETs	Renewable Energy Technologies
SMEs	Small and Medium Enterprises
SYSMIN	*Système de Stabilisation des Recettes d'Exportation*
SDRs	Special Drawing Rights
VAT	Value added tax
WTI	West Texas Intermediate

Executive Summary

Across Asia and the Pacific, soaring oil prices are threatening the prospects of millions of poor households – and posing an unforeseen challenge to the Millennium Development Goals. Since 2003, prices have been rising inexorably, from around US$22 to above US$80 a barrel now, and have been showing little sign of easing. Indeed, many developing countries in the region are likely to become even more exposed to rising prices, as measured in this Report by a new 'Oil Price Vulnerability Index' (OPVI). In response, the Report represents a set of policy options and priorities that can help reduce national vulnerability to future price rises and protect the interests of the poor.

How oil price rises have hit the poor

The Report starts by asking poor communities how they have been affected by rising oil prices. For this purpose, field studies were carried out in rural and urban areas of four countries: China, India, Indonesia and Lao PDR, interviewing 500 mostly poor households along with local authorities, public service institutions and other community stakeholders. These communities used four main petroleum fuels – kerosene, liquefied petroleum gas (LPG), diesel and gasoline. In addition, farming communities use chemical fertilizers for which the feedstocks are often petroleum products and natural gas.

Kerosene – Rural communities mainly use kerosene for lighting whereas urban households use it for both lighting and cooking.

LPG – Most urban households prefer this for cooking because it is convenient, efficient and clean, though many rural households may opt to cook with traditional fuels.

Diesel – In rural areas diesel can be used as a fuel for farm machinery and as a source of electricity in power generators. The poorest households, however, tend to use diesel more indirectly, through public transportation.

Gasoline – This is the least significant fuel for poor households, since it is used mainly in cars and motorcycles that relatively few can afford.

Chemical fertilizers – Expenditure on petroleum-based fertilizers can be quite substantial for poor households.

The poor communities interviewed experienced steep increases in the retail prices of all these oil products. Before 2003, they had been protected to some extent by government subsidies. But when prices started on their upward spiral, these policies proved difficult to sustain and subsidy shields are steadily being stripped away. In some countries, the resulting price increases have provoked a public backlash, posing a dilemma for governments torn between the conflicting priorities of fiscal prudence and social justice.

Between 2002 and 2005, the households interviewed suffered some dramatic price increases, paying as a whole 74 percent more for their energy needs. This included:

- 171 percent more for cooking fuels;
- 120 percent more for transportation;
- 67 percent more for electricity;
- 55 percent more for lighting fuels; and
- 33 percent more for petroleum-based fertilizers and other agricultural inputs.

The survey asked how they had coped with these increases. Most reported they had, to some extent, been climbing down the 'energy ladder' and reverting to inferior fuels. In India and Indonesia, for example, many rural communities have had to cut back on kerosene for cooking, and instead have reverted wholly or partly to biomass and dung cakes. Or they are simply going without: if they cannot afford kerosene for lamps during power outages, they stay in darkness.

Faced with rising fares, families have also had to cut back on transport. Unable to afford public buses, they may now be walking to the nearest health centre or school. Or they may simply have cut back on travel: urban migrant workers in India, for example, now return less frequently to their home villages.

On the whole, rising oil prices have left the poor with few choices other than to cut back on their consumption of oil products or make other cuts in their household budgets. The urban poor tend to be worse off since they do not have the alternative of collecting fuelwood or other biomass. The rural poor, however, are more vulnerable to higher prices for lighting fuels, especially in unelectrified villages. They are also at a greater disadvantage when high transport costs isolate them from essential services that they do not have in their villages. In India, rising transport costs have compelled a number of households in both rural and urban areas to move their children from better but more distant schools to others closer to their homes, and, as a result, the quality of children's education has suffered.

Switching back to biomass fuels has especially serious consequences for women and children, who not only suffer from increased pollution at home, but also have to spend more time and effort gathering fuels. And to meet rising household fuel bills, women have in addition been forced to take on extra work outside the home.

In fact, given the steep price rise it is surprising that the effects have not been more severe. This is largely because many of these households might be classified as 'near-poor' – they have a small financial cushion that can temporarily absorb the additional expenses. But if oil prices continue on their present trajectory, these resources will soon be exhausted and households will find that these price increases are not only undermining their present lifestyles but also their future prospects. Less able to provide a decent education for their children, to work because of an unhealthy home environment, and to use transport to seize opportunities to earn additional income, many poor families are seeing their futures compromised.

The macroeconomic impact

Millions of poor people have been hit by these rising prices. But the effects do not yet seem to have been severe on national economies. Certainly the impact has been nothing as severe as might have been expected based on the experience 30 years ago. The current rising prices are, however, in many respects different from those during the oil shock of the 1970s. Although the increases have been substantial and persistent, they are nonetheless not as steep as before. Their cause too is slightly different: in the 1970s, the sudden hikes were due primarily to disruptions in supply, but over the past five years, the increases have been due more to strong demand, as well as to geopolitical and other factors that have kept supplies tight.

Prices have also become more volatile. Previously, fluctuations in supply and demand were dampened by three main buffers: surplus production capacity among OPEC members, large oil inventories, and surplus refining capacity in consuming countries. All three buffers have, however, been shrinking, and, as a result, the world oil market has become much less predictable. This uncertain environment could have serious long-term implications for the Asia-Pacific region, particularly for the least developed countries and for the poorest communities, which have faced sudden rises in the price of energy.

Rising oil prices do not appear to have stifled economic growth, which has continued to flourish, both at the global level and within Asian developing countries. The price rises might also have stoked inflation, but at the global level this does not appear to have happened either; indeed, inflation declined, though in developing countries in Asia there have been some signs of rising inflation.

Another possible outcome is that higher prices could have encouraged countries to become less oil intensive to use fewer barrels of oil per unit of GDP. In fact, many countries had already been reducing their dependence on oil in the 1990s, so this trend largely continues. Even so, the region's oil intensity remains higher than the global average and is likely to stay quite high. In India and China, for example, growth in demand is expected to cause oil consumption to rise by about 3 percent per year.

Why have the macroeconomic effects been so small? Partly because this time the price rises occurred in the midst of a global boom, and despite the price increases countries have been able to maintain their economic momentum. Another factor is that governments have often shielded consumers from the price increases through subsidies, which has helped to curb inflation. Of course, it is possible too that the macroeconomic effects have simply been delayed, and could emerge in the future, especially if recent increases represent the start of a long upward trend.

National vulnerability to oil price rises

Rising oil prices affect every country, but some are more exposed than others: those that are highly oil dependent perhaps, or those relying heavily on imports. One indicator of dependence is 'oil intensity,' the amount of oil required to produce a unit of economic output. On this basis, both large and small countries are vulnerable to high oil prices for different reasons. Larger countries like China, India and Thailand appear to be more vulnerable because they have high oil intensities and also depend heavily on oil imports. Some smaller countries are also at risk, including Cambodia, Nepal and the Pacific Island Countries, as they are heavily oil import dependent for critical purposes such as transport and power generation.

As they have developed, particularly at the outset, most countries have become more oil intensive. But at higher levels of per capita GDP, their oil intensity can start to drop as they switch to cleaner and more efficient forms of energy. China and India, for example, have been able to slow the rate of growth in oil consumption without sacrificing economic growth.

At lower levels of income, the transition to more modern fuels can trigger a substantial improvement in human development. So while it might be tempting to encourage countries at early stages of economic development to reduce their dependence on oil, this could also deny many people the benefits of modern energy – not just the comfort and convenience it brings but also the economic opportunities it creates. Nevertheless, it should be possible to enable poor people to switch to some extent to non-oil sources without sacrificing human development. Even if the poor now rely on kerosene and LPG as 'transition fuels,' they can, as their incomes increase, switch to natural gas or electricity.

National vulnerability to oil price increases depends not just on oil intensity and on how much of the oil has to be imported, but also on the resilience of the economy. To highlight the relative vulnerability of countries, this Report presents an 'Oil Price Vulnerability Index'. It incorporates variables that represent economic strength, economic performance and the extent to which countries base their growth on the use of oil. The country occupying first place, that is, the least vulnerable, is Iran, followed by China and Malaysia. At the other end of the scale are countries with low economic strength, lower economic performance and high oil dependency – such as Cambodia, Maldives and Vanuatu.

Based on their OPVIs, countries can be grouped into one of three categories: high, medium or low:

- *Low vulnerable countries (low OPVI)* – China, Iran, Malaysia
- *Medium vulnerable countries (medium OPVI)* – Bhutan, India, Indonesia, Mongolia, Myanmar, Papua New Guinea, Thailand, Viet Nam
- *High vulnerable countries (high OPVI)* – Afghanistan, Bangladesh, Cambodia, Fiji, Lao PDR, Maldives, Nepal, Pakistan, Philippines, Samoa, Solomon Islands, Sri Lanka, Vanuatu

Reducing oil price vulnerability

What should countries do to reduce their vulnerability? Clearly, they will want to boost supplies and restrain demand. But they will also need to find ways of managing oil price risks while at the same time preparing for potential oil shocks. The options can be divided into five categories:

In contrast to the 1970s, recent increases in oil prices have been due more to strong demand than to tight supplies

Managing oil price risk – Many governments have shielded consumers from the effects of oil price rises through a series of pricing measures that have regulated the 'pass-through' of global prices to domestic prices. They have often, for example, subsidized petroleum products, smoothed prices for consumers by adjusting the rates of taxation, or passed the subsidy burden on to the private sector by requiring companies to absorb international oil price increases. Governments can also try to offset the impact on the poor by compensating them in various ways, through cash transfer schemes and other forms of safety nets. To deal with price volatility, they might also be able to use sophisticated financial products, including futures and swaps. Other options include building up oil price stabilization funds and engaging in long-term supply contracts.

Enhancing oil supply – Though the supply of oil is finite, governments can take a number of measures to enhance supplies. They can, for example, strengthen oil exploration and extraction and increase refining capacity. They can also diversify their sources of supply, by investing in foreign oil fields, perhaps, or importing from a wider range of countries, or tapping the region's own oil resources by expanding cross-border trade between producing and consuming countries. Another option is to engage in barter, trading manufactured products, industrial crops or services for oil.

Restraining oil demand – This does not mean cutting demand at the cost of economic or social activity, but rather increasing efficiency and concentrating the use of oil on purposes for which cheaper alternatives are unavailable. In the transport sector, this would include improving public transport and reducing fuel wastage in cars through congestion charges in cities, and encouraging industry and households to use energy-efficient equipment.

Diversifying fuels – Restraining demand for oil will have to be accompanied by efforts to switch, in the medium and long term, from oil to alternative sources, including natural gas, coal, large hydro and renewable energy technologies. The consumption of natural gas, for example, is expected to rise significantly, particularly for power generation and also to some extent for transport. Some countries also have the option of using more coal, particularly through clean coal technologies.

Preparing for emergencies – Each country also needs to prepare for abrupt disruptions in oil supplies, by building strategic reserves, for example, or making plans for rationing.

Options in renewable energy

One of the most promising forms of fuel diversification is to make greater use of renewable energy sources. These include small hydro, biomass, wind, solar and geothermal sources as well as biofuels for transportation. These options are becoming increasingly viable: the technology is developing fast, and in many situations small-scale renewable energy is now the cheapest option for the poor.

Renewable energy technologies are already being used to provide power to electrical grids. Most of this is coming from large hydro systems, but increasingly countries are considering small hydropower installations along with wind energy. The other main source for grid electricity is biomass, using agricultural wastes, such as bagasse, rice husk, wood wastes, and palm oil empty fruit bunches. In many cases, renewables can generate power competitively with fossil fuel sources.

The national grid does not, however, always extend to the poor in the more remote areas, who typically have to rely on gasoline- or diesel-powered generator sets for electricity in either off-grid or mini-grid systems. For these purposes, renewables can be cheaper than gasoline or diesel – though solar photovoltaic systems usually work out more expensive. These developments have considerable significance for poor and remote rural communities that use off-grid or mini-grid electricity for heating and lighting as well as for boosting production and household income.

Conventional energy systems tend to have low capital costs but significant operating costs. For renewable systems, the picture is reversed: capital costs are high, but, over time, these are offset by low operating costs. Added to this are the environmental benefits, the prospect of increased employment, reduced import dependence, and reduced burden on foreign exchange.

However, the marketplace does not account for any of this value creation. Nor does it regard the rural poor as good credit risks, seeing off-grid systems as high-risk, low-return propositions. In the past, some governments have responded with large subsidies in the hope that this would attract the private sector into the market. But it now seems unlikely that this on its own will do much to deliver energy services to the rural poor. Instead of withdrawing to let private markets develop on their own, a better approach is to work alongside local communities and the private sector to remove barriers and reduce risks.

Another important renewable option is the use of biofuels – either bioethanol, which comes mainly from corn or sugar cane, or biodiesel from refined vegetable oils such as rapeseed, soy, palm and coconut. One of the newer options is *Jatropha Curcas*, a fast-growing, drought-resistant perennial that can be planted even in wastelands. In preliminary applications, it has shown a high oil content and can be burned in a simple diesel engine without being refined. However, there is a widening and increasing recognition of the need to further assess the economic viability and the ecological, environmental and social impacts of growing *Jatropha* as experience of cultivating this plant for commercial use has been limited to date.

Even today, some biofuels are competitive with petroleum-based products. Others can compete only with the help of subsidies, though with improved technologies and economies of scale, prices generally are coming down. Nevertheless, even if biofuels are competitive, they may not always be a good choice. The rapid recent increase in biofuels production has triggered concerns about the negative impact on food supply and prices. Using food crops such as corn to produce ethanol will push up the prices of corn and corn-derived food items. There is also concern about converting land from food crops to biofuel feedstock crops, with the danger that biofuels development, instead of helping to reduce poverty by providing employment in growing the feedstocks, could instead exacerbate food insecurity. There are also environmental risks in converting forests to monoculture biofuel feedstock plantations, in addition to age-old rural and agricultural development issues such as land tenure. All these issues need to be dealt with properly, assuring fair and equitable sharing of profit and income with the poor.

Policies for an uncertain oil price future

What can the countries of the region do to protect themselves in an increasingly uncertain energy environment? To arrive at a more precise sequence, it is useful to consider different possible scenarios. The four proposed in this Report are: *baseline*, *supply shock*, *peak oil price* and *energy security*.

- *Baseline* – Oil prices remain between US$65 and US$75 per barrel.
- *Supply Shock* – A supply crisis suddenly pushes prices beyond US$100 per barrel in the short to medium term, but over the long term prices decline to their previous levels.
- *Peak Oil Price* – This scenario reflects the Hubbert's Peak theory, according to which, world oil production will start to peak. Prices rise gradually toward US$100 per barrel and increase exponentially thereafter.
- *Energy Security* – Concerns for both energy and environmental security lead to reduced oil demand, so prices fall back to a lower equilibrium at around US$50 per barrel.

Given these scenarios, which strategies should governments adopt? The scenarios to which they immediately need to respond are the first three – baseline, supply shock and peak oil price. Long-term strategy, however, is to move to an energy secure scenario. In order to bring prices to a lower level, many conscious policies need to be pursued. While some such policies might be inherent to the first three scenarios, these by themselves will not be sufficient to engineer a lower oil intensity. In the early years under the energy secure scenario, it is possible that prices get reduced due to a drop in absolute demand, meaning curtailment of consumption. But in later years, lower prices can be sustained without compromising demand growth only through conscious policies on efficiency and fuel substitition. Table 1 ranks the significance of the strategies for each scenario from 1, the least important, to 5, the most important. Not surprisingly, when it comes to the sudden shock scenario, emergency preparedness jumps into first place. While these listings give an overall indication, the list of priorities will depend on national circumstances and opportunities.

The Report also gives a detailed listing of strategies and sub-strategies for the four focus countries: China, India, Indonesia, and Lao PDR – policies that could also be extended to other countries in the region that have similar OPVI scores. Much will depend, however, on each country's source of vulnerability; countries for whom vulnerability derives from overdependence on oil rather than economic fragility, for example, will need to concentrate more on fuel diversification.

Safeguarding the interests of the poor

Rising oil prices have had a serious impact on the poor, causing some rural households to revert either completely or partially to biomass fuels. Policies to help the poor include:

- *Cooking fuels* – Providing access to sustainable wood resources, as well as to solar- or biogas-powered cookers, LPG and in some cases piped natural gas.

Table 1 Priority of strategies during each oil price scenario

	Managing oil price risk	Enhancing oil supply	Restraining oil demand	Fuel diversification	Emergency preparedness
Time frame	*Short-term, medium-term*	*Medium-term, long-term*	*Short-term, medium-term, long-term*	*Short-term, medium-term*	*Short-term, medium-term*
Baseline	5	2	4	1	3
Supply Shock	4	1	3	2	5
Peak Oil Price	5	1	4	3	2

- *Subsidies* – Offering cash transfers to eligible beneficiaries through coupons, bank transfers or smart cards.

- *Transport* – Introducing smart cards or other mechanisms to provide poor households with access to public transport at subsidized rates.

- *Liquid biofuels* – Developing bioethanol and biodiesel to boost rural agricultural production and employment, particularly for remote mountainous and island communities.

- *Income generation* – Investing in decentralized renewable energy sources to offer new power sources for households and for productive activities.

In pursuing such recommendations, countries in the region should also be able to rely on support from bilateral and multilateral development agencies, which can help build alliances and institutional frameworks, promote research and advise on some of the necessary mechanisms, such as oil price stabilization funds and innovative compensation and subsidy schemes.

Proposal for a regional compensatory oil finance facility

With small foreign exchange surpluses and low or no trade surpluses, many least developed countries in the region will see their current account deficits widen and could increasingly sink into debt in order to pay for more expensive oil imports. One solution would be to create an Asia-Pacific Compensatory Oil Finance Facility. This would have two purposes. First, it would enhance a country's liquidity to help it overcome a balance of payments or fiscal deficit. Second, it would help the country finance essential structural changes to reduce its dependence on oil. A portion of the financial assistance could also be earmarked for measures to enhance energy access for the poor. The facility could derive the bulk of its funds from bonds issued in regional and international capital markets, supplemented by donor grants, along with financing from existing international exogenous shocks facilities.

Where do we go from here?

Along with the rest of the world, developing countries of the Asia-Pacific region face an uncertain oil future. While no one can predict how oil prices will move in the coming years, more signs seem to indicate an upward move than not. But in the final analysis, they converge on a single point, which is that the world's finite oil resources will one day or another be exhausted.

Yet for the poor to rise above poverty, they will have to consume more electricity and modern fuels, including oil. Failure to ensure this means the poor will remain poor – indeed millions will slip back to relying on biomass fuels and human labour, back to eking out subsistence-level incomes while the rest of the population moves farther ahead in social status and economic affluence.

This Report outlines a range of solutions to prevent this from happening. While each country will doubtless weigh them in the light of its own circumstances, the broad direction should be clear. While adopting strategies to secure the future of their economies, all developing countries must alleviate the suffering of their poor in the immediate present. This means providing the poor with essential relief against rising fuel prices, by way of focused subsidies, compensation and direct cash transfers. Simultaneously, a concerted effort is needed to shift the future trajectory of energy consumption, not only of the poor but also of whole economies, away from a reliance on oil. Reducing the oil intensity of development is no longer a matter of choice; it is the only course. The time to act is now – before affordable oil becomes a distant memory.

How oil price rises have hit the poor

1

Will soaring oil prices dash the poor's hopes of escape from poverty? This is a distinct possibility if alternatives are not found quickly. In a number of countries, rising costs of domestic fuels and public transport have severely affected poor households. In some cases, the ensuing discontent has spilled out onto the streets. Now at record levels, oil prices pose an unforeseen challenge to the Millennium Development Goals – crucially, the overarching goal to eradicate extreme poverty and hunger.

This Report examines the impact of rising oil prices since 2003 on developing countries of the Asia-Pacific region. Its central aim, captured in this chapter, is to find out how the poor in these countries have fared in the past five years of high oil prices, and what needs to be done to protect their interests. The Report is framed by the awareness that even after a persistent five-year run from around US$22 to over US$80 a barrel, global oil prices show little indication of easing. With futures markets pricing a barrel of oil at more than US$100 a year from now[1], the impacts observed so far may presage worse to come.

A key feature of the ongoing oil price 'shock' is that it has arrived in the midst of a global economic boom from which the Asia-Pacific region may have benefited most. As a result, the region as a whole has managed to sidestep economic downturns of the kind triggered by past oil price spikes. Although some signs of strain are showing of late, the macroeconomic fundamentals of most countries have, by and large, remained intact. However, underneath this fabric of general well-being, the poor are being hurt in numerous ways by rising fuel prices. Many are being forced to surrender hard-won gains in their lifestyles and livelihoods. If their problems are not resolved, their distress can escalate into a larger socioeconomic setback.

This introductory chapter revolves around case studies of 14 rural and urban communities in China, India, Indonesia and Lao PDR. Though limited in scope, the case studies offer a lens through which to view ground-level realities largely lost in the glare of aggregated statistics at national levels. The story they tell is disturbing.

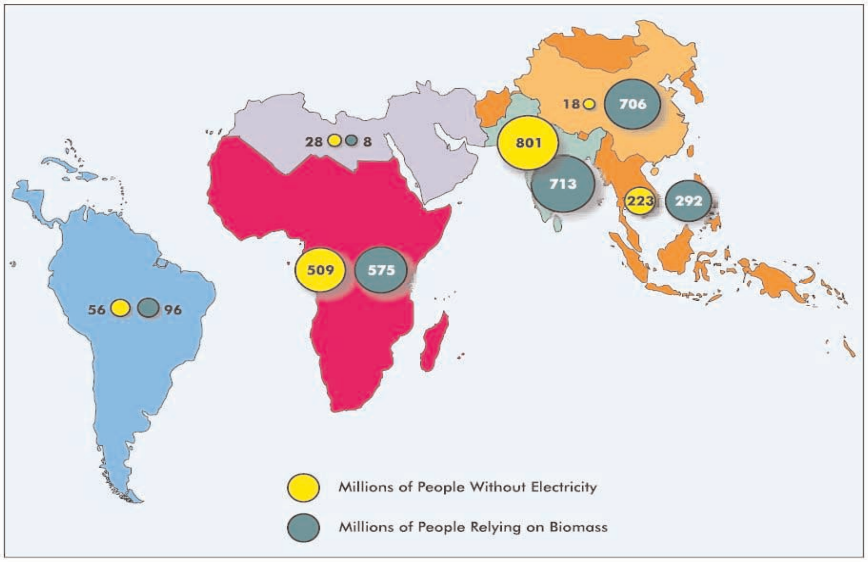
The energy connection to poverty

Energy deprivation is a defining characteristic of poverty and a formidable barrier to its resolution. In order to understand the impacts of oil prices on the poor, one must first grasp the role that energy plays, or fails to play, in their lives.

The Asia-Pacific region is home to more than half of the world's population and two-thirds of its poor. While the proportion of people surviving on less than US$1 a day fell from 31 to 20 percent between 1990 and 2001, the poor population's absolute number remained high, at 679 million (UNESCAP 2005). The majority of these people live in rural areas with no, or low, access to electricity and are unable to afford more than a modicum of modern fuels like kerosene for essential lighting. At the same time, relentless urbanization, projected to increase between 2000 and 2030 from 35 percent to 53 percent of the population (UNDESA 2002), has been steadily shifting poverty from rural communities to urban settlements. Although the urban poor may seem to have better access to fuels and electricity, many continue to rely heavily on inferior biomass for cooking which, in poor households, is the single largest use for energy, because they cannot afford modern energy alternatives (Appendix A.1 details the socioeconomic and energy profiles of the region).

Poverty in the region is thus closely linked to high biomass consumption and low access to electricity (Figure 1-1). As many as 72 percent of the world's people who depend on biomass fuels live in the region. Nearly a third of the population,

Figure 1-1 Electricity access and biomass dependence in developing countries



Note: The boundaries and names shown on the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Source: IEA 2002a

more than 1 billion people, in Asia-Pacific developing countries lacked access to electricity in 2000. It is estimated that 1,000 kilogrammes of oil equivalent of energy is needed per individual annually to ensure an acceptable standard of life (Goldemberg & Johansson 1995). Against this, an individual in poorer countries of the region consumes just 400 kilogrammes of oil equivalent or less, and even this consists largely of fuelwood, agricultural residue and animal waste.

The evidence is compelling. Raising the poor's consumption of modern fuels – including oil-based ones like kerosene, diesel and liquefied petroleum gas (LPG) – and electricity is essential for eradicating poverty. These energy sources are vital for meeting the poor's day-to-day needs and assuring them of a minimum level of human comfort. More important, they are a prerequisite to help the poor break out of poverty by putting energy to use in productive activities that currently involve onerous, and wasteful, human labour.

The very state of being poor encompasses a vicious cycle that denies people the energy they need to rise out of poverty

The connection of energy to poverty is fundamental. It is also a paradox, in that the poor are caught in a vicious cycle whereby the very state of being poor denies them the energy they need to rise out of poverty. If the cost of energy goes up, as is now happening with oil, prices not only perpetuate this vicious cycle, but can also drag people who have escaped poverty back to where they were. How to break out of this cycle is the dilemma the poor stare at each day and the hurdle that governments must navigate if they are to reach their MDG targets.

Who are the poor, and how important is oil to them?

The poor are everywhere in the Asia-Pacific region, although the vast majority of them – 75 percent – live in India and China. They live in rural areas, where distance and remoteness mean a shortage of all things modern, including energy. They live in urban slums that are often islands of want in seas of plenty of almost everything. They live in Least Developed Countries (LDCs) where poverty and energy scarcity are pervasive. Sometimes, they live in energy-rich countries that may benefit from the current shock. But all of them are grappling with the impact of higher oil prices.

Case studies of seven rural communities and an equal number of urban communities in China, India, Indonesia and Lao PDR covered 500 mostly poor households, which were interviewed in depth along with local authorities, public service institutions and other community stakeholders (Appendix A.2 provides the details of the socioeconomic profiles of the surveyed households).[2] These communities represent but a small splinter of the multitude of others like them across the region, but they offer learning experiences on the impacts and implications of high oil prices.

Because the underlying intent of the study was to look at the impacts of oil prices on the economically vulnerable, while establishing the extent of poverty in a community, both households living below the poverty line and 'near-poor' households just above the poverty line were considered. Near-poor households typically had incomes up to 25 percent above the poverty line[3] and are especially vulnerable to shocks since they fall in and out of poverty in large numbers.

Although absolute numbers of the poor are high in China, the survey found the lowest proportion of poor households there, with the majority in both rural and urban communities having incomes above the national poverty line. Not surprisingly, the highest proportion of the poor was in Lao PDR, where 67 percent of rural households and 75 percent of urban households fell below the national poverty line in the communities surveyed. In India, the average incomes of rural and urban households surveyed were slightly above US$1 per day, and in Indonesia they were around US$1.75 per day. The socioeconomic and energy consumption profiles of the communities in the four countries are outlined in (Box 1-1).

Notable differences exist between the energy consumption patterns of the rural poor and those of the urban poor, with oil products playing a greater role among the latter in all four countries studied. Four petroleum fuels – kerosene, LPG diesel and gasoline – feature in poor people's lives. In addition, inorganic (chemical) fertilizers used in farming depend heavily on petroleum and natural gas.

The rural poor and urban poor use energy differently, with oil products playing a greater role among the latter

Box 1-1 The view from the ground: Four countries

China

Around two-thirds of China's primary energy consumption is derived from coal, of which the country is the world's largest consumer and producer. Much of the rest comes from oil. Since 2002 China has been the world's second-largest consumer of oil products. Chinese households have also been consuming more LPG, some of which is produced locally. Between 2000 and 2003 consumption increased from 10 million to 13 million tonnes. In some regions prices have been deregulated, and increased demand has resulted in LPG shortages in regions that rely on imports.

Most households have access to electricity. In just over 50 years, China has extended supplies to more than 900 million rural residents. By 2004 it had achieved an electrification rate of 98 percent. It delivers electricity in some places through a combination of national and local grids, the latter supplied largely by small-scale hydropower in the more remote rural areas. As a result, per capita electricity consumption has been rising rapidly: between 1980 and 2004, it rose nationally by 7 percent and in the rural areas by 11 percent per year.

The surveyed communities

Two rural and two urban communities in the northern and southern regions of the country were surveyed: Tanchang village (Miaofengshan town, Mentougou district, Beijing city), Jiuyan village (Dongqiao town, Zhongxiang city, Hubei province), Chunshu street (Xuanwu district, Beijing city) and Wuhan city (Hubei province). Tanchang village is in a mountainous area 45 km from Beijing. Jiuyan village is 248 km from Wuhan city. In both villages, households use electricity for lighting, and coal, electricity, fuelwood and crop residues for cooking. Around 70 percent of their income comes from farming.

The urban settlement of Chunshu street is an area populated mostly by civil servants, private sector practitioners and service professionals, along with temporary migrants. It is a fairly well-developed district, with only around 1 percent of the population below the poverty line. The other urban settlement, Wuhan, is a city of 2.5 million households. Its infrastructure is also well developed. Residents in both communities use electricity, coal and LPG for cooking, and electricity for lighting. Wuhan has extreme climatic conditions – hot in summer, and cold, damp and cloudy in winter. Its residents use air-conditioning and cooling fans in the summer, and coal stoves and electric heating in the winter.

India

India's total energy consumption was 394 million tonnes of oil equivalent in 2003, with the residential sector being the largest consumer, followed by industry and transport. In the rural areas, 76 percent of households depend on fuelwood and other biomass, while only 5 percent use LPG for cooking. However, 51 percent of households use kerosene which, in unelectrified areas, is mainly for lighting.

In urban areas, electricity is the main source of energy for lighting for 89 percent of households, with most of the rest coming from kerosene; for cooking, 22 percent of urban households use fuelwood and other biomass, while 44 percent use LPG. Oil accounts for about 34 percent of total energy consumption. India has some local production, but 72 percent of crude oil must be imported.

The surveyed communities

Two rural and two urban communities were covered by the survey: the adjoining villages of Deepdi and Bangrasia (Bhopal district, Madhya Pradesh), Hoglagare village (Kolar district, Karnataka), Kalyanpuri slum (Delhi, part of India's National Capital Territory), and Koramangala slum (Ambedkarnagar, Bangalore, capital of Karnataka). Madhya Pradesh, where the villages of Deepdi and Bangrasia are located, is one of India's least developed states. Around 25 percent of the working population in the two villages are employed as casual labour and in the small services sector. Most houses in the village are electrified, although there are seasonal variations in supply and households experience outages of four to eight hours per day. The main cooking fuel used is biomass, followed by LPG. Kerosene is mostly used for lighting. For agricultural activities, farmers use diesel and electricity, primarily for tractors and pump sets.

Hogalagere village is 25 km from Kolar city in India's eighth-largest state, Karnataka. It is in a semi-arid, drought-prone region, but is rich in biomass resources. Three-quarters of its working population is involved in agriculture. The village is fully electrified, though power cuts are common throughout the year, especially during the summer months, and can last for 12 hours a day.

Ambedkarnagar colony in Bangalore is a slum settlement with 80 percent of its people below the poverty line. Around half work as daily labourers and the rest in private services, mainly housekeeping, courier companies and garment factories. Most families live in *kuchcha* houses – temporary structures with thatched or asbestos roofs – or semi-permanent houses made partly from concrete. Sanitation is poor and living conditions generally unhealthy. For cooking, most people either use LPG or fuelwood. Around 90 percent of the households have access to electricity. The second urban location, Kalyanpuri, is a densely populated and overcrowded area with rundown housing. Most households combine two or more cooking fuels – dung cakes or fuelwood, complemented by kerosene and LPG. However, many also use electric heaters by illegally tapping supplies from neighbouring colonies. They also use such supplies for lighting. Although the electricity is free, households occasionally have to pay a middleman to reattach disrupted connections.

Indonesia

During the 1990s, Indonesia, the only South-East Asian member of OPEC, was one of the largest oil exporters. Between 1990 and 1995, annual crude oil production rose from 467 million to 551 million barrels. It started to decline thereafter due to aging oil fields and stagnant investments in new technology. By 2006 production had fallen to 386 million barrels. However, consumption of petroleum products continued to rise, and eventually could no longer be met from national production.

Indonesia is also a major producer of coal and is expected to become the world's third-largest exporter soon, after Australia and China. Much of the local consumption is for power generation. In 2004, the country produced over 2 million tonnes. The coal is widely used by industry and by middle- and upper-class households in major cities. In Jakarta alone, LPG consumption averages around 1,500 tonnes per day. In the rural areas, however, the primary fuel for cooking and other thermal energy applications is biomass.

The surveyed communities

The rural communities covered were in two sites in the province of West Java: Mekarjaya and Sukamaju, both some 40 km from the provincial capital, Bandung. The urban settlements were Cikutra and Cisereuh in Bandung city. Most people in Mekarjaya and Sukamaju work as farm labourers or small farmers. Their other sources of income include household businesses related to local industries that often involve woodcraft and carpentry. Their main sources of energy are kerosene and fuelwood for cooking, and electricity for lighting. Some houses in these villages share electricity from a single connection, which they also use to operate television sets and music players.

Most people in Cikutra and Cisereuh work as daily labourers, in both the formal and informal sectors, while a few run their own businesses. Households in these urban communities typically use kerosene for cooking, electricity for lighting and gasoline for motorcycles, one of the main means of travelling between home and work. Unlike in the rural areas, urban consumers do not have the option of switching to traditional fuels.

Lao PDR

Lao PDR's total energy consumption increased modestly, by about 5 percent, between 1996 and 2002. The most important source of energy, accounting for 57 percent of consumption, is fuelwood. Fuel oil is next, at 17 percent. The country has no oil production or refining capacity of its own, so it has to import all its needs. Lao PDR has local deposits of coal, however, which it uses for industrial purposes. In addition, it generates significant quantities of electricity from hydropower, whose share of energy consumption rose between 1996 and 2002 from 5 percent to 12 percent. Very few people use LPG.

The surveyed communities

One rural and one urban community were surveyed: Ban Nammadao village (Luangprabang province in the north of the country) and two central districts of Vientiane city (the capital). People in Ban Nammadao are mostly engaged in traditional farming, with a minority having small shops. Most people belong to the H'Mong ethnic minority and live in traditional houses – small wooden huts with kitchen and sleeping spaces in different corners of the same room. Fuelwood, which is readily available, is their main source of energy for cooking. For lighting, they use kerosene or candles, and occasionally battery-operated torches. Other than kerosene, the use of petroleum products is very limited.

People in the urban districts of Vientiane municipality live in clusters of semi-concrete or wooden dwellings. Despite having access to both electricity- and petroleum-based fuels, many households continue to use fuelwood and charcoal for cooking – largely because fuelwood supply is still easily available. Vientiane has hot, humid summers and relatively warm winters, so almost all households use electric fans, while around one-quarter use air conditioners. All houses are electrified, but power outages make the use of candles necessary.

Kerosene

Most people without access to electricity live in the rural areas, where remoteness and high costs prevent electricity supply through the centralized grid or the use of decentralized power generating options to any appreciable extent. For rural households without electricity, kerosene is the next best option for lighting because of its relative ease of use and low (subsidized) cost compared to other options like candles or batteries. It is also an essential backup for households that have an electricity connection, but with erratic supply. This happens in both rural and urban areas, partly due to overall supply constraints and partly because of equipment breakdowns. It is used as a cooking fuel when families upgrade from biomass and inferior fuels like charcoal, but are either unable to afford or do not have access to other modern energy sources like LPG and electricity.

Lacking electricity, the poor mainly turn to kerosene for home lighting

Among the rural communities surveyed, the use of kerosene for lighting is common in Lao PDR and India, but in rather different circumstances. None of the village households in Lao PDR has an electricity connection, so kerosene is their primary lighting fuel. By contrast, all households in the two Indian rural communities have an electricity connection, although supply is highly unreliable. As a result, 100 percent of the households in one village and 73 percent in the other use kerosene as a backup. In both Lao PDR and India, all urban households in the communities surveyed have electricity, but they are less affected by power outages. Consequently, from zero to 25 percent of these households use kerosene for backup, much lower than in the rural communities.

In Indonesia, none of the rural and urban communities surveyed reported power outages, so no household consumes kerosene for lighting. The situation was similar in the two urban communities in China. Its two rural communities, however, reported some infrequent power outages, which they managed with candles.

The use of kerosene as a cooking fuel, meanwhile, is closely related to the availability of biomass fuels. Where biomass is readily available, it is the preferred fuel for both convenience and cost reasons among rural and urban households alike in India, Indonesia and Lao PDR. Kerosene for cooking is used mainly by non-poor households and sparingly by a minority of poor households. The situation among the communities surveyed in China, both rural and urban, is different. In their case, alternatives to kerosene are wider, comprising biomass, coal, LPG and electricity. None of the Chinese households reported using kerosene for cooking.

LPG

Convenience, efficiency and cleanliness make LPG the preferred choice for cooking for most urban households, but not necessarily so for rural households, which either have concerns over its safety or feel traditional fuels are more compatible with their cooking habits. The main barriers to its use are its availability and cost. LPG is a pressurized mixture – consisting primarily of propane or butane, or both – usually sold in cylinders for domestic use. Its retail distribution requires a transport network more readily available in urban areas and less so in rural areas. More important, its higher cost compared to biomass, charcoal and kerosene limits its use to households that have the necessary income.

LPG use for cooking was observed in only four of the 14 communities surveyed. All are urban communities and almost entirely non-poor. These households also often use kerosene as a backup or as a supplement, for example, using it for certain cooking tasks while limiting LPG use to others. This has a bearing on poor households: while they have little to do with LPG, they can be affected if its supply is disrupted, causing kerosene consumption among non-poor LPG users to rise and creating potential supply problems with the kerosene that poor households do use.

LPG is also very occasionally used as a transport fuel. Among the 14 communities surveyed in all four countries, just one urban (non-poor) household in India reported using it, for a three-wheeled vehicle.

Diesel

Diesel has multiple uses in rural communities: as a transport fuel in public and private vehicles, as a fuel for farm machinery (tractors, threshers, irrigation pump sets), and as a source of electricity in power generators catering for a variety of domestic and commercial applications, such as lighting, grinding and operation of electrical machinery. Urban households use it mainly as a transport fuel, while urban establishments – hospitals, hotels, shopping and apartment complexes – also employ it in power generators as an emergency backup against grid outages.

Diesel for public transportation creates access to a variety of services, from education and health to markets and employment

Given its versatility, diesel is used for one purpose or another by all households in all communities surveyed. However, its use among poor households is confined largely to public transportation. This is because diesel-using equipment is capital-intensive and, more often than not, beyond the reach of the poor. Few poor households in the four countries reported the direct use of diesel for transport, farming or power generation, although one household in India reported using a diesel lamp.

The poor's indirect use of diesel through public transport vehicles is, however, extremely important, because these vehicles are their main means of conveyance to markets, schools, health facilities and places of work in rural areas. This is equally true for those in urban areas; many people commute routinely to their places of work and markets, with migrant workers also relying on public transport to travel to their home villages. In Lao PDR, for instance, 61 percent of the national petroleum product demand is for diesel, the bulk of which is for public transportation.

In all communities surveyed, reliance on public transportation is pervasive, highest in three of the communities where none of the households own a personal vehicle. The situation is somewhat better in the other communities where personal vehicle ownership, usually of motorcycles, range between 8 and 14 percent in India and Indonesia, and between 16 and 43 percent in China. The exception to the trend, surprisingly, is in Vientiane (Lao PDR), where 92 percent of households in the community surveyed – with 75 percent living below the poverty line – own motorcycles. This arises from weak public transport facilities in the city, where public vehicles are limited in number and serve only select routes.

Gasoline (petrol)

Expenditures on petroleum-based chemical fertilizers can be a considerable burden on farmers' limited cash resources

Gasoline is used mainly in private vehicles (cars and motorcycles). It is also a source of backup electrical power, though on a much smaller scale than diesel generators. It is consumed by households that own personal vehicles in the communities surveyed. With the exception of Vientiane, ownership of private vehicles among the poor is low to zero in the communities surveyed. No community reported using gasoline in power generators.

Chemical fertilizers

Chemical fertilizers are important to ensure the food security of developing countries in which population pressures on available agricultural land are continuous and, therefore, increasing the productivity of soil is critical. Most chemical fertilizers contain compounds of nitrogen, phosphorus and potassium, commonly known as NPK fertilizers. Although these basic chemicals can be derived from a number of sources, petroleum products like naphtha and fuel oil, along with natural gas, are a major feedstock for them. They are also used to produce a variety of pesticides, herbicides and insecticides essential to crop production.

To the extent chemical fertilizers are produced from petroleum products, their use amounts to an 'indirect' consumption of energy. Expenditure on such indirect energy consumption can be quite substantial for poor households, at times even more than what they spend on petroleum fuels in direct energy consumption. For instance, poor farming households in the mountainous Sichuan province of China spend as much as 16 to 32 percent of their recurring expenditure on chemical fertilizers to extract the most from a reluctant land under harsh climatic conditions, against only 4 percent on kerosene, candles and electricity from decentralized micro-hydro systems (Ramani 2003).

The use of chemical fertilizers is widespread in all rural communities surveyed for this Report in China, India and Indonesia. Lao PDR is the exception, where rural people rely mostly on natural organic fertilizers like crop residue and animal waste. The extent to which poor households consume fertilizers depends largely on whether they own agricultural land or are employed as farm labourers.

By this measure, the largest numbers of poor households using chemical fertilizers were in the two rural communities surveyed in China, one with 97 percent and the other with 69 percent. China's land tenure system combines private rights with public ownership, with agricultural land nominally owned by village collectives but allocated among individual households who operate it. This results in the vast majority of households, poor or not, using fertilizers in both villages.

On the other hand, private ownership of farm land in India and Indonesia tends to exclude the poor (though not the near-poor). Hoglagare village in India, for instance, has a poor household population of 28 percent, the same as the proportion of households depending on daily wages as their primary source of income. As many as 65 percent of the households in Sukamaju in Indonesia and 69 percent in Deepdi-Bangrasia in

India are similarly dependent on daily wages, implying their lack of ownership of agricultural land and, therefore, the lack of fertilizer use as well.

This picture of consumption patterns in the four countries leads to the following conclusions about the extent of the poor's dependence on oil:

- Kerosene for home lighting and diesel for public transportation are the most critical oil products for the poor. Where the poor own or operate agricultural land for their own benefit, petroleum-based chemical fertilizers are just as important.

- The poor's modest consumption of kerosene, often just one to two litres a month, does not add up to a significant share of the total petroleum product demand in developing countries. But this can be deceptive: lighting is vital for human life. Its presence or absence affects a wide range of human activities upon which it is hard to place an economic value.

- Because the demand for kerosene arises mainly from the lack of electricity, a reliable electric supply can reduce or eliminate the poor's dependence on kerosene. It also can lower their consumption of diesel in non-transport activities, such as irrigation and drinking water pumping.

- The diesel consumed indirectly by the poor via public transportation enables them to access a variety of services, from education and health to markets and employment. Reliable data are hard to come by on the proportion that the poor's diesel consumption occupies in national petroleum demands. However, as with kerosene, its value to the poor is very high because it makes the difference between connecting with the outside world and being isolated.

- Meeting the poor's cooking energy needs – which account for as much as 80 percent of their total household energy consumption – through petroleum products will be a huge challenge. While it is socially and environmentally desirable to help poor households make the transition from biomass fuels to cleaner ones like kerosene, LPG and electricity, the cost of such a move can be substantial, given the large numbers of poor currently relying on biomass.

- Expenditures on petroleum-based chemical fertilizers can be a considerable burden on the limited cash resources of poor farmers. This can be reduced by switching to organic fertilizers, such as slurry from biogas digesters, or inorganic fertilizers made from other sources like coal.

Exposing the poor to the oil price shock

Shrinking subsidies and soaring prices

The main outcome of the ongoing high oil price spell has been a gradual, and in some countries abrupt, rise in the retail prices of oil products. Before oil prices began their upward spiral in 2003, the prices of oil products that matter to the poor were largely regulated by governments in most developing countries of the region; in other words, governments subsidized the prices of such products to ensure the poor could afford them.

However, as the price of crude oil in world markets has continued to surge, the mostly oil-importing countries of the region have struggled to sustain this policy. The widening gap between international costs and domestic prices of oil products has stretched their capacity to maintain subsidies at the same levels as in the past.

Governments subsidized the prices of oil products to ensure the poor could afford them, and now that capacity is overstretched

Juggling between the need to rein in a ballooning subsidy burden on government finances and the imperative to protect the poor's interests has not been easy. While the overall trend has been to move domestic product prices closer to world market prices, most governments have approached the process of price liberalization gingerly, feeling their way through depending on their respective economic circumstances. But mounting pressure from world markets has forced them to hike domestic prices in larger increments in more recent years.

As a result, the poor find the subsidy shield being stripped away from them, and they resent it. In some countries where retail prices have jumped sharply, the resentment has erupted into a public backlash, posing a dilemma for governments torn between the conflicting priorities of fiscal prudence and social justice (Box 1-2).

An important indicator of the extent to which oil product prices are being deregulated is the 'pass-through coefficient,' which has varied from country to country. This is the ratio of change in domestic retail prices over a given period to the change in corresponding international product prices during the same period. The higher the pass-through coefficient, the closer domestic retail prices will get to international prices.

Box 1-2 Public protests over fuel price increases

Bangladesh – Bangladesh's capital city of Dhaka has ground to a halt, gripped by protests over high fuel prices. Police said that some 4,000 riot police were on standby. Shops, offices and schools remained shut, although government offices and state-run banks opened as usual. Police sprayed water cannons from riot cars to disperse activists, and early reports said roads were mostly deserted.

The Government increased prices of oil products by almost 14 percent earlier this month. Many people are already struggling to cope with higher bills for water, gas and electricity. The state Minister for Energy has blamed the increase in fuel prices on the high cost of crude oil in the international market.

Arab News, 19 September 2005

Nepal – Shops are closed and vehicles are off the roads in Nepal's capital, Kathmandu, as angry protests against steep fuel price rises continue for a second day. Protestors have been out in the streets, and the city is now littered with burning tyres and road barricades. On Saturday, protestors blocked all routes into and out of the city and attacked or burnt dozens of vehicles and buildings, including petrol stations.

Price hikes of up to 35 percent were announced on Friday but the government Minister concerned has hinted that there may now be some reductions. These are crippling price rises hitting one of Asia's poorest countries. The basic retail cost of petrol has gone up by 25 percent at once, and by much more in some rural areas. The price of paraffin, the commonest cooking fuel, has risen by a similar amount, and that of diesel by 11 percent.

BBC News, 20 August 2006

Myanmar – In a major demonstration in recent times, over 500 people spearheaded by prominent pro-democracy activists on Sunday took to the streets of Myanmar's biggest city, Yangon, protesting against the recent unprecedented and massive hike in petroleum prices.

On August 14, the military rulers of Myanmar increased the price of compressed natural gas by 500 percent and petrol and diesel by more than 100 percent, without any prior announcement. The fuel price hike triggered an increase in bus fares and sent prices of essential commodities soaring.

Mizzima News, 19 August 2007

Table 1-1 illustrates how the pass-through has been lower for diesel, which has greater relevance for the poor, compared to that of gasoline, which is consumed mostly by the non-poor, in the four countries surveyed. A value in excess of one indicates a faster *rate of change* in domestic prices than that in international prices. It does not mean domestic prices have reached parity with international prices by removing subsidies altogether. Rather, it signifies that countries starting from a low price level (high subsidies) have had to reduce them more rapidly to catch up. In all four countries, varying elements of subsidies remain. Also, while reducing subsidies, their governments have adopted other measures to compensate the poor to some extent.

Table 1-1 Pass-through coefficients for gasoline and diesel in local currency (January 2004-April 2006)

	Gasoline	Diesel
China	0.71	0.53
India	1.25	0.66
Indonesia	1.20	1.02
Lao PDR	1.86	1.35

Source: ESMAP 2006a

Differences – at times steep – exist between official price increases sanctioned by government policy or national average prices and what the poor actually incur. The reasons behind this are:

1) *Transport costs* – Distance determines the cost of transporting fuels, over and above the costs of the fuels themselves. Hence, communities in more distant locations may incur higher end-user prices.
2) *Intermediary costs* – Where people consume fuels indirectly, as with public transport services, additional costs may be hidden in transport tariffs. Such costs could be legitimate – for example, to cover higher wages of employees of transport service providers as a result of inflation – or opportunistic, when service providers piggyback higher profit margins over a government decision to increase fuel prices.
3) *Scarcity costs* – What are often called 'black market prices' are, in fact, prices loaded with a supply shortage premium, often due to unscrupulous practices like hoarding, diverting subsidized fuels intended for the poor to the open market and so on. Or they may be those governed by market dynamics, such as meeting demand that exceeds rationed quotas or during a real supply crunch.

The policy changes that have occurred in the four countries are described at length in Chapter 4. They are summarized briefly in the next part to provide the context for the price rises faced by the poor between 2002 and 2005.

China

Since 1998, China has linked petroleum prices to average crude oil prices in the international market. It also adjusts retail product prices, generally when there is a difference of more than 8 percent between domestic prices and the weighted average of prices in New York, Singapore and Rotterdam. It further subjects petroleum products to excise duties and value added tax (VAT).

Oil product prices in the country have been rising steadily according to this formula since 2002, in tandem with international market prices. In March 2006 the government imposed a special oil income levy on revenues earned by state-owned oil enterprises from the sale of locally produced crude oil. As a result, ex-refinery retail prices of gasoline and diesel increased further, by 10 to 15 percent.

To counter the increases, the government provides targeted subsidies for certain groups: fishers, farmers, state-owned forestry enterprises and urban public transportation firms. Early in 2006, for a limited period, some provinces also offered cash compensation to poor residents to offset rising LPG prices.

Figure 1-2 shows the overall increase in fuel prices nationwide between 2002 and 2005. While coal prices remained low, the price of LPG jumped substantially, and the prices of diesel and gasoline more than doubled.

While these increases are significant enough, households in the communities surveyed indicated their energy expenditure has, in fact, risen far more sharply (Figure 1-3):

- Against the national average increase of 100 percent in the price of coal and 56.5 percent in the price of LPG, rural households reported an increase of about 215 percent in their expenditure on cooking fuels. The increase was steeper among urban households, at around 290 percent.

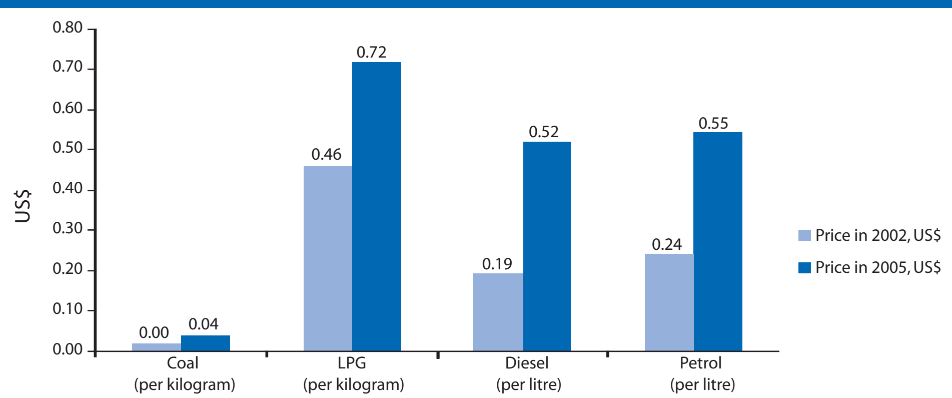
- Diesel and petrol prices increased across the country by 174 percent and 129 percent respectively, that is, an average of 151.5 percent. Transport expenditure among households in the communities surveyed rose faster, by about 218 percent in the two villages and by 305 percent in the two urban areas.

- Increases in public transport tariffs paid by households were, however, kept low at between 25 and 35 percent as a result of government subsidies to the transport companies. Overall, urban households encountered steeper increases than rural households, as reflected in their overall energy expenditure, which rose at twice the rate of the latter.

India

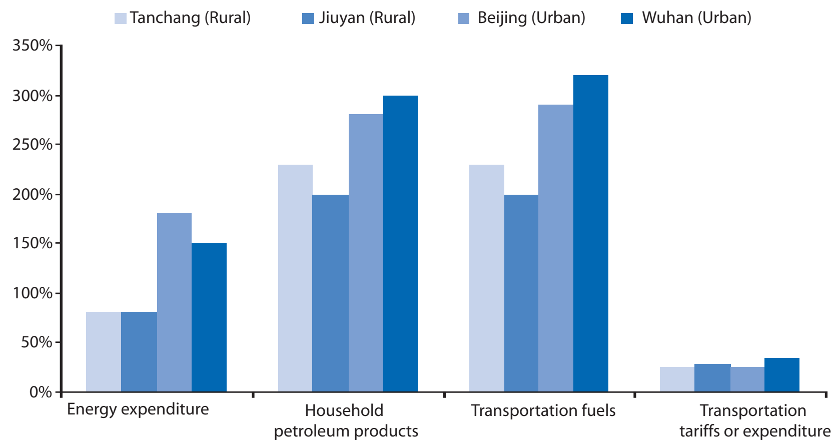
Until 2003, India had an administered pricing mechanism for petroleum products. This has now been dismantled. However, while the price of indigenously produced crude oil is linked to international crude prices, the oil marketing companies are not free to set the prices of petroleum products and have to absorb losses arising from government control over product prices. Since 2005, the government has issued 'oil bonds' to these companies to offset their losses.

Figure 1-2 China – changes in prices of petroleum products and other fuels



Retail price of coal and petroleum products in China, US$

Figure 1-3 China – energy expenditure changes experienced by poor communities



In spite of the subsidies, India has South Asia's highest retail prices for both petrol and diesel. This is due to high levels of taxes and duties – about 50 percent of the retail price consists of basic excise and customs duties – and the government applies additional duties to fund certain activities, such as road construction.

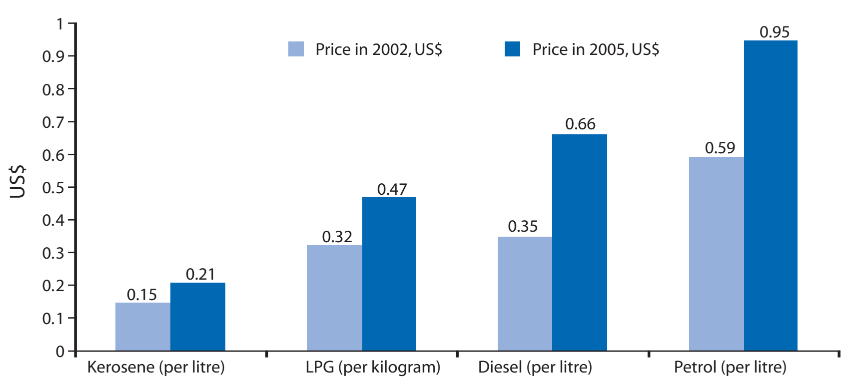
To protect the most vulnerable consumers, the government subsidizes the prices for household consumption of LPG and kerosene, on which it has removed customs and excise duties since 2004. Schemes also exist to improve electricity access to poor homes, such as the *kutir jyoti* or 'bright home' programme, subsidise electrical power for agriculture, and develop biogas plants and improved stoves in rural areas.

The average retail price increases in the country from 2002 to 2005 are shown in Figure 1-4 and the increase in household energy expenditure is shown in Figure 1-5. Increases in the prices of kerosene and LPG have been quite modest, largely because of continuing subsidies. In practice, though, these fuels are not always available at the official prices, forcing many households to buy on the black market. The increases have been larger for transportation fuels, in spite of the government's attempt to keep prices down by obliging refining companies to bear the losses.

- Households in the communities surveyed reported an increase of about 20 percent in kerosene prices, half the increase in the national average. This reflects the government's measure to remove customs and excise duties on domestic cooking fuels.

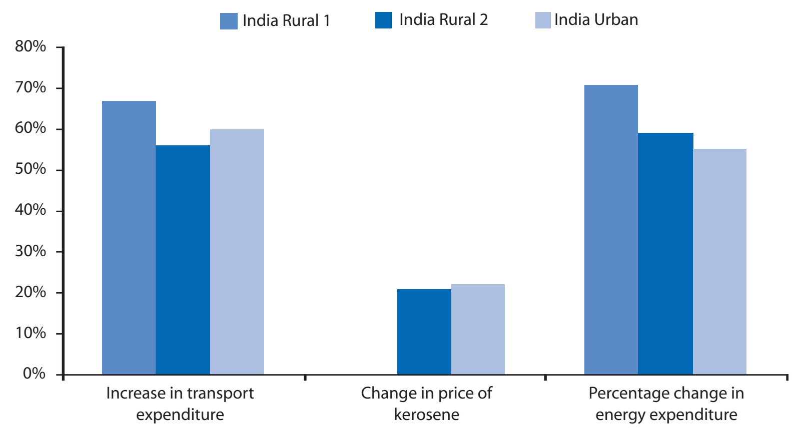
- Household expenditure on transport rose at a rate of 63 percent in rural communities surveyed and 60 percent in urban communities. This was somewhat lower than the average increases of 88.5 percent in the price of diesel and 61 percent in the price of petrol, mainly because of reduced consumption of these fuels.

Figure 1-4 India – changes in prices of petroleum products



Retail prices of petroleum products in India, US$

Figure 1-5 India – energy expenditure changes experienced by poor communities



- Overall energy expenditures in rural households rose faster than in urban households. However, urban households were worst affected by the price rise in cooking fuels since the rural households rely on traditional fuels.

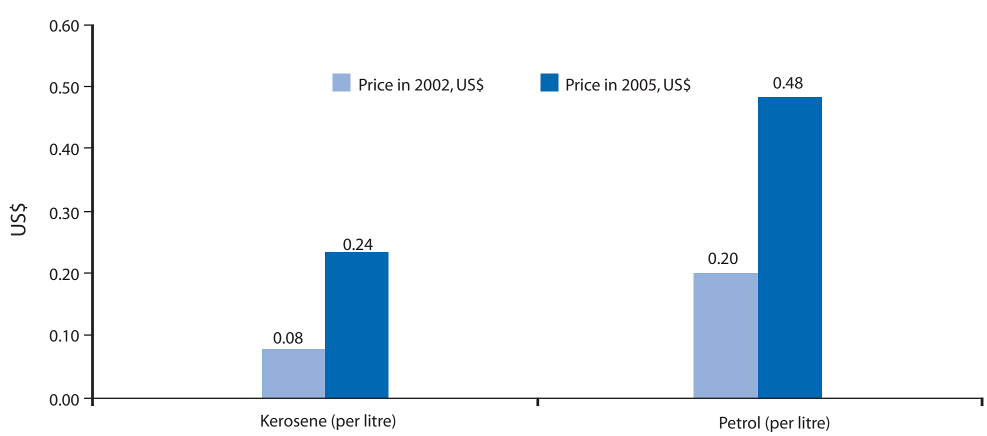
Indonesia

Since the Asian financial crisis of 1997, the Indonesian government has provided large subsidies for domestic retail fuels, equivalent to 5.5 percent of GDP in 2000 (IMF 2003). In 2002, however, it introduced an automatic price adjustment system under which Pertamina, the state-owned oil company, resets the prices of domestic oil products each month (except for kerosene), at 75 percent of international prices. In September 2005, the government announced another sharp rollback of subsidies, which more than doubled the retail prices of gasoline and diesel.

To protect the poor from the effect of these increases, the government uses some of the savings from the reduction in subsidies to introduce a programme of cash transfers. These are aimed at financing poverty reduction, rural development, and education and health programmes. The government still maintains subsidies on kerosene prices, although there have been moves toward more targeted subsidies.

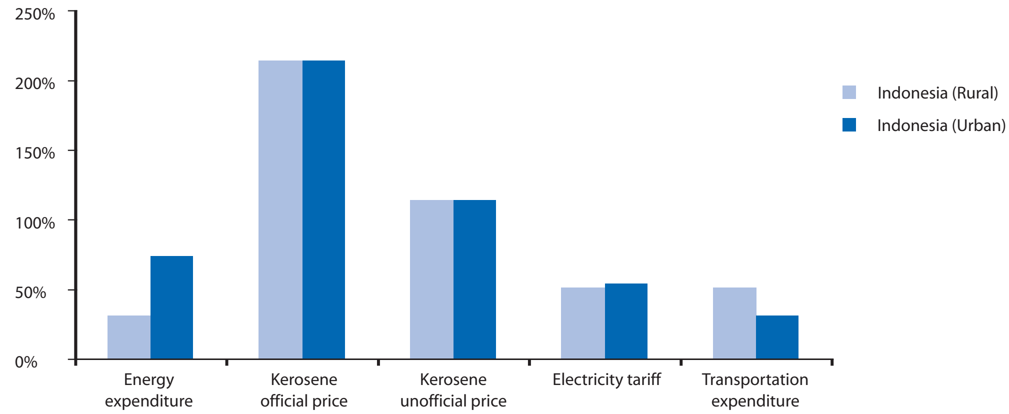
By 2020, Indonesia aims to extend electricity access to 90 percent of the population through novel approaches based on community initiatives and diversified business and financing models. In addition, an Asian Development Bank-aided scheme supports the deferment of start-up costs of new electricity connections for poor families in the outer islands.

Figure 1-6 Indonesia – changes in prices of petroleum products



Retail price of petroleum products in Indonesia, US$

Figure 1-7 Indonesia – energy expenditure changes experienced by poor communities



Changes in fuel prices in Indonesia between 2002 and 2005 are indicated in Figure 1-6 and the corresponding increases in the energy expenditure of households are expressed in Figure 1-7. A comparison of the two shows:

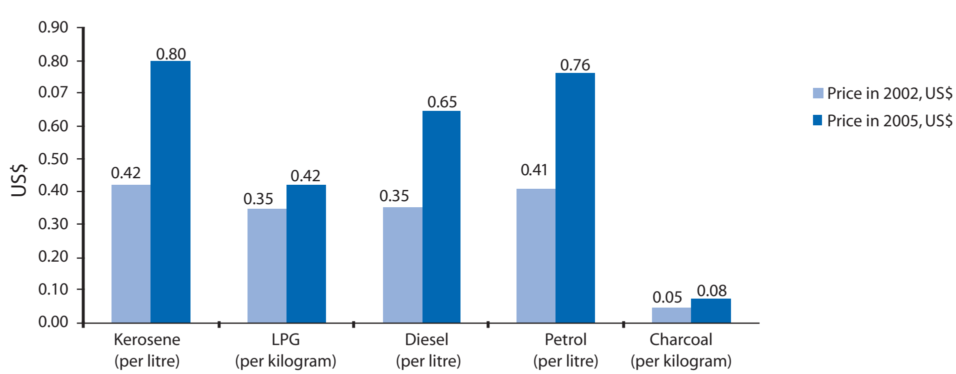
- Both rural and urban households experienced a 210 percent increase in their expenditure on kerosene at unofficial (black market) prices, which were nearly double those of official prices. In fact, the unofficial price prevailed across the country.
- Petrol prices rose by 140 percent, which affected households with motorcycles, though these were not necessarily the poor.
- Expenditure on public transport rose faster among rural households, at 50 percent, compared to 30 percent among urban households, because of longer distances covered by the former.
- Urban households, however, experienced significantly higher energy expenditure due to their greater reliance on petroleum products and their lack of recourse to biomass fuels for cooking – a 70 percent increase compared to the 30 percent rise among rural households.

Lao PDR

Retail prices of petroleum products in Lao PDR generally reflect changes in import prices. But some price control exists through the tax and duty structure, along with other charges. Prices also differ between areas to reflect transportation costs.

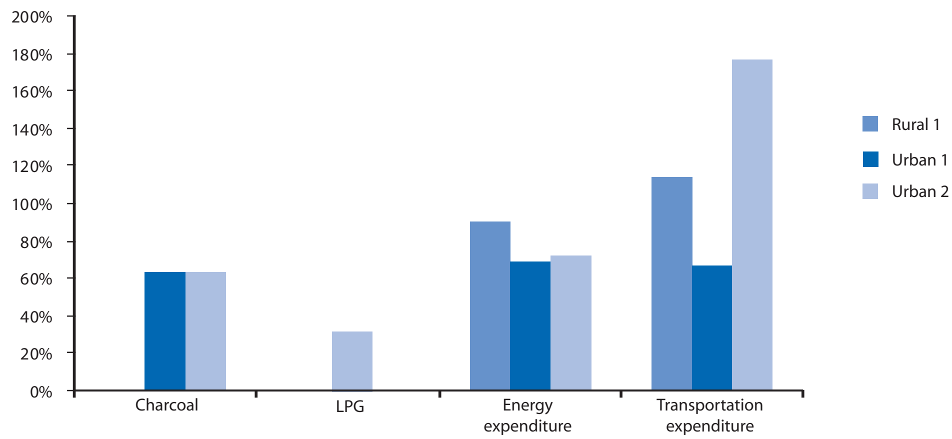
Between 2003 and 2006, retail prices of gasoline and diesel almost doubled, though the government has intermittently introduced duty exemptions to slow the pass-through. In order to reduce the costs of transportation and production, the government has kept diesel prices around 15 percent below gasoline prices. It also regulates electricity tariffs, which are subject to differentiated pricing and subsidies, with poorer residential and agricultural users benefiting the most.

Figure 1-8 Lao PDR – changes in prices of petroleum products and other fuels



Retail prices of petroleum products and charcoal in Lao PDR

Figure 1-9 Lao PDR – energy expenditure changes experienced by poor communities



Changes in fuel prices during 2002-2005 are shown in Figure 1-8. Comparing them against the expenditure patterns of households surveyed (Figure 1-9) indicates that:

- Kerosene prices increased by 90.5 percent, while LPG prices grew at a much lower rate of 20 percent. Since only urban households, mainly the non-poor, use LPG, the rural poor have suffered more through the steep rise in prices for kerosene, which is essential for home lighting.
- Both rural and urban households are affected by the sympathetic increase, by 60 percent, in the price of charcoal, which they use for cooking.
- The average increase in diesel and petrol prices has been 85.5 percent across the country. However, expenditure on public transport among rural households rose by 118 percent, suggesting a scarcity premium imposed by transport service providers.
- The rise in transportation expenditure among urban households was 63 percent in one district and 178 percent in another district of Vientiane. The higher expenditure was incurred by households owning motorcycles, and the rate of the increase, compared to the official price, suggests the existence of a black market for petrol.
- Overall expenditures on energy increased by 90 percent among rural households, somewhat higher than the 85 percent increase experienced by urban households.

Across the countries

The poor's exposure to higher oil prices varies widely between the four countries, a result of the following factors:

Steeper price rises have occurred in countries with higher subsidies to dismantle

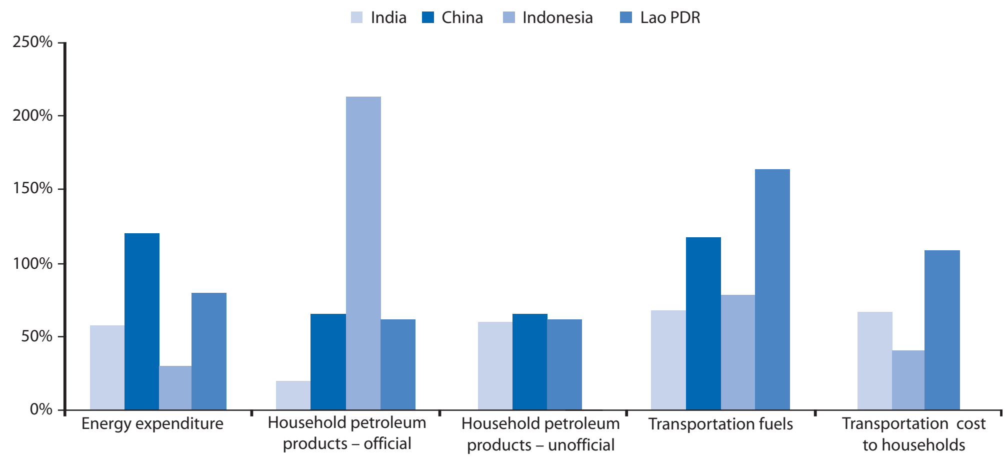
- To begin with, not all countries started at the same level of subsidies. Steeper price rises have therefore occurred in those with higher subsidies to dismantle.
- Policy measures have been different as each country judges the extent to which its people can cope with price increases and varies the amount and timing of the increases.
- Large variations between the rate of change in official prices/national average prices and the rate of change in expenditures actually incurred by the poor are due to the existence of a parallel black market where fuels are sold at unofficial premium prices.

A parallel black market exists where fuels are sold, often to the poor, at unofficial premium prices

- The actual expenditure incurred by the poor on different fuels depends on the extent to which they can adjust, obviously downward, their volume of consumption without sacrificing essential needs. Steep increases in their expenditure on a fuel indicate limits on their ability to do so.

The extent to which these factors have been at play across the four countries is illustrated in Figure 1-10. For example, while retail kerosene prices increased by less than 50 percent in India, a major oil importer, they increased by about 200 percent in Indonesia, a major oil producer. This was due to higher subsidies in Indonesia ahead of the oil price rise. By 2005, prices in India and

Figure 1- 10 Increase in poor's fuel expenditure across the four countries between 2002 and 2005



Indonesia had edged closer to one another, at 24 and 21 US cents a litre respectively. Both countries, however, kept prices well below international prices through continuing subsidies.

In contrast, the highest price for kerosene in 2005, 80 US cents a litre, was in Lao PDR, which had a starting point of 42 US cents a litre in 2002. Its prices are, in fact, close to international prices. This faster pace of price liberalization presumably owes to the low volume of kerosene consumption. The merits of such a policy are debatable, however, as the logic can apply equally against such a steep increase when the subsidy burden on the government is relatively low.

In just a few years, the average poor household paid 74 percent more for energy as a whole

Overall, energy expenditure among poor households rose most in China, where expenditure on LPG for cooking, and on diesel and petrol for transportation, increased steeply. The scope for households in the country to reduce LPG consumption is limited as cooking energy requirements cannot be easily scaled down. Although this is generally not the case with transportation expenditure, rising income levels combine with higher levels of agricultural mechanization, in China's case, to inhibit a lowering of petrol and diesel consumption as well.

The large differences between official fuel price increases and prices paid by the poor in India, Indonesia and Lao PDR indicate the existence of a parallel unofficial market. While distances contribute to an extent in such higher black market prices, supply unreliability is an equally important factor, especially for people in remote rural areas (Box 1-3).

It must be noted that although the poor benefit from subsidies of oil products, so do many other people, as a result of 'leakages' to non-poor households. In Indonesia, for example, an estimated 70 percent of subsidized kerosene is consumed by non-poor households. In India, around 40 percent of the LPG subsidy is enjoyed by the top 7 percent of the population.

The poor pay the price

The case studies across the four countries show that even if their national economies have not suffered greatly as a result of the oil price rise, poor communities in them have clearly been hit hard. Within this group of countries, in just a few years (2002 to 2005) the average poor household paid:

- 171 percent more for cooking fuels;
- 120 percent more for transportation;
- 67 percent more for electricity;
- 55 percent more for lighting fuels;
- 33 percent more for petroleum-based fertilizers and other agricultural inputs; and
- 74 percent more for energy as a whole.

On average, a poor family spent some 12 percent of its household expenditure on fuels and electricity and slightly over 16 percent on transport expenditure, most of which is oil-related. Thus, the total expenditure affected by high oil prices comes to 28 percent of household expenditure – for families with no or low surplus to spare. How are they coping?

Box 1-3 Poor in India suffer from both high prices and shortages of fuels

The supply of kerosene to households in India is rationed per household and made available at a subsidized rate from fair price shops under the Public Distribution System (PDS). For this, separate categories of ration cards are issued for families below poverty line (BPL) and above poverty line (APL), defined according to the national poverty line. Though BPL and APL households get kerosene at the same price through the PDS, BPL households are allocated a higher quantity at the subsidized price.

However, the poor households do not necessarily get either their cards or their allocated quota of kerosene. This is partly because of bureaucratic delays but also because of discrimination in the distribution. For example, in Deepdi and Bangrasia, villages in Madhya Pradesh, kerosene distribution is in the hands of a discriminatory local self-governance unit (panchayat). Consequently, households are compelled to purchase kerosene from the local market at a much higher price – typically double the PDS rate – thus making the fuel unaffordable to many poor households.

Unofficial kerosene rates also differ seasonally. Households surveyed in Koramangala, Bangalore, reported that during the rainy season, as the demand for kerosene increased with fuelwood becoming damp and difficult to use, the price of kerosene in the unofficial market also rose.

Another factor in many areas is the poor availability of LPG cylinders. As a result, many non-poor households that can afford LPG are unable to obtain adequate supplies. LPG-using households surveyed in Deepdi and Bangrasia reported reducing LPG consumption by one-third. Some better-off households illegally purchase LPG cylinders at a higher rate.

There are two ways to approach the question. One is to look at changes that have been brought about in the poor's energy consumption patterns as a result of the price increases. The other is to examine the eventual impacts of such changes on their lifestyles and livelihoods. The latter is more important for this Report.

Climbing down the energy ladder

The energy ladder is a concept describing the process of people switching to increasingly efficient (and more expensive) modern energy sources as their incomes rise. For those at the bottom rungs of the ladder, the poor, it means moving up from a labour-intensive way of life that consumes a disproportionate amount of their time to an energy-intensive way of life that unleashes their human potential for betterment. Increases in the prices of oil products have reversed this process for many poor households, forcing them to either consume less of these products or to fall back upon inferior sources of energy. For certain critical uses, these households have had little option but to pay ever-increasing prices for fuels and other oil products, which has encroached upon their other needs. Among the 14 communities surveyed:

- Some 36 percent of kerosene-using households in India and 80 percent in the rural communities of Indonesia have reduced their consumption of kerosene for cooking. Instead, they have reverted to biomass and dung cakes, wholly or partly. Urban households in Indonesia that do not have these options continue to pay higher prices for kerosene, but at the cost of other household expenditures.
- In China, 89 percent of the rural households using LPG and coal for cooking have switched partly or entirely to fuelwood and crop residue. Some 29 percent of the urban households have reached the limits of their ability to absorb higher LPG prices and plan to shift to coal if LPG prices climb further.
- Higher public transport costs have curtailed the poor's access to essential services, especially those in remote rural communities. Several villagers in Lao PDR have gone back to travelling by foot or horseback to the nearest district centre, where the health care services and markets are located.
- Urban migrant workers in India now travel less frequently to their home villages. Motorcycle users in China, Indonesia and Lao PDR, unable to restrict their essential travels, have borne higher petrol prices, with adverse implications for their other expenditures.
- Lacking other options, most poor households have continued to incur higher expenditures on kerosene for home lighting. Some very poor households in India, unable to pay the price, stay in darkness during long hours of power outages.

- Farming households have had to absorb higher costs of fertilizers and fuel to operate agricultural machinery, on which their livelihoods depend. Large increases in fuel costs have hit them harder.

On the whole, rising oil prices have left the poor with few choices other than to cut back on their consumption of oil products or, for uses that cannot be avoided, to bear the higher prices and look elsewhere in their household budgets to find the additional money. Since the urban poor rely more on oil products like kerosene and LPG, they are worse off than their rural counterparts, who are either biomass users or have the biomass option to fall back upon. The rural poor, however, are more vulnerable to higher lighting fuel prices, especially in unelectrified villages but also in electrified villages subject to frequent supply disruptions. They also are at a greater disadvantage when it comes to transport fuel costs, because inability to pay means forgoing essential services not available in the villages.

Rising oil prices have made some poor people go back to using biomass fuels, deepening energy poverty

Impact on lifestyles and livelihoods

Across all countries, wherever families have switched to biomass fuels, the worst-affected have been women and children, who not only suffer from increased pollution at home but also have to spend more time and effort gathering fuels. This has been a particularly critical phenomenon in China and India, where such a switch has occurred in large numbers.

As a result of rising transport costs, 64 percent of the surveyed rural households in Lao PDR reported scaling down their expenditures on children's education, and 35 percent said they are able to spend less on items other than the most essential like food, clothing and health care. In India, rising transport costs have compelled a number of households in both rural and urban contexts to move their children to schools closer to their homes from better ones farther away. The quality of children's education has suffered as a result.

Rising household expenditures due in part to higher energy costs have obliged women to take on extra work. Among urban households surveyed in India, many women have started working, mostly as domestic help in other houses, in order to supplement family incomes. They also reported rising domestic tensions due to heightened financial pressure. The majority of families interviewed are contemplating loans from moneylenders, self-help groups, banks and family members to cope.

The foregoing impacts do not surprise. What should surprise is that they have not been more widespread than reported so far, considering how steep the rise has been in their essential expenditures on oil products.

A good part of the reason behind this is that many of the households covered by the case studies are in the 'near-poor' category, meaning they had some financial cushion to absorb the additional expenses. However, it would be a mistake to presume this can last long if oil prices continue on their present trajectory.

Implications for the MDGs

The linkages between high oil prices and the MDGs are complex and not easily quantifiable. However, based on the pathways shown in Figure 1-11, a number of commonsense conclusions can be drawn.

MDG 1: Eradicate extreme poverty and hunger

Higher retail prices of fuels and petroleum products like fertilizers can have economy-wide inflationary and/or recessionary impacts, leading to higher unemployment. At local levels, drastic reductions in or the complete removal of fuel subsidies will result in high prices for agricultural inputs, transport services to workplaces and markets, lower incomes and the elimination of savings. These can slow the rate of poverty reduction. To an extent, this can be mitigated through new employment opportunities emerging from the introduction of renewable energy supplies to remote rural areas and commercial cultivation for biofuel production. The latter can, however, have negative implications for food security and may worsen problems of malnutrition and hunger.

MDG 2: Achieve universal primary education

Education costs will rise if the rate of inflation climbs due to higher oil import bills and spillover effects across the economy. Schools will have to pay more for their infrastructure and teaching staff. The choices for poor children to attend good education facilities will be reduced, potentially relegating them to cheaper, qualitatively inferior schools. Rising transport costs can play a role in this for children in rural communities having to travel to schools located in urban centres.

MDG 3: Promote gender equality and empower women

In households forced to switch back to traditional biomass fuels, demands upon the time of women and children for fuel collection and cooking will increase. This will eat into the time they will have for other, more productive activities. Families pressured to curtail household expenses may opt to withdraw girls rather than boys from schools, thus worsening gender disparity. On the other hand, gender equality may be boosted if non-working women come out of their homes to earn additional incomes for their families.

MDG 4: Reduce child mortality

Smoke from inefficient wood-burning and coal stoves will raise pollution within homes to the detriment of all. Infants will be particularly susceptible. Their health care costs can go up due to general inflation, raising the risk to their lives.

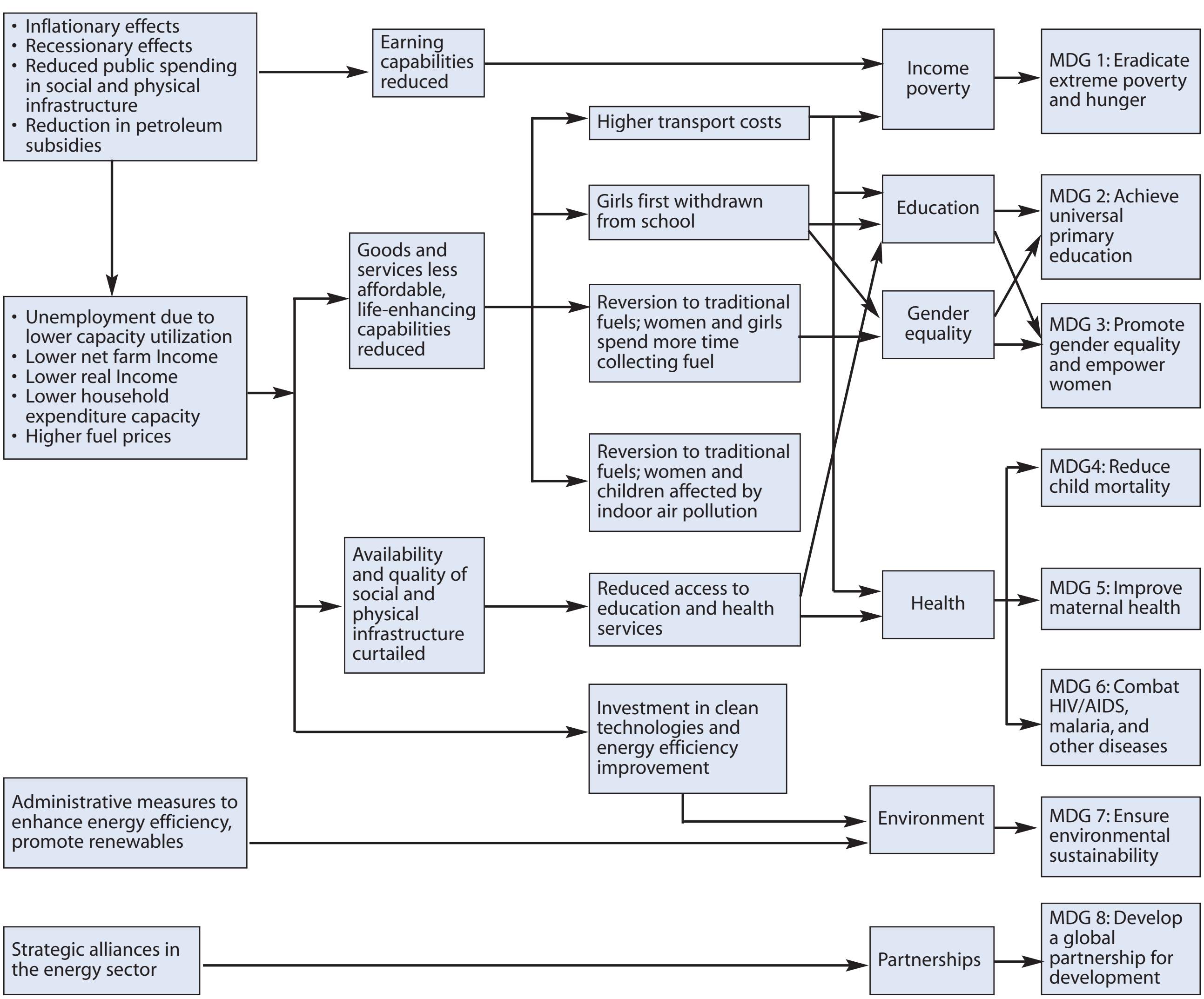
MDG 5: Improve maternal health

For similar reasons, the health of nursing mothers will also be affected. In addition, higher medical and travel costs may prevent poor women from obtaining proper pre- and post-natal care.

MDG 6: Combat HIV/AIDS and other communicable diseases

Higher transport and health service costs can slow the efforts of health authorities to prevent the occurrence of epidemics and other communicable diseases. Those affected may not be able to access or afford adequate medical attention in time.

Figure 1-11 – Oil price pathways to the MDGs



MDG 7: Ensure environmental sustainability

As is already happening, investment in renewable energy technologies and energy efficiency improvement will increase significantly in order to reduce the oil dependence of countries. This will carry a range of environmental benefits to all, including the poor, via decentralized rural electric supply and the use of clean technologies.

MDG 8: Develop a global partnership for development

New opportunities for international cooperation will emerge as markets for renewable energy and efficient energy equipment expand at an accelerated pace. These can add significantly to existing opportunities for partnership under global environmental treaties and agreements.

Energy security and human security: two sides of the same coin

The impacts experienced by poor households indicate that it is not only their present lifestyles that are being undermined, but their future prospects as well

While their implications for the MDGs are largely negative, high oil prices carry some potential benefits, as noted above. In the short to medium term, however, it is the negative implications that are more likely to materialize. The impacts experienced by poor households indicate that it is not only their present lifestyles that are being undermined, but their future prospects as well. Reduced ability to provide a decent education to their children, loss of productivity due to an unhealthy home environment, and missed opportunities to earn additional income because of dwindling mobility are all evident in the scattered warning signals appearing now among those living below the poverty line. If or when they catch up with those perched precariously just above the line, such impacts can multiply rapidly across whole societies, to devastating effects.

The oil price rise has heightened international concern over energy security, a concept associated mostly with the supply security of nations. This has led to a frenzy of actions to secure new oil supply sources, look for new reserves, expand and protect supply routes and pipelines, and enhance cooperation in sharing new technologies and knowledge. The findings of this chapter draw attention to the other face of the concept, which has to do with the security of people within a country, especially the poor.

Although the poor are insignificant consumers of oil in the totality of a country's oil dependence, there are millions of them. The uses to which they put oil are not just critical to their survival; they are the passage to the poor's social and economic integration with the rest of the population. Countries that have eliminated poverty or reduced it drastically are now benefiting in numerous ways from the enormous boost to their economic capacity by the induction of the erstwhile poor into the mainstream. High oil prices thus not only deny the poor the opportunity they deserve to escape poverty, but they also rob countries of the added strength that an enlarged, skilled labour force will bring.

As noted at the outset and elaborated in the next chapter, the macroeconomic impacts of the oil price rise have been subdued in most countries of the Asia-Pacific region for a variety of reasons. However, this can result in complacency that overlooks the tragedy in the making among the poor. While high oil prices raise questions for national energy security, the ultimate objective must always be human security.

Endnotes

1 http://www.oil-price.net/ on 12 September 2007.

2 The main factors that determined the selection of communities in each country were two-fold: (a) the presence of a significant number of poor households and (b) their use of oil products like kerosene, diesel and LPG. National poverty lines at around US$1.5/day were used to determine the former in all countries except Lao PDR, where the international poverty line of US$1 a day was applied.

3 The importance of including them is underlined by the example of Indonesia, where only 7.5 percent of the population lives below US$1 a day but as many as 42 percent are between US$1 and US$2 a day, with an extremely high number near the national poverty line of US$1.5 a day (World Bank 2007a).

2

The macroeconomic impact

The previous chapter looked at the impact of rising oil prices on poor communities in four developing countries in Asia and the Pacific. This chapter takes a wider perspective, setting the oil price rises in context and looking at macroeconomic impacts across the region.

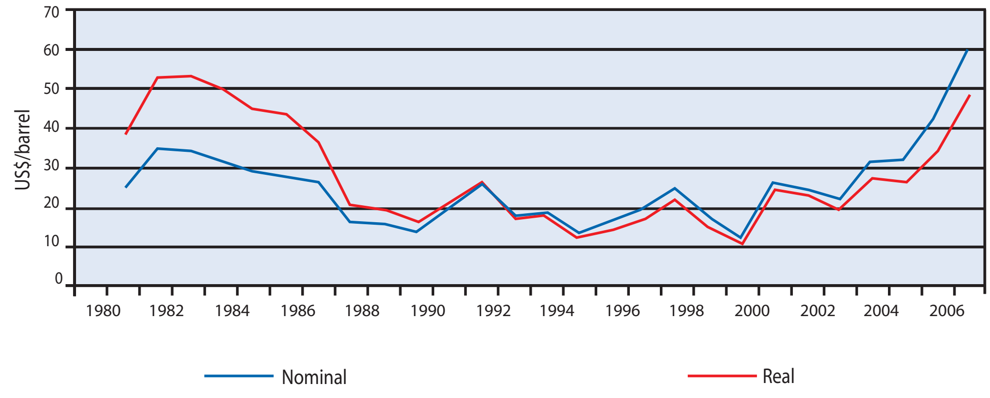
Following a decade of fluctuation within a relatively narrow range in the 1990s, and a low point of US$13 per barrel in 1998, the price of oil has increased sharply. Between 2002 and July 2006 the price nearly tripled, from US$25 to US$74 per barrel, and in mid-2007 remained around US$70.

Figure 2-1 tracks these changes, showing the average nominal and real annual prices from 1980 to 2006. While oil price increases have been substantial and persistent, they are not as steep as in some earlier periods. For one category, West Texas Intermediate (WTI), for example, the largest monthly rise was in October 2004 – 16 percent –which is substantially lower than the 48 percent spike in August 1990 and significantly lower than the levels seen in the 1970s.

Another feature of recent trends in oil prices is the gradual reduction in the difference between nominal prices and real prices. Nominal prices are converted to real prices using a 'GDP deflator,' in this case using 2000 as a base year with a value of 100. In 1980, for example, the deflator, based on year 2000 dollars, fell as low as 87, while in the 1990s it fluctuated in a narrow band between 90 and 110. One reason for the convergence in real and nominal prices in the 1990s and the early 2000s has been the general stability of prices. Since 2004, there has been some divergence between nominal and real prices, though not on the same scale as in the 1990s.

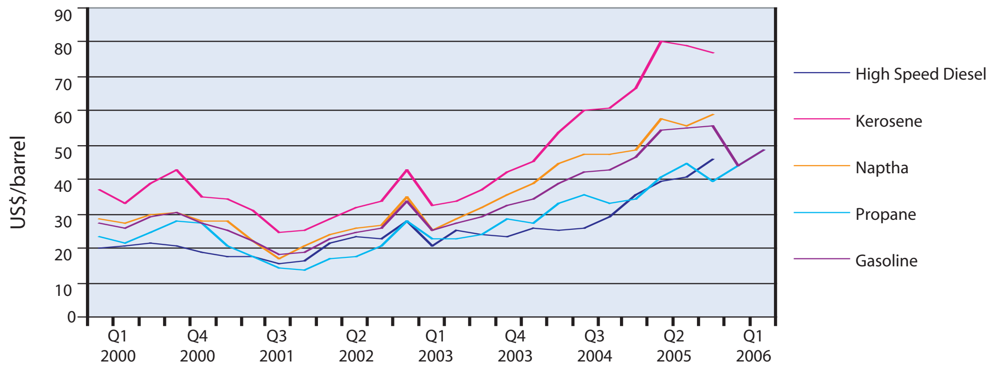
Increases in prices for crude oil have been matched by increases in the prices of petroleum and other oil products, with differing rates of increase. Figure 2-2 presents this in greater detail, showing the quarterly changes in prices of various products over 2000-2006; the percentage increases over this period were: diesel, 101 percent; kerosene, 130 percent; naphtha, 123 percent; liquefied petroleum gas (LPG), 92 percent; and gasoline, 208 percent.

Figure 2-1 Real and nominal average crude oil prices, 1980-2006



Note: Yearly trend in nominal prices — WTI (West Texas Intermediate) and Brent (a combination of crude oil from several oil fields in the North Sea) as well as the OPEC (Organisation of Petroleum Exporting Countries) reference basket.
Sources: EIA 2007a; EIA 2007b; World Bank 2005a

Figure 2-2 Petroleum products, quarterly prices, 2000-2006



Notes: 1. The price for kerosene has been estimated from that of ATF. 2. The price used for LPG is that of propane.
3. All prices are non-subsidized – f.o.b. Singapore.
Sources: IEA 2006; IEA 2002b; EIA 2007c

The main products of interest for households are kerosene and LPG; for industry, they are naphtha, fuel oil and diesel; and for the transport sector, they are gasoline, diesel and aviation turbine fuel (ATF). The uses of these products are summarized in Table 2-1. For consumers, some of these products have been subsidized, typically those such as kerosene, which is used by the poor, or diesel, which affects the price of transport. But recently, in efforts to balance their budgets, governments have been cutting down on subsidies, resulting in steep price increases for consumers.

It should also be noted that recent increases have been greater for certain types of oil: higher for light-sweet crudes, such as WTI, than for heavy-sour crudes, such as those in the OPEC basket. The price differential between WTI and the OPEC basket was around US$1.9 early in 2002, but by various quarters in 2004 and 2005, it had increased to between US$6 and US$9.5. This was due to a number of factors: rising demand for light-oil products, particularly gasoline for transportation; stronger regulations on the quality of petroleum products; bottlenecks in refining capacity for processing heavy or high-sulphur crude oil; and changes in the supply mix, with a falling proportion of light-sweet crude.

Oil prices have also been affected by the falling value of the US dollar. As the US dollar has lost value, the oil price rises have been higher in US dollars than in euros or yen, which has created problems for certain countries (Box 2-1). Moreover, the depreciating US dollar combined with low interest rates may itself have contributed to increasing oil demand and thus to the rise in oil prices (IMF 2006a, and consultations with energy experts).

Table 2-1 Uses of major petroleum products

	Diesel	Kerosene	LPG	Naphtha	Gasoline
Major user sectors	Transportation, agriculture, power generation	Households: for lighting and cooking Transportation: used by some vehicles instead of diesel if the price is lower	Households: for cooking Transportation: limited use in some countries	Agricultural sector: for fertilizers, and also by some industries	Transportation
Relevance for poor households	Used directly by poor farmers and indirectly by poor households through public transport	Important for lighting in non-electrified households and during power outages; also used for cooking	Used for cooking and heating; Usually sold in large cylinders that are expensive for poor households	Only relevant indirectly, e.g. through the price of fertilizers	Not widely used in public transport; Not an important fuel for poor households

Box 2-1 Rising oil prices and the sliding dollar

The infrastructure of the oil market is based almost entirely on the US dollar. Crude oil contracts are traded in dollars, exposing most oil-exporting or oil-importing countries, excluding of course the United States, not just to oil price risks but also to currency exchange risks. This has been evident during the recent period of dollar weakness: consumers in countries whose currencies appreciated against the dollar have gained, while those with dollar-pegged currencies have paid more per barrel of oil.

Because of this, some analysts have explored the possibility of switching the oil transaction currency to the euro, especially given the extensive trade links between OPEC member countries and the euro zone. But this could create further problems: a rapid and complete move to the euro might, for example, cause a US dollar crash, which would have huge implications for the world economy, and especially for those developing countries holding large amounts of their foreign exchange reserves in US dollars. Even using a parallel system, the US dollar alongside the euro, would create difficulties for buyers and sellers alike by reducing the transparency in oil pricing and increasing the risk of currency arbitrage.

Causes of oil price increases

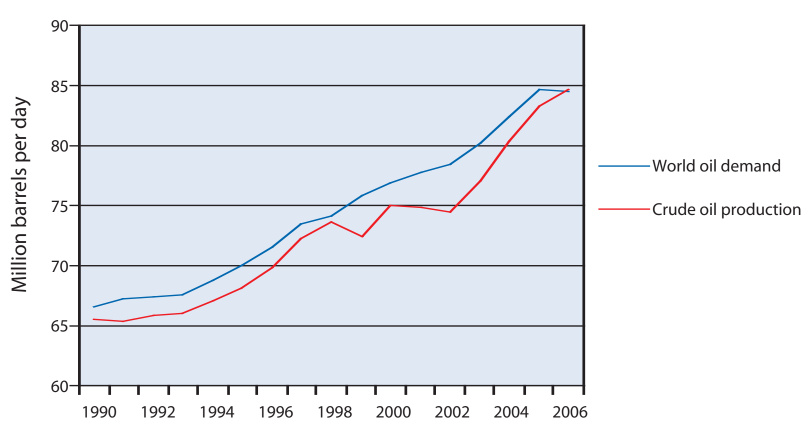
Why have oil prices been rising? In the 1970s, for example, price rises were due primarily to disruptions in supply. But recently, in a period when supplies have been tight, the increases have been due more to strong demand. At the same time, prices have also been pushed up by rises in marginal costs. In the OPEC region, for example, more of the output is coming from smaller oilfields which have higher unit costs, while in the non-OPEC countries more output is coming from mature basins, which tend to have higher marginal costs (Verleger 2005, OECD/IEA 2004, IEA 2004a, Koyama 2005). Geopolitical tensions and conflicts in some major oil-producing regions, especially the Middle East, are another potential cause of price increases, because they are raising the prospect of supply disruptions and adding a 'risk premium' to prices. These and other factors behind the current oil price rise are considered in the sections below.

Growth in world oil demand

The rise in crude prices in recent years has been driven partly by the conspicuous growth in demand. According to the International Energy Agency, between 2002 and 2005 world oil demand expanded by 7 percent, to 84 million barrels per day. Much of this growth in demand came from the United States and from Asian developing countries, notably China, which over the period 2002-2005 accounted for 30 percent of total demand growth. This prompted many oil producers to increase their production. It also absorbed much of OPEC's surplus capacity, making the oil market more vulnerable to supply or demand fluctuations (Figure 2-3). This figure shows demand to be consistently ahead of supply. Before 2003 the gaps were due not to a real shortfall but mainly to the OPEC cartel's control of production to fix prices. In recent years, growth in demand is straining physical supply, so the supply gap is more real and market-determined.

In contrast to the 1970s, recent rises in oil prices have been due more to strong demand than to tight supplies

Figure 2-3 International crudes, demand and production, 1990-2006



Sources: BP 2007; EIA 2007d

An important feature of this rising demand is that much of it has been for gasoline and diesel. The United States continues to be a major user of gasoline for cars, but developing countries like Brazil, China and India are also consuming more gasoline for personal transportation. European countries, on the other hand, have been switching more to diesel for cars (Figure 2-4). Asian developing countries are also using more diesel, though in this case it is used to fuel the many backup generators, as well as to replace coal in large-scale electricity generating plants in efforts (ICF 2005).

Shrinking buffers

Surplus production capacity, oil inventories and surplus refining capacity have all been shrinking, making the world market much more volatile

In the past, fluctuations in supply and demand have been dampened by three main buffers: surplus production capacity among OPEC members, large oil inventories and surplus refining capacity in consuming countries. All three buffers have, however, been shrinking. As a result, the world oil market has become more vulnerable to price volatility and supply disruptions.

In the past, much of the surplus production capacity was provided by OPEC. This has now decreased: between 2000 and 2004, it fell from around 7.0 to 0.6 million barrels per day. Subsequently it rose, reaching 2.2 million barrels per day by May 2005, but is still relatively small. Moreover, this surplus comes from just a few countries, notably Saudi Arabia and Iraq, so any problems with their exports will have major repercussions for the world oil market.

A further cause of tightening oil markets is shrinking oil inventories. To rationalize their production and cut costs, oil companies, particularly in the United States, have been holding lower stocks of both oil and gasoline. Refineries too are working with less slack. Despite rising demand, the oil companies have not been building many new refineries, preferring instead to reduce their surplus refining capacity.

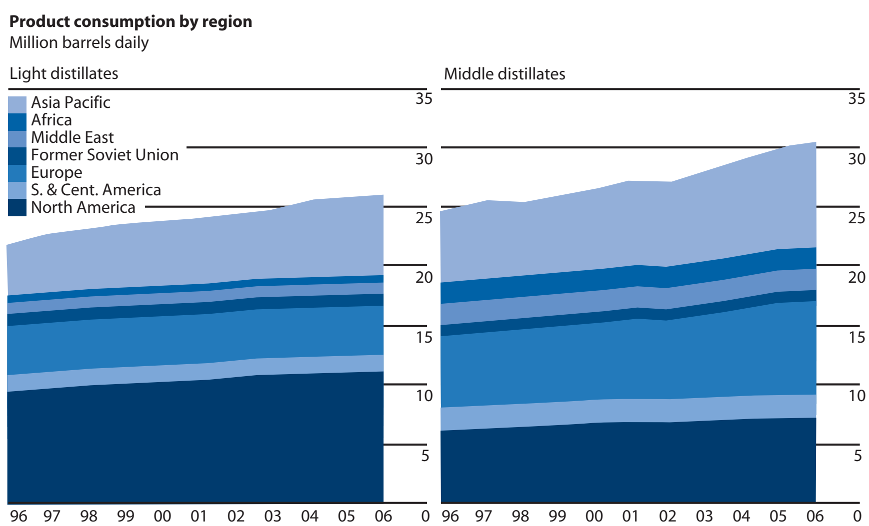
The combination of tighter supplies and changing demand – or speculation about such changes – has made prices much more volatile and increased vulnerability to disruptions in supply, particularly in oil-importing developing countries.

Oil supply insecurity

Oil prices have also been affected by security issues, linked primarily to the unstable situation in the Middle East. In May 2004, for example, oil facilities in Saudi Arabia, the world's largest oil producer, suffered two attacks. These did not reduce Saudi production, but they did have a psychological impact, raising doubts about the country's security and causing price hikes in the market for crude-oil futures.

Added to this is the uncertainty created by the situation in Iraq. Around the time of the Iraq War, oil production fluctuated wildly before returning in March 2004 to the pre-war level of 2.4 million barrels per day. Since then, deteriorating public security and attacks by insurgents on oil facilities have again undermined production, which has been as low as 1.8 million barrels per day.

Figure 2-4 Demand for light and middle distillates, 1996-2006



Source: BP 2007

Oil supply problems also have occurred in other parts of the world. In 2004, legal problems with the government led to the collapse of Russia's largest oil company, Yukos; in Mexico, devastating hurricanes hit the oil-producing Mexican Gulf coast; and in Nigeria, intermittent militant attacks on facilities have made it more difficult to maintain supplies. The situation is further aggravated by the possibility of structural changes in countries like Bolivia and Venezuela, which are nationalizing their oil and gas industries. Furthermore, in some parts of the world, notably Mexico and OECD Europe, production prospects are deteriorating because of low levels of investment in exploration.

All these factors are heightening oil supply insecurity. They have also raised questions as to whether world oil production has already peaked (Box 2-2).

Speculation in the world oil market

Oil supply-demand imbalances and uncertainties have been exacerbated by a massive influx of speculative money into the market for crude oil futures. Speculators, reacting to vulnerabilities in supply, fluctuations in demand and external shocks, have expanded their trading, often basing their judgments on media reports. In so doing, they have heightened the price volatility.

Speculative activity can push oil prices higher, since this unstable situation adds a larger 'risk premium.' Over the short term, futures prices thus may be subject to excessive hikes that bear no direct relation to current supply or demand fundamentals. However, these prices can themselves trigger further changes in supply or demand, leading to another round of wild fluctuations.

The oil price hikes also incorporate an element of 'geopolitical risk premium.' Buyers who fear the prospect of damage to oil facilities in the Middle East are prepared to pay more to secure supplies (OECD/IEA 2004). This is thought to be contributing to between 20 and 25 percent of the current oil price.

Underinvestment in exploration and refining

Prices have also been higher because of underinvestment. The key players in the global energy industry, OPEC national companies and the large multinational companies, failed to anticipate the growth in demand and did not sufficiently expand their output. Indeed, at the end of the 20th Century, following the collapse of the price, they had often reduced or even stopped investment and then did not subsequently step up production as prices rose.

Key players in the global energy industry have not sufficiently expanded output, resulting in underinvestment in exploration and refining

Some people argue that the recent price rises, particularly for sweet-light crudes such as WTI, have actually served a useful purpose in stimulating investment across the oil supply chain. This is also often seen as a 'justification' for the oil price rise.

However, underinvestment in the oil sector may not be simply an inadequate response to rising demand but also may reflect a general situation of uncertainty and price volatility, leading to a vicious circle whereby the lack of investment could once again propel prices upward.

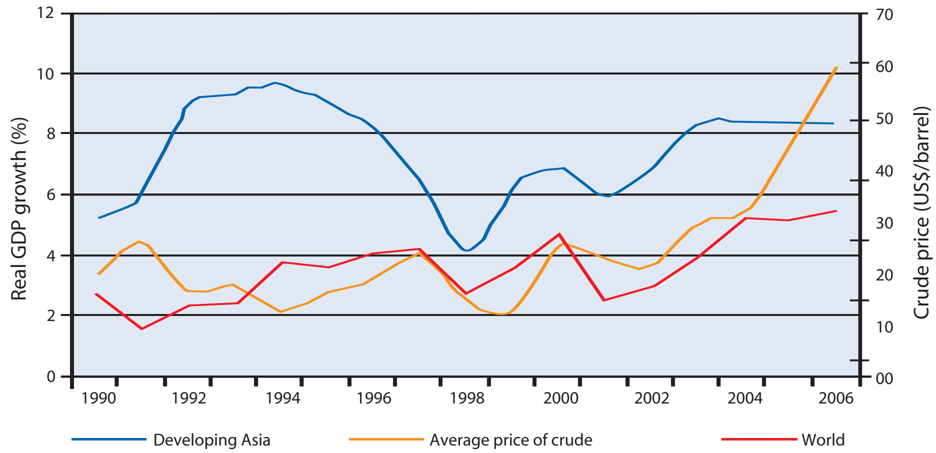
Added to underinvestment in exploration is inadequate investment in refining capacity, particularly for the lighter products that have to be processed out of heavy-sour crudes, mainly gasoline, diesel and ATF.

Box 2-2 Has world oil production peaked?

Recent oil price rises have again triggered discussions about natural limits to oil production – 'peak oil' – and revived the 'Hubbert's Peak' theory, which concerns the long-term rate of extraction and depletion of conventional oil and other fossil fuels. In 1956, geophysicist M. King Hubbert created a model of known reserves and proposed that oil production in the continental United States would peak between 1965 and 1970, and that world production would peak in 2000. He was more or less right about the US, where oil production peaked in 1971. He was wrong about global production, although supporters of his theory suggest that the global peak has merely been delayed by the 1973 and 1979 OPEC oil shocks, which effectively reduced global demand.

The oil price rise in late 2002 focused greater attention on Hubbert's theory and its potential implications, including discussions about whether the peak has in fact been reached. Some, like the Association for the Study of Peak Oil and Gas, assert that the peak was reached in 2004/2005. Others, such as the International Energy Agency (IEA), feel that oil production will peak only in 2039, pointing, for example, to limited exploration in the Middle East and Russia; large reserves in countries whose governments prefer not to explore; untapped frontiers in deepwater and polar regions; the potential for development of new and unconventional oil and gas products; and continued underinvestment in exploration and production.

Figure 2-5 Real GDP growth and rising oil prices, 1990-2006



Sources: IMF 2006b; EIA 2007a; EIA 2007b

The macroeconomic impact

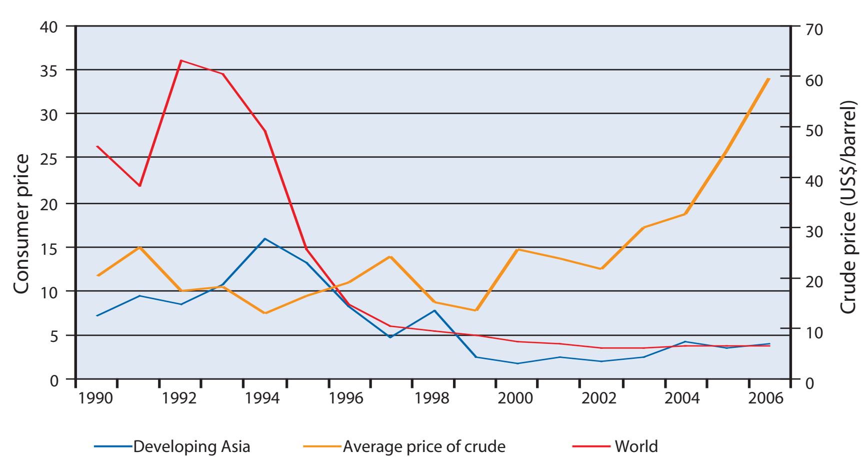
What have been the macroeconomic consequences of these steep rises in oil prices? The following paragraphs assess the effects, globally, regionally and subregionally, on GDP growth and inflation, as well as on foreign exchange reserves and current account balances. They also look at changes in the consumption of other forms of energy.

GDP growth, inflation and oil intensity of GDP

One of the greatest worries about a steep rise in the price of oil is that it will stifle economic growth. The simplest way of assessing this is to compare rates of GDP growth with changes in the average price of oil. As Figure 2-5 indicates, though oil-price rise does not appear to have affected growth significantly till 2004, either at the global level or within the Asian developing countries, it appears the impact is being felt post-2005. Over the period 1999-2004, the crude price more than trebled, but real GDP continued to grow, both for the world as a whole and for developing Asia. The steep increase in oil prices since 2005, it appears, has caused a slight decrease in the GDP growth rate both at the global as well as regional level. This declining trend is more pronounced in the case of Asian developing countries. Though it needs to be verified with more recent data, the trend shows that the global economy is feeling the heat of oil price rise.

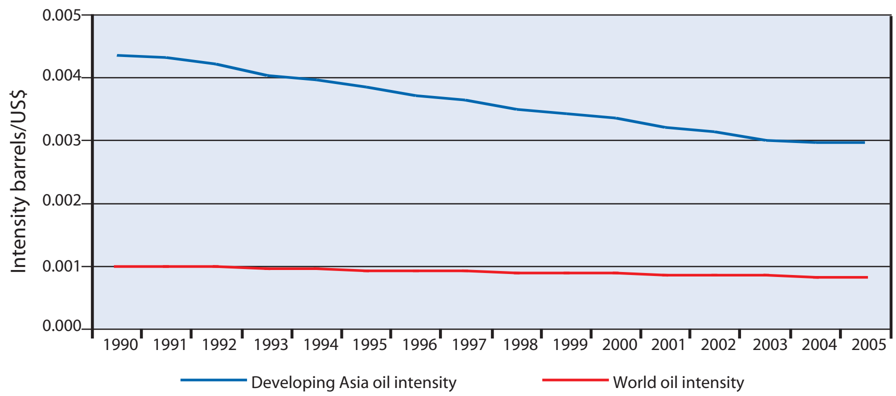
The increase in the prices of petroleum products could also have stoked inflation. But again, at the global level this does not appear to have happened; indeed, inflation declined (Figure 2-6).

Figure 2-6 Oil product prices and the consumer price index, 1990-2006



Sources: IMF 2000; IMF 2006b

Figure 2-7 Oil intensity of GDP for the world and developing Asia, 1990-2005



Sources: IMF 2006c; BP 2005

The situation is different in developing countries in Asia because of some inflationary trends. Quarterly data showed that after fluctuations between 2002 and 2004, the inflation rate had stabilized toward the end of 2005 but showed an upward trend in the first quarter of 2006.

A further possible macroeconomic consequence is that economic growth could have become less oil intensive, encouraging countries to use fewer barrels of oil per unit of GDP. As indicated in Figure 2-7, this had already been happening throughout the 1990s, though the region's oil intensity is still much higher than the global average, implying higher dependence on oil and lower efficiency of oil consumption.

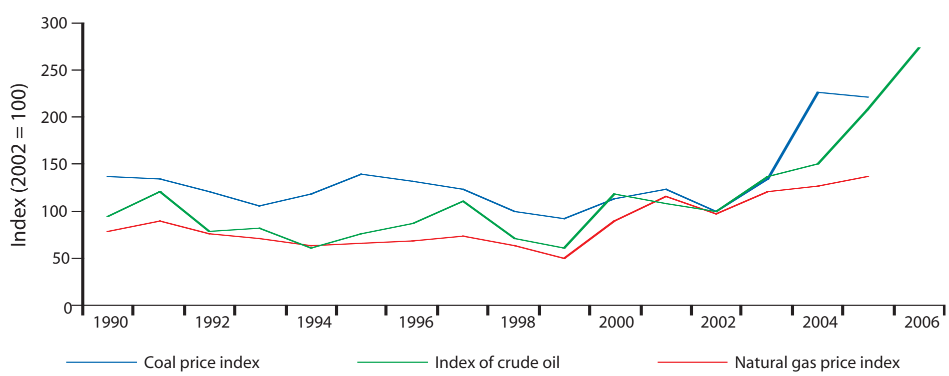
For all three variables – GDP, inflation and oil intensity – the average values for the periods before and after the price hike are shown in Table B-1 of Appendix B. This further reinforces the above observations reflecting the minimal influence of the oil price increase on macroeconomic indicators.

Trends in prices of other energy sources and other essential items

The rise in the price of oil also can influence, either directly or indirectly, the prices of other energy sources, particularly those of gas and coal, as well as a number of other items.

Gas – Because oil and gas can be substituted for many uses, including power generation and as a feedstock for fertilizers, the price of oil has had a strong influence on that of gas, as is evident in Figure 2-8. In the years ahead the two prices may decouple to some extent, since long-term gas contracts are based more on spot or futures gas prices. Similarly, for the power sector, which by 2030 is likely to account for nearly half of gas demand, gas prices are likely to be indexed on electricity prices. Nevertheless, since gas and oil still compete in non-power sectors, such as fertilizer and steel, oil prices will continue to influence gas prices on the spot and futures markets. It should also be pointed out that gas

Figure 2-8 Movements of prices of crude oil, coal and natural gas – indexed to 2002, 1990-2006



Sources: IMF 2006c; BP 2005

Table 2-2 Price trends for other commodities, 2003-2005

Commodities	Weights	2003	2004	2005/Q2	05 Q3	05 Q4	06 Q1	06 Q2[2]
Non-fuel commodities[1]	52	82	97	107	107	111	122	138
Food	22	86	98	98	98	98	103	109
Metals	16	81	110	139	138	151	177	218
Energy	48	161	211	292	326	311	332	369
Spot crude[3]	40	168	220	310	349	329	355	397
Natural gas	5	162	180	256	272	312	283	288
Coal	3	74	146	130	133	109	130	144

Notes: 1. Weights are based on 1995-97 average world export earnings. 2. Provisional. 3. Average Petroleum Spot Price (APSP). Average of U.K. Brent, Dubai and West Texas Intermediate, equally weighted.
Mombasa Auction price (Best PFI, Kenyan) replaces London Auction price beginning July 1998
Source: IMF 2006b

markets, unlike those for oil, are highly regionalized, and prices often diverge substantially across and within regions (OECD/IEA 2004).

Coal – In most sectors coal and oil are not directly substitutable, especially in the short to medium term, so the prices are not closely linked (Figure 2-8). Nevertheless, in several developing nations in the region, high and rising oil prices may in the longer term propel a shift from oil toward more coal-intensive technologies.

Commodity prices – Oil can also be expected to influence the prices of other commodities. Table 2-2 shows the price indices for major commodity groups, which divide overall into fuel and non-fuel. The weights refer to the proportion that each represents of total export earnings. The energy group, in which oil has a large weight, closely tracks increasing oil prices. Food, on the other hand, has not shown a large increase – only 27 percent – as production has kept pace with demand and, for some basic items, prices are regulated. For metals, the price rises will reflect global economic expansion, with consequent increases in demand as well as rises in production costs because of the increase in the price of coking coal.

The oil price rise does not appear to have dramatically affected economic growth across the region as a whole

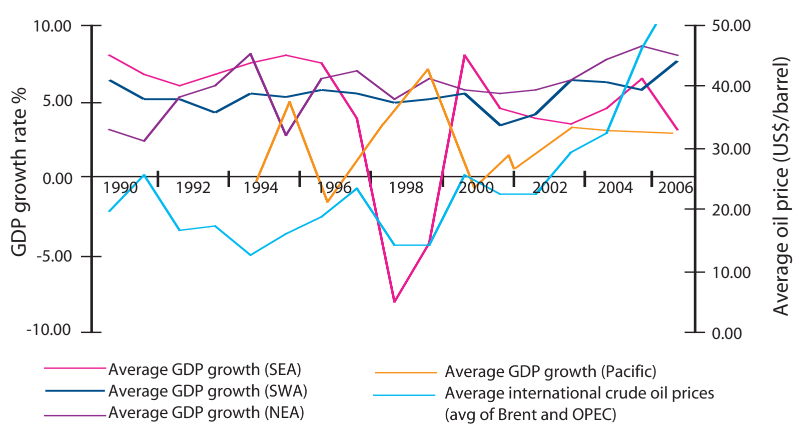
Impact by subregion

Oil price rises can have greater impacts in certain regions and countries. This section tracks these differences with respect to four macroeconomic variables: the GDP growth rate; the inflation rate; the change in foreign exchange reserves; and the current account balance as a percentage of GDP. It would also have been interesting to monitor central government expenditure but this proved impossible because of the lack of uniform data.

GDP growth

In general, the Asian economies are benefiting from a strong world economy with unabated demand for varied products (Figure 2-9). Some countries will also have been affected by non-economic factors: Nepal and Sri Lanka, for example, have been coping with political turmoil and insurgency, while Maldives, which depends heavily on international tourism, was devastated by the December 2004 tsunami.

Figure 2-9 GDP growth rate by subregion, 1990-2006



Sources: World Bank 2005a; World Bank 2007b; IEA 2006

North-East Asia and the Mekong subregion – Here growth has remained strong. China, the largest developing economy, has benefited from buoyant domestic investment and exports and for four years has enjoyed annual GDP growth in excess of 9 percent. But growth rates have also been sustained elsewhere: in Lao PDR, by investments in mining and hydropower; in Mongolia, by the rebuilding of livestock herds and the expansion of mining; in Viet Nam, by surging private investment; and in Cambodia, by strong agricultural production.

South and West Asia – In India, growth has been driven largely by private investment. Demand has also been sustained in Pakistan, which has been extending large-scale manufacturing. Bangladesh too has expanded manufacturing as well as services, though growth here may be slackening. Bhutan has benefited from hydropower exports as well as support from international partners.

South-East Asia – The subregion appears to have recovered from the financial crisis of 1997-99. In Indonesia, this recovery has been aided by government and private consumption and fixed investment. Malaysia has benefited from strong demand for electronic products. The Philippines has large flows of overseas workers' remittances, and Thailand has had growth in tourism. Of late, Myanmar has seen improvements in agriculture, forestry, fisheries and manufacturing.

Pacific Island Countries – These economies appear to have been hardest hit by the rise in oil prices: between 2004 and 2005 the average growth rate fell. Most depend heavily on oil, but being located far from world oil markets, they also face higher shipping costs. Nevertheless, some factors may cushion the impact. Tourism, for example, is doing well, helped in part by the arrival of budget airlines into the subregion. Aid flows and workers' remittances also help, and government trust funds have benefited from the continuing strength of international capital markets. Finally, Papua New Guinea is itself an oil exporter, and in addition, its agricultural sector has benefited from strong international prices for products like coffee and rubber.

Inflation

Although inflation rates are generally quite low, there have been increases in a number of countries (Figure 2-10). Since international oil prices began to rise, many Asian economies, most of which regulate oil prices, increased the retail prices of petroleum products, particularly in 2005 (ADB 2006).

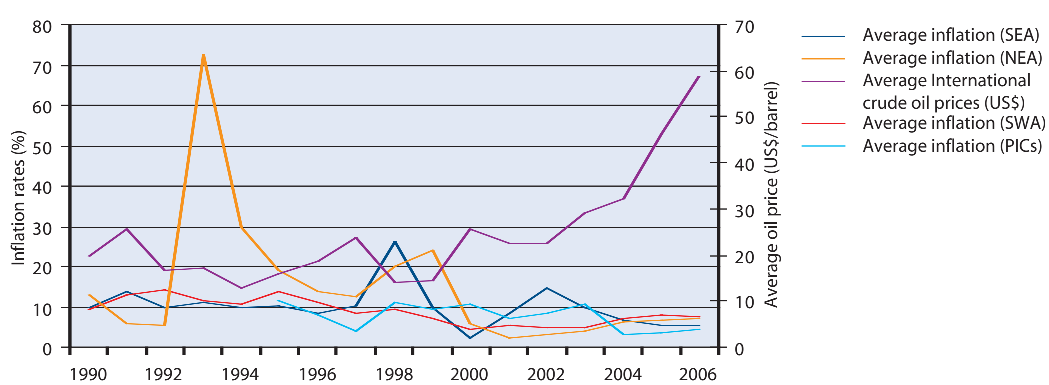
North-East Asia and the Mekong subregion – Average inflation rates show a relatively modest increase from 2002, primarily due to the stabilizing of Viet Nam's inflation rate, which in 2002 had touched a high of 57 percent. In Mongolia in early 2005, this was due to higher prices for fuel, utilities and food, though food price inflation subsequently eased. In Viet Nam, inflation has risen as a result of more expensive retail petroleum products.

Pacific Island Countries have been hardest hit by the rise in oil prices, although tourism and workers' remittances are cushioning the impact

South and West Asia – Inflation has also increased here. In Pakistan, for example, higher domestic oil prices have pushed up transport costs. And in India, it proved difficult in 2006 to cushion the impact of rising global prices on the domestic economy.

South-East Asia – Between 2004 and 2005, all countries in the subregion recorded higher inflation rates. In most cases this was due to

Figure 2-10 Average inflation rate by subregion, 1990-2006



Sources: World Bank 2005a; World Bank 2007b; IEA 2006 higher retail fuel prices or reduced subsidies: Malaysia, for example, had kept inflation at around 1.5 percent for five years, but in 2005 the government reduced fuel subsidies, which, combined with other fiscal measures, increased inflation to 3 percent. In the Philippines in 2005, rising oil prices, combined with the effects of a drought, increased inflation. In Thailand, higher power and transport prices have been accompanied by wage increases that have pushed inflation to the highest level in seven years.

Pacific Island Countries – Most of the subregion relies on imported petroleum products for air and sea transportation and for generating electricity. The remote locations also entail higher transport costs. Increased costs due to higher oil prices have been experienced by Samoa, the Solomon Islands and Tonga. Few countries have strong regulatory mechanisms to influence domestic wholesale and retail prices, but some, such as Fiji, have been controlling the price of fuels.

Foreign exchange reserves

Asia's foreign exchange reserves have grown substantially since 2001 because of capital inflows and increased aid flows into developing countries. However, the growth rate appeared to level off in 2005-2006 (Figure 2-11).

North-East Asia and the Mekong subregion – The healthy position here is largely due to foreign investment in manufacturing capacity in China. But China, along with a number of other countries, including Viet Nam, has also benefited from a flow of remittances. Aid has also contributed in Lao PDR and Cambodia, and there has been substantial investment in mining in Mongolia and in hydropower in Lao PDR.

South and West Asia – India has had strong foreign investment inflows, though much of this is portfolio investment. India also benefits substantially from remittances, as do Bangladesh and Pakistan. Countries like Bhutan and Bangladesh also have their reserves boosted by significant flows of official development assistance.

South-East Asia – Reserves here have been increasing, if not rapidly, at least consistently as a result, for example, of foreign direct investments in the oil, gas and finance sectors in Indonesia, Malaysia and Timor-Leste. Personal remittances also are important, particularly in the Philippines.

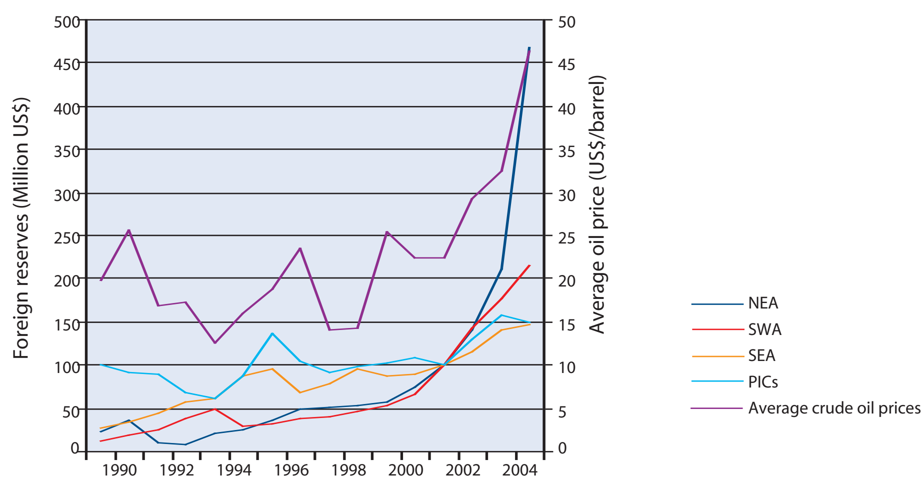
Pacific Island Countries – This subregion is the only one to have seen a deceleration in foreign exchange inflows, though these countries can still rely on foreign funds from tourism, remittances and aid.

Current account balance

With the notable exception of China, Asia's current account balances are on a downward trend (Figure 2-12).

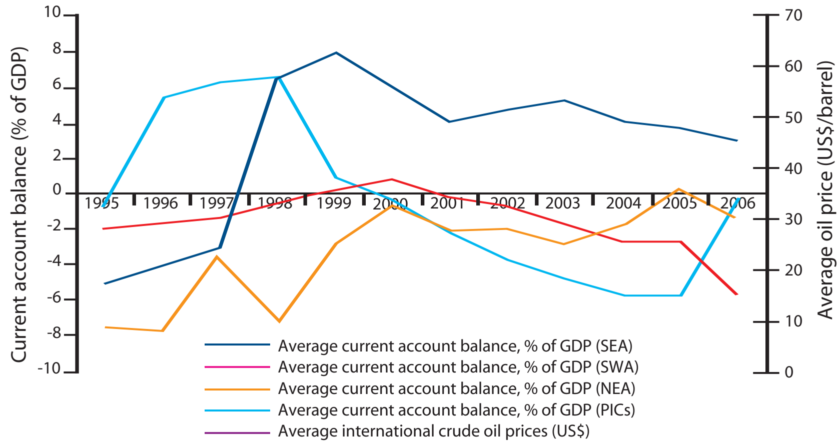
North-East Asia and the Mekong subregion – China's current account surplus continues to rise as a result of the boom in exports and the fall in the growth rate of imports, which offset the rising

Figure 2-11 Growth rate of foreign exchange reserves, by subregion, 1990-2005



Note: At the time of this publication for 2006, only few countries 2006 data were available, therefore the data for the purpose of consistency stops at 2005.
Sources: IMF 2006c; IEA 2006

Figure 2-12 Current account balances, by subregion, 1995-2006



Sources: UNESCAP 2006; UNESCAP 2007; IEA 2006

oil import bills. Except for Viet Nam, all the countries are oil importers. Viet Nam benefits from increased export earnings of the crude oil it produces, though this is offset to some extent by the need to import refined petroleum products, also at increased rates, since the country has no refining capacity of its own.

South and West Asia – Since 2003, current account deficits have been widening in all countries, except for Nepal and Iran, which is an OPEC oil-exporting country. In Pakistan and Bangladesh, some of the effects have been offset by strong flows of remittances.

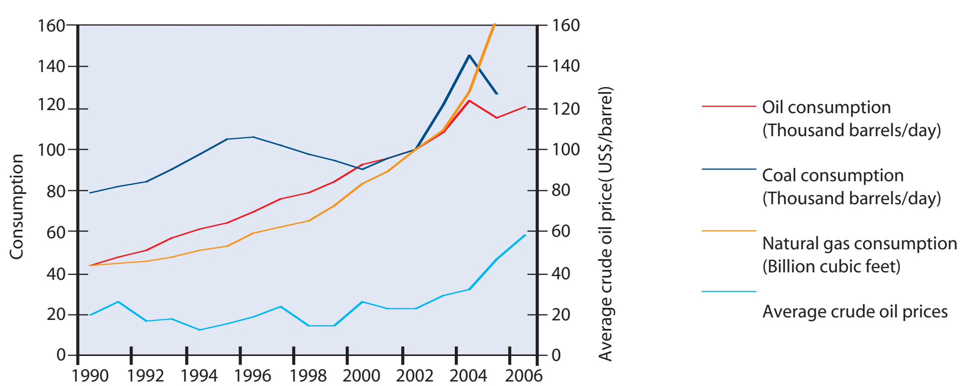
South-East Asia – A number of countries are under pressure. Current account balances have declined in Malaysia and Indonesia, and Thailand slipped into deficit in 2005. As ever, the Philippines has been protected somewhat by strong flows of remittances.

Pacific Island Countries – These countries are particularly vulnerable, hit both by rising prices and by the cost of shipping oil to remote countries. They could also lose out when supplies are short since, offering only small markets, they represent a low priority for oil exporters (UNDP 2005).

Changes in consumption of oil, natural gas and coal, by subregion

Despite the rise in prices, Asia will remain a major consumer of oil. Strong economic growth, particularly in India and China, and the growth in transport sector oil demand, are expected to see consumption rise by about 3 percent per year. Between 2002 and 2030, South and East Asia are likely to account for around 20 percent of the increase in total world energy demand (IEA 2004a).

Figure 2-13 Growth in consumption of coal, oil and natural gas in North-East Asia and the Mekong, 1990-2006



Sources: EIA 2006; IEA 2006

The rise in coal and gas consumption is even greater than for oil, indicating 'fuel switching' and new energy demands being met by non-oil options

At the same time, however, most countries are also encouraging the use of primary fuels other than oil. In addition, some are also developing non-conventional energy sources. Given different units of measurement for coal, natural gas and oil consumption, growth rates have been presented below in indexed form, where 2002 = 100.

North-East Asia and the Mekong subregion – Since 2002, consumption of coal and natural gas appears to be rising more rapidly than that of oil. For coal this is largely driven by China, and for gas, by both China and Viet Nam (Figure 2-13).

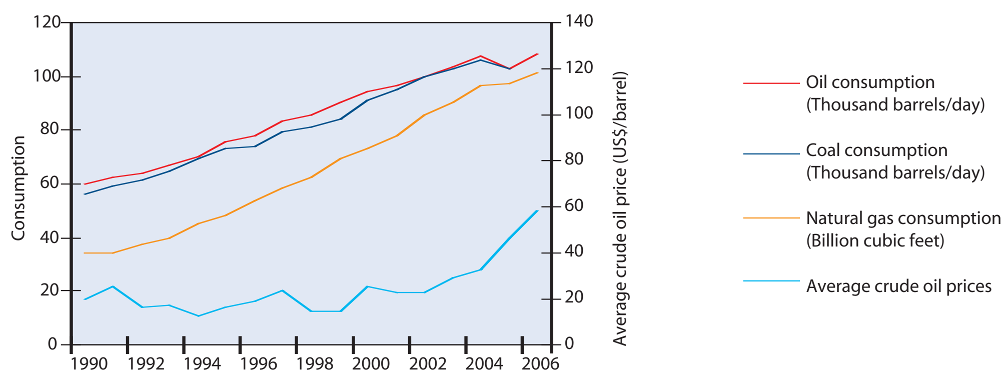
South and West Asia – Here consumption of natural gas has been growing more rapidly than that of oil, primarily reflecting the situation in India and Iran. Except for India, the other countries in the region have been using less coal (Figure 2-14).

South-East Asia – Consumption of natural gas has been growing faster than that of oil, even in oil-exporting Malaysia. At the same time, overall consumption of coal has been falling, particularly in Indonesia (Figure 2-15).

Pacific Island Countries – Most countries in the subregion primarily use oil. Fiji and Papua New Guinea consume small amounts of coal; only Papua New Guinea consumes natural gas.

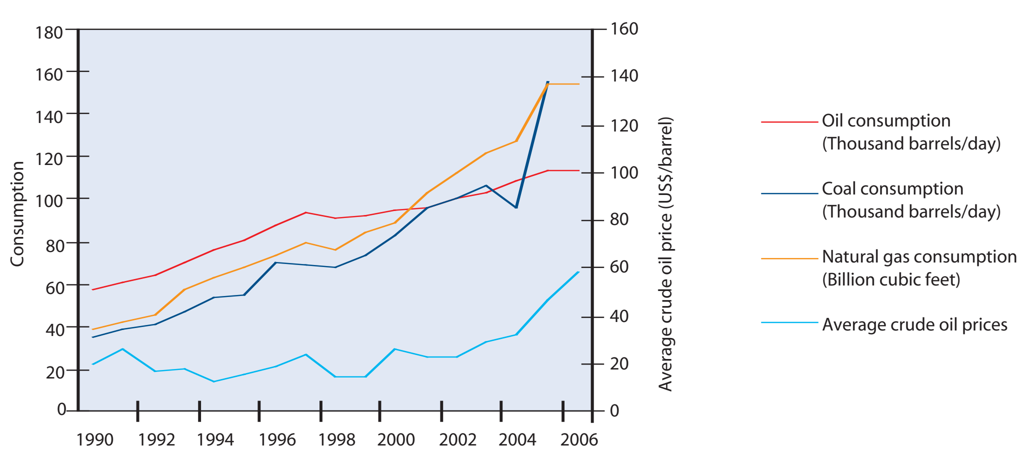
Overall, therefore, the message from around the subregion is that while oil consumption continues to increase, there are even greater rises in the consumption of coal and gas. This not only indicates 'fuel switching' in all subregions and countries away from oil, but also new demand for energy being met increasingly by non-oil options. However, oil is not being substituted to any appreciable extent in the transport sector.

Figure 2-14 Growth in consumption of coal, oil and natural gas in South and West Asia, 1990-2006



Sources: EIA 2006; IEA 2006

Figure 2-15 Growth in consumption of coal, oil and natural gas in South-East Asia, 1990 -2006



Sources: EIA 2006; IEA 2006

Electricity generation

One of the most important uses of primary energy sources is to generate electricity, the availability of which has a direct impact on the lives of the poor, for a whole range of uses from lighting to powering agricultural equipment. Across the countries surveyed in this report, there appears to have been a shift toward generating electricity from natural gas. Coal also remains important, as does hydropower, though its use appears to be diminishing in countries like Myanmar, Sri Lanka and Viet Nam. Nuclear energy too is making inroads; in 2002 it constituted around 1 percent of the primary energy mix in China and India (IEA 2004a).

Encouragingly, between 1990 and 2003 all countries saw significant rises in electricity production, from 110 percent in the Philippines to 370 percent in Viet Nam. The most rapid progress seems to have been in Malaysia and Thailand, as well as in China. But striking contrasts exist across the region: per-capita electricity consumption in high-income countries is about 26 times that in low-income countries. This is indicated in Table 2-3, which also shows that three countries, Nepal, Myanmar and Sri Lanka, have per capita electricity consumption figures that are lower than the low-income group average.

Table 2-3 Electricity production and proportion produced from oil and natural gas

	Percentage increase in electricity production (bn kWh) 1990-2003	Electricity consumption per capita, (kWh) 2003	Percentage of oil in total electricity generation		Percentage of natural gas in total electricity generation		Observations
			1990	2003	1990	2003	
China	207	1,379	7.9	3	0.5	0.3	High usage of coal: 80% of all electricity generated from coal in 2003
India	119	435	4.3	4.6	3.4	11.5	High usage of coal: 68.3% of all electricity generated from coal in 2003
Indonesia	239	440	42.7	24.6	2.3	20.3	Diminishing role of hydropower as a source of energy generation
Iran	158	1,916	37.3	16	52.5	76.7	Natural gas main source of electricity generation; diminishing role of oil
Malaysia	241	3,061	50	4.3	20.4	74	Natural gas main source of electricity generation; diminishing role of oil
Myanmar	148	101	10.9	6.8	39.3	57	Natural gas replacing hydropower as the major source of electricity generation
Nepal	156	68	0.1	0.2	…	…	Almost 100% of electricity generated from hydropower
Pakistan	114	408	20.6	15.7	33.6	48.5	Natural gas replacing hydropower as a major source of electricity generation
Philippines	110	574	46.7	14.2	…	24.9	Coal and natural gas accounts for 28% and 25% of electricity generated; diminishing role of hydropower
Sri Lanka	138	352	0.2	56.5	…	…	Oil replacing hydropower as the main source of electricity generation
Thailand	165	1,752	23.5	2.7	40.2	73	In 1990, coal, oil and hydropower contributed to 25%, 23% and 11%, respectively, of electricity generated
Viet Nam	370	429	15	6.5	0.1	29.4	Percentage of electricity generated from hydropower decreased from 62% in 1990 to 46% in 2003

Source: World Bank 2006

A closer look at the impact in 10 countries

The global and regional data in this chapter give a reasonable overall assessment of the macroeconomic impact, but they do aggregate countries, even within regions, that are very different in size. This section provides 'before and after' data on 10 countries in the region, two from each subregion: five with higher human development indices, five with lower ones. The 'before' period is 2000 to 2002; the 'after' period is from 2003 to the first quarter of 2006. The results are shown in Appendix B, Table B-2. As this indicates, all countries saw a rise in GDP growth, while some saw a rise in inflation. Most also suffered a deterioration in the current account balance that, for the oil-importing countries, might be attributed partly to the rise in oil prices. In terms of budget balances, however, there have been significant improvements: before the price rises, all had budget deficits, while after the price rises, all countries except Lao PDR reduced their deficits, probably because of a reduction in subsidies for oil and oil products to consumers.

For these periods the available data on other variables are more limited. But overall unemployment, for example, seems to have risen in the period after the price increase. The data on extreme poverty on the US$1-per-day measure show mixed results: down in China, India and Indonesia; up in Bangladesh, Lao PDR and Sri Lanka. Inequality rose in Bangladesh, China, India, Lao PDR, Malaysia and Sri Lanka, but fell in Indonesia and Thailand.

Why have the effects been so small?

Apart from some increases in inflation and a worsening of current account balances due to rising oil import bills, recent oil price rises do not appear to have had a dramatic macroeconomic impact on the low-income and developing nations of the Asia-Pacific region. Certainly the impact has been much less than earlier oil shocks, which led to a period of stagflation.

The difference this time around has been the occurrence of the oil price rises in the midst of a global economic boom, especially in the Asia-Pacific region, where economic growth has been accelerating in recent years, not only in China and India but also among many middle- and even lower-income countries. Ballooning exports have gained Asian economies US$3.6 trillion (nearly 60 percent) of the global foreign exchange reserves of US$6.1 trillion by mid-2007 (IMF 2007), allowing them to finance their oil import bills far more comfortably than in the past, when the foreign reserves of most regional countries were on a shaky footing. Thus, while the region's dependence on imported oil has grown, its economic capacity to sustain imports has grown faster, at least until now.

Over the period of the current oil price rises, both supply and demand for goods and services at large have remained quite high. Supply has been maintained because the larger economies, China and India, have been able to expand production using ample cheap labour with the added discipline of fierce competitive pressures to keep costs low. Meanwhile, demand has been sustained at least in part by relatively low interest rates that led to 'cheap money'. The result appears to have been fairly robust growth combined with inflation rates which, even if increasing, are still relatively low.

There are, however, several provisos. One is that inflation may have been restrained because governments have taken measures to shield consumers from oil price rises by subsidizing the prices of oil products. One indicator of this is the 'pass-through' coefficient, which, as noted in Chapter 1, measures the extent to which crude oil price rises have been passed on to consumers (ESMAP 2006a). For those of the 10 countries for which data are available, the coefficients are shown in Table 2-4 (see also Table 1-1 for the case-study countries alone). A coefficient less than one means that not all the percentage increase has been passed on. A coefficient greater than one means that more than the percentage increases has been passed on. Though some countries can be starting from high levels of subsidy, they could increase domestic prices by more than the increase in the world market and still leave a large element of subsidy.

As is evident from this table, apart from Malaysia, governments are more likely to pass on the prices of gasoline than of diesel to consumers, since gasoline is used more for private cars and diesel more for public transport. In the end, of course, someone has to pay, so the effect is to reduce consumer price inflation at the expense of the government budget.

Another overall issue is the fact that although the effects have yet to appear, they could still do so in the future after a longer time lag. This will depend to some extent on whether the current high prices represent a correction to the oil price collapses of the early 1990s, in which case the

Table 2-4 Pass-through coefficients, gasoline and diesel

Country	Gasoline	Diesel
Bangladesh	0.79	0.43
China	0.71	0.53
India	1.25	0.66
Indonesia	1.20	1.02
Lao PDR	1.86	1.35
Malaysia	0.75	0.84
Sri Lanka	1.80	0.83
Thailand	1.37	1.15

Note: The period considered is January 2004 to April 2006. The pass-through coefficient is the ratio of change in domestic retail prices to the change in the appropriate international product converted to local currency. The international reference prices used are the Persian Gulf for South Asia and Singapore for East Asia.

Source: ESMAP 2006a

macroeconomic effects may not actually be great. On the other hand, they could represent a longer secular trend, and impacts in the future could be quite serious.

It is also notable that despite the oil price increase, there does not seem to have been a fall in demand for oil. This is partly because oil consumption does not seem very sensitive to price increases, that is, short-run 'demand elasticity' is quite low, ranging between -0.02 and -0.03 percent. On the other hand, as their incomes rise, consumers tend to require even more oil, that is, 'income elasticity' is quite high, ranging between 0.12 and 0.19 percent. Thus, despite rising prices these two elasticities have sustained increased oil consumption.

3

National vulnerability to oil price rises

Rising oil prices affect every country to some extent, but some are much more exposed than others – highly oil dependent, perhaps, or relying heavily on expensive imports. This chapter assesses this vulnerability for the developing countries across the region, along with the potential impacts on human development. The vulnerability levels are assessed through an indexing system with three dimensions that capture the combined influence of oil availability on economic strength, performance and growth.

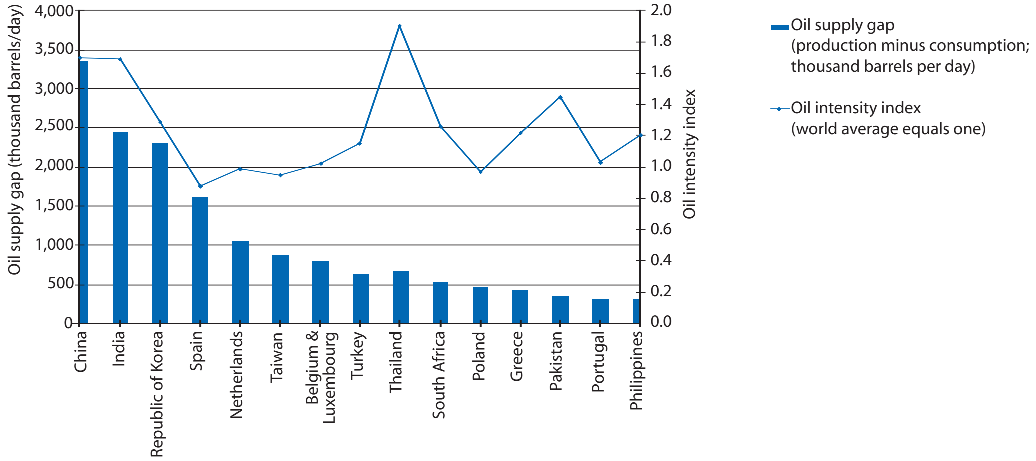
Rising oil prices have serious implications for the Asia-Pacific region. Of the region's commercially traded energy, 30 percent comes from oil and most of the rest, 47 percent, comes from coal, with natural gas a distant but rising third at 11 percent (BP 2006). Although many countries, notably China and India, have domestic supplies of coal, when it comes to oil and gas, they are more likely to rely on imports.

Oil intensity

One useful indicator of dependence on oil is 'oil intensity,' which is the amount of oil required to produce a unit of economic output, conveniently expressed through an 'oil intensity index' where the global average is 1.0. This can then be considered alongside estimates of the 'oil supply gap,' or the difference between domestic production and consumption, to indicate the extent of a country's vulnerability to international oil price fluctuations. The information for some of the larger countries in the region and elsewhere is presented in Figure 3-1. Of these, China, India, the Republic of Korea and Thailand appear to be at greatest risk, because they have high oil intensities and also depend heavily on imports. In addition, though not included in this figure, some smaller countries in the region also are at risk, including Cambodia, Nepal and the Pacific Island Countries.

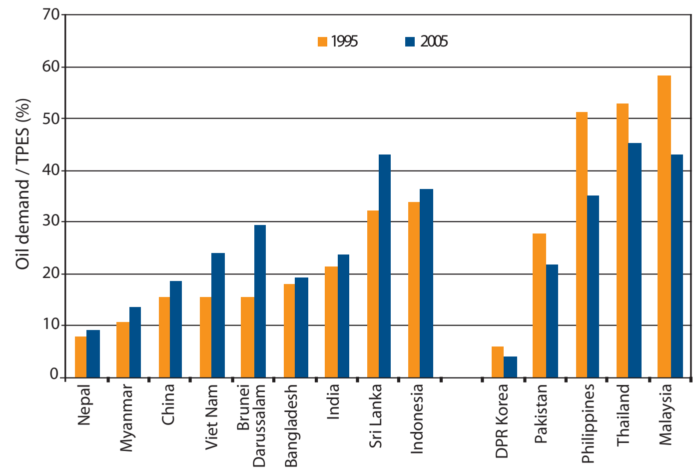
The situation in most countries has also been exacerbated by rising oil consumption. The significance of this can be appreciated by considering the proportion that oil represents of the country's total energy supply and the extent to which it has changed over the past 10 years. This is illustrated for a range of countries in Figure 3-2, which shows that for most countries, grouped to the left of the figure, the proportion of oil in the mix has increased – especially in Sri Lanka, for power generation, and in Viet Nam, for transport and industrial steam. Nevertheless, even among this group, the share of energy coming from oil can still be quite modest. In China and India this is because they have other options, including coal and hydropower.

Figure 3-1 Oil intensity index and oil supply gap for some major oil importers, 2004



Source: Economist Intelligence Unit 2006

Figure 3-2 Changes in the share of oil in total primary energy supply, 1995-2005



Data source: IEA 2007a

The smaller group of countries on the right of Figure 3-2 have reduced their oil dependence. These include the more advanced developing countries like Malaysia and Thailand, which have been basing their growth more on service industries that are less energy intensive, while they have been able to substitute oil with natural gas and coal for power generation.

Oil consumption and economic growth

In general, per capita oil consumption in Asia-Pacific developing countries still remains low: in 2004, it was less than 0.8 tonnes of oil equivalent (toe), against the average of 4.7 in the OECD countries. Nevertheless, most countries in the region have been increasing oil consumption as part of more rapid economic growth. They have, for example, been mechanizing agriculture, expanding their industries, and using more personal and freight transport. At the same time, they have been modernizing away from traditional forms of energy such as biomass, human or animal labour, and in some cases solid fuels, and towards more modern fuels, including electricity, oil and gas. This has been happening, for example, in China, India, Sri Lanka and Viet Nam.

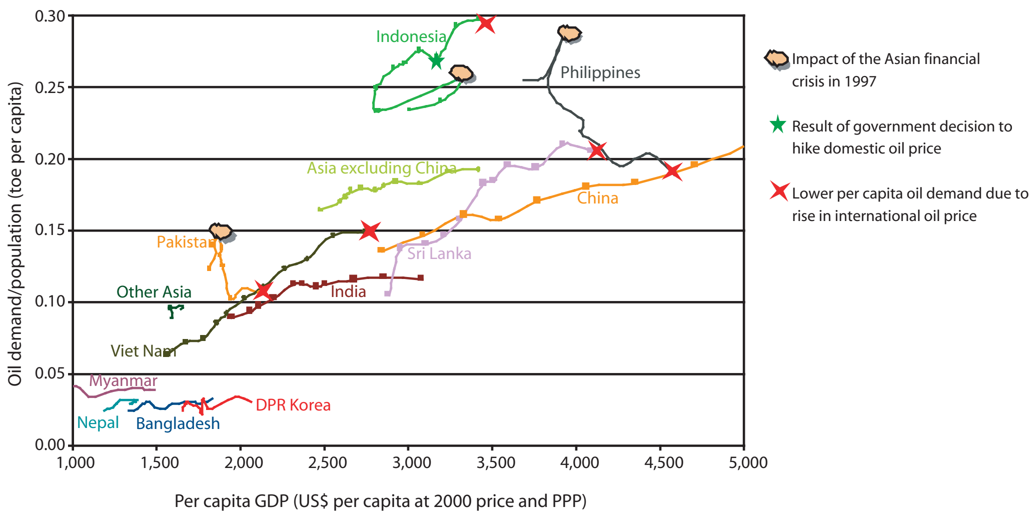
Yet if poor countries do not become more oil intensive, their growth is likely to be further hampered

Figure 3-3 illustrates, for selected countries, the correlation between oil consumption and economic growth. For each country the lines join the points for these pairs of variables, in date order. The story is clearest, perhaps, for countries like China, whose fairly straight line indicates that per capita oil consumption has risen steadily along with increases in per capita GDP. The situation is similar in India, though the overall changes in both variables have been smaller. For Viet Nam the line has also been fairly straight, but is much steeper, implying that growth is becoming more oil intensive at a greater pace than in other countries, because people use more motorcycles and cars along with other oil-based appliances for industrial steam generation.

For other countries the situation is different. For Myanmar, for example, the line is virtually flat, an unusual case. This means that although the country has a rapidly expanding economy, it has not seen a corresponding rise in per capita oil consumption. This could be because its growth is based on higher state earnings – from the export of oil and gas and other natural resources – while within the economy, people have not been making greater use of transportation and other oil-consuming sectors have only grown slowly. Other countries such as Pakistan and the Philippines, on the other hand, have more eccentric lines, reflecting the fact that per capita GDP and/or per capita oil consumption have at times risen and at times fallen.

It is not surprising that economic growth should result in increased consumption of modern forms of energy, including hydroelectricity, coal and oil. Less acknowledged, perhaps, is the fact that in order to achieve faster growth, countries need to make greater use of oil products, that is, they need to become more oil intensive. If they cannot make this change, their growth is likely to be hampered. If they want to expand rural transportation, for example, they will need to consume more gasoline and diesel for some time to come.

Figure 3-3 Evolution of per capita oil consumption and per capita GDP, 1995-2005

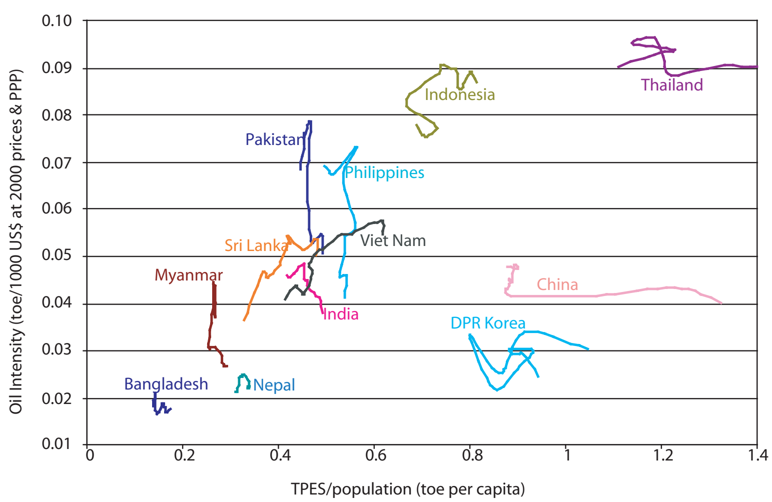


Note: For each country, the lines join the points, in date order, of the two variables.
Source: IEA 2007a

Figure 3-4 indicates the extent to which countries, while increasing their total per capita energy consumption, have also increased their oil intensity. Though the lines are generally not straight, their overall direction is clear: most countries in the region, especially the less developed ones, while using more energy per capita have also become more oil intensive.

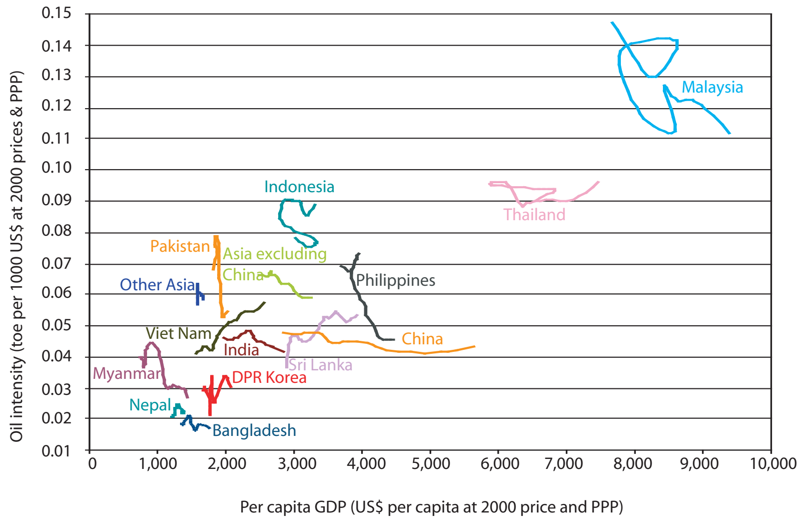
Most countries, as they have become richer, have also become more oil intensive, but at higher levels of per capita GDP, their oil intensity can then start to drop as they switch to other forms of energy, which are often cleaner and renewable. China and India, for example, have been able to slow the rate of growth in oil consumption without sacrificing economic growth, partly by ensuring that newer facilities use more efficient technologies, but also by deliberately shifting from oil to other forms of energy, such as coal, natural gas or hydropower. This was further facilitated by structural changes in the economies through a shift from energy-intensive manufacturing to the energy-light services sector, such as information technology, banking and insurance. This is illustrated in Figure 3-5, where for countries at higher levels of GDP, oil intensity is static or falling.

Figure 3-4 Evolution of per capita energy use and oil intensity, 1995-2005



Note: For each country, the lines join the points, in date order, of the two variables.
Source: IEA 2007a

Figure 3-5 Evolution of oil intensity and per capita GDP, 1995-2005



Note: For each country, the lines join the points, in date order, of the two variables
Source: IEA 2007a

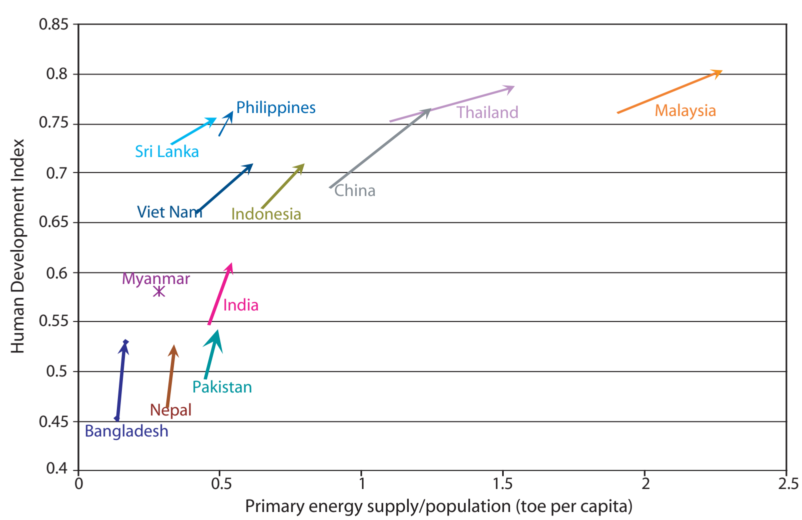
Nevertheless, declines in oil intensity have not always been due to gains in efficiency. Malaysia and Thailand, for example, saw a drop in oil intensity because of the Asian financial crisis in the late 1990s which resulted in temporary declines in per capita GDP. Viet Nam, on the other hand, has seen an increase in oil intensity as a result of structural changes in its economy.

Oil and human development

Countries that increase their oil consumption can thus accelerate economic growth. However, they will not see a real improvement in human development unless they ensure that the benefits are shared broadly across their societies. Otherwise, there is a danger that the benefits will be seized by the affluent minority, who tend to be more prolific consumers of electricity and oil. Countries therefore need to ensure that the poor too can make best use of modern sources of energy.

The value of increased energy supplies for human development is illustrated in Figure 3-6. The tail of the arrow represents the 1995 position and the tip, the 2004 position. This shows first, as might be expected, that countries with higher per capita energy use also have higher levels of human

Figure 3-6 Human Development Index and per capita energy use, 1995 and 2004



Sources: IEA 2007a; UNDP 2006

development, as measured by their human development index (HDI). At the top are Malaysia and Thailand, with high HDI rankings and primary energy consumptions exceeding 1.5 toe per capita. At the bottom are Bangladesh, Myanmar and Nepal, with poor HDI rankings and primary energy per capita below 0.5 toe per capita. But it is also important to consider the gradients of the lines, which are steeper for the poorest countries. In these cases, small increments in energy use can trigger a substantial improvement in HDI by satisfying the basic needs of the poor.

A similar association is evident for the use of oil. Countries with a low HDI generally have low per capita oil consumption, at less than one barrel per capita (Figure 3-7). An increase to two barrels per capita, however, is associated with a substantial improvement in HDI. This is understandable, since people in rural communities in remote areas isolated from the electricity grid typically turn to oil for basic home lighting and irrigation, and in order to power pumps that supply drinking water. They also rely on oil for transport. This is especially true in small island nations, where people depend on oil for power and for sea transport.

This has important implications. While it might be tempting to encourage countries at early stages of economic development to reduce their dependence on oil, there is a danger that this could also deny many people the benefits of modern energy – not just the comfort and convenience it brings, but also the economic opportunities.

Nevertheless, it should be possible to enable poor people to switch, to some extent, to non-oil sources without sacrificing human development. One analysis shows that even if the poor now rely on kerosene and LPG as 'transition fuels,' they can also, as their incomes increase, switch to natural gas or electricity (IEA 2002b).

In poor countries, small increments in energy use can trigger substantial improvements in human development by satisfying basic needs

Oil price vulnerability of the Asia-Pacific region

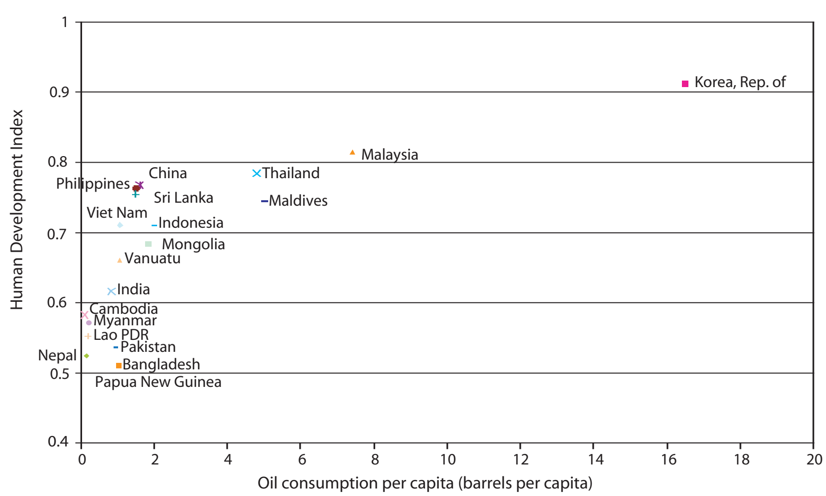
As countries become more oil intensive they are likely to become more vulnerable to oil price rises. However, the effects will vary substantially between subregions and in individual countries. Table C-1 (in Appendix C) and Table 3.1 to 3.3 show some of the key data as well as the results of an analysis performed to assess this potential vulnerability.

North-East Asia and the Mekong subregion

If countries just beginning economic development reduce their dependence on oil, it could deny many people the benefits of modern energy

China's strong economic position enables it to diversify oil supply sources through intensive exploration activities and investments in foreign oilfields, diminishing its long-term vulnerability to higher oil prices despite a current decline in its proven oil reserves. This is in marked contrast to the other countries in North-East Asia, which for oil are almost entirely dependent on imports. Moreover, oil consumption levels have been rising significantly. Between 1995 and 2004, consumption rose by 90 percent in China and 144 percent in Viet Nam. Viet Nam does have oil

Figure 3-7 Correlation between per capita oil consumption and the Human Development Index



Sources: ADB 2005; UNDP 2003

reserves, but lacks adequate refining capacity. So although it exports crude oil, it has to import petroleum products, largely eroding the financial benefits of higher oil prices.

On the positive side, most countries use diverse sources of energy. Coal is extremely important in China and Mongolia, and natural gas consumption is increasing rapidly in China and Viet Nam. Cambodia and Lao PDR, on the other hand, appear to be less vulnerable because of their high reliance on traditional energy sources. However, in the long run, with a shift towards modern fuels, especially petroleum products, their vulnerability could reach critical levels. A high proportion of energy use is from traditional sources – 77 percent in Lao PDR and 92 percent in Cambodia – so they are less exposed to the effects of price rises, but this also means that the poor often lack access to the energy they need, and in both countries forest cover is declining.

South and West Asia

Except for Nepal, countries in South and West Asia have been growing by more than 5 percent annually. However, increases in domestic gasoline product prices since 2004 have triggered inflationary concerns in many countries. Most have forms of administrative control in the oil sector, but given rising global oil prices, even here domestic prices have been rising.

Proven oil reserves are static or non-existent in all these countries except for oil-exporting Iran. As countries like Bangladesh, Pakistan and India expand their industries, they will also become more vulnerable to rising oil prices.

Nepal, Sri Lanka, Bhutan, Bangladesh, and to a lesser extent Pakistan, appear vulnerable due to their relatively weak economic capacity to absorb oil price shocks, as does Maldives due to its high dependence on imported oil. Iran, with its oil reserves, is currently seen to be the least vulnerable in the region, followed by India, which derives its strength from its economic performance. Encouragingly, most countries are increasing their consumption of non-oil-based energy sources, and natural gas use in particular has risen in Bangladesh, India and Pakistan.

Despite declining poverty levels in general, inequality has risen in Bangladesh, India and Pakistan. Sri Lanka has seen an increase in poverty, but, nevertheless, income is fairly equitably distributed. However, deforestation is a cause for concern in Sri Lanka and particularly in Nepal, which meets about 90 percent of its energy requirements through traditional fuels from sources like biomass.

South-East Asia

Overall, the region appears to have recovered from the Asian financial crisis in 1997, as reflected in GDP growth rates and foreign exchange reserves. Inflation, however, is on the rise. Poverty levels have declined in all countries, although inequality seems to have increased to a small extent in Indonesia and the Philippines.

Though South-East Asia is endowed with oil and natural gas reserves, all the countries currently import oil or oil products. Malaysia, however, is a net exporter, while all others are net importers. Many are increasing their use of natural gas, so they should become less dependent on oil. Another redeeming feature on the energy access front is the decline, except in Myanmar, in the use of traditional fuels.

The Philippines is more vulnerable to higher oil prices than Indonesia, Myanmar, Malaysia and Thailand. This is because it is more oil import intensive and also has some of the highest levels of poverty and inequality. Myanmar, in the short run, is less vulnerable because of its low oil dependency. Timor-Leste is a low-income country currently fraught with political instabilities, but it has vast oil and natural gas reserves and may therefore be less vulnerable in the longer term.

Pacific Island Countries

Economic growth in most Pacific Island economies is closely tied to external events and conditions. Almost all the countries are heavily dependent on imports for many essential supplies, while relying on a narrow range of commodity and natural resource exports or international tourism for their export receipts. Many islands are also highly dependent on aid inflows. Personal remittances from members of the diaspora are significant and serve to fuel domestic consumption demand. Many also suffer from significant and growing levels of poverty. Although data are scarce, more than 25 percent of the populations of Fiji, Kiribati, Micronesia, Papua New Guinea, Solomon Islands, Tuvalu and Vanuatu are believed to be living in poverty (ADB 2005).

The Pacific Island Countries in general are extremely vulnerable to increased oil prices. They comprise distant and small markets and have to bear the added burden of higher shipping costs. Electrical power generation in the islands is largely fuelled by diesel. Those less vulnerable are the larger countries of Samoa and Papua New Guinea. Samoa has one of the region's most efficient retail fuel markets as well as the strongest economic performance, with lower levels of poverty than most other Pacific Island Countries. Papua New Guinea produces and exports crude oil, and refines oil at the recently commissioned Napanapa oil refinery both for export and domestic consumption. The rise in oil prices has therefore had considerable positive implications for, and has made a big contribution to, the government budget.

An Oil Price Vulnerability Index

Is it possible to quantify the extent of this vulnerability? The earlier part of this chapter considered this by assessing which countries were both oil intensive and also relied on oil imports. But as the section above has shown, this is only a small part of the story. The degree of vulnerability will depend on many other factors, such as the GDP growth rate, and on foreign exchange reserves. The extent to which poor people are vulnerable will also vary, for example, according to the types of energy they use and to how much they depend on oil as an energy source.

One way to highlight the relative vulnerability of countries in the region is to construct an 'Oil Price Vulnerability Index' (OPVI). This needs to capture the three commonly accepted aspects of vulnerability: hazards, resistance and damage. Hazards are international events not under the country's control. Resistance represents the resilience and fundamental strength of the economy. Damage is measured through social vulnerability and is tracked by indicators of human development.

Developing a robust OPVI thus involves combining relevant economic, energy and social variables. For this exercise 15 variables were initially identified. They could be broadly divided into two categories: economy related and energy related. The 10 economy-related variables were: real GDP growth rate, GDP per capita, balance of payments, current account, budget balance, import cover, share of net oil fuel subsidy or tax revenue in GDP, contribution of food and beverages to inflation, trade as a percentage of GDP, the Gini index and the Human Development Index. The five energy-related variables were: oil intensity of GDP, oil import dependence, share of oil in primary energy consumption, the ratio of oil reserves to production, and the share of transport in oil consumption. Table C-1 in Appendix C shows the values of these variables for the 24 countries in the region for which comparable data were available.

As with any index constructed with a large number of variables, there is likely to be significant redundancy or overlap. Some variables could be dependent on each other; others could involve double counting. An assessment was therefore carried out using logical reasoning and correlation analysis to justify the inclusion of each variable. This exercise reduced the number of variables to eight which, using 'principal component analysis,' a popular statistical technique, were then grouped through linear combinations of variables into three principal components, logically related to three 'dimensions.' The process for developing the OPVI is elaborated in Figure 3.8 and details of the methods used are given in Appendix C.

The three resulting dimensions were:

1. Economic strength (Strength)
    - Balance of payments: current account
    - Budget balance
    - Import cover
    - Oil import dependence

Strength represents the economic capacity to afford oil imports. A country will be less vulnerable if it has high and positive scores for balance of payments, budget balance and import cover, and a lower score for oil import dependence.

2. Economic performance (Performance)
    - GDP per capita
    - Oil intensity of GDP

Better economic performance results in higher levels of GDP per capita, which should make a country less vulnerable. In developing countries that are shifting from low-quality traditional fuels to high-quality modern fuels such as petroleum products, this will lead to an increase in oil intensity. This may not be an attractive indicator from an environmental standpoint but is relevant at initial stages of economic development.

3. Economic growth with low share of oil (low-oil growth)
   - Real GDP growth rate
   - Share of oil in primary energy consumption

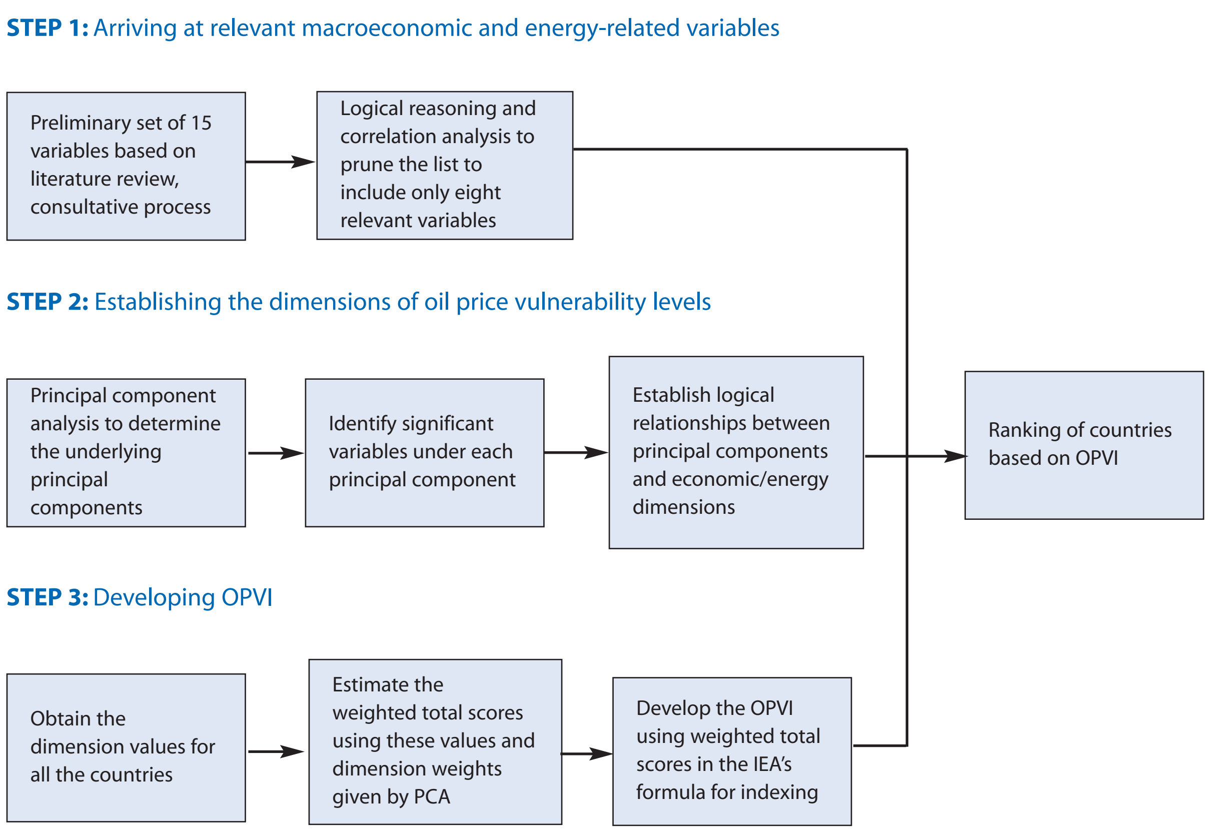
Many countries initially base their development on primary energy sources other than oil, traditional fuels perhaps or, as in the cases of China and India, coal and hydro. But they are likely to become increasingly oil dependent. A country will be less vulnerable if it can combine a high GDP growth rate with a low share of oil in primary energy consumption.

Combining the component variables in a linear fashion produced overall scores for the three dimensions. The scores for all the developing countries of Asia and the Pacific are listed in the first three columns of Table 3-1. The next step was to combine these dimension scores into a single index. Instead of uniform weights, the relative importance was used to come up with the final ranking.[1] The relative importance (weights) of these three dimensions are determined based on their ability to explain the changes in the level of vulnerability.

The OPVI for each of the countries was calculated from these weighted total scores using a formula that draws on the methodology for the International Energy Agency's Energy Development Index.[2] The third column of Table 3-1 shows the resulting index score, and using this, the ranking of countries was done in increasing order of vulnerability. At the top of the list are countries with high strength and performance, combined with low-oil growth. In first place is Iran, which, although highly reliant on oil, is a net oil exporter, followed by China and Malaysia. At the other end of the scale are countries with low economic strength, lower economic performance and high oil dependency – such as Maldives, Vanuatu and Cambodia.

India ranks quite high. Although its oil has to be imported, this does not represent a high share of total primary energy consumption since India uses more coal. India is also showing excellent economic performance. A number of other countries are less vulnerable by virtue of their energy profiles: Iran, Malaysia, China, Indonesia and Papua New Guinea.

Figure 3-8 Schematic process for developing the Oil Price Vulnerability Index



Bhutan's high rank might appear odd. This is because Bhutan, with ample hydroelectricity, has a low share of oil in primary energy consumption, at 12 percent, and its economy does not rely heavily on oil. At the same time, it has managed high growth with a higher-than-average per capita income. This is highlighted in Table 3-2 which ranks countries based on the individual dimensions. Bhutan is in first place for low-oil growth.

Based on their OPVIs, countries can be grouped into one of three categories: low, medium or high (Table 3-3). The dividing lines are based on how the OPVI scores are distributed around the average value of OPVI (refer to Appendix D).

- *Low-OPVI countries* – High economic capacity, or strength, to absorb oil price shocks, performing better, with high per capita GDP and economic growth rate, and with either low reliance on oil or a net exporter of oil
- *Medium-OPVI countries* – Medium economic capacity, or strength, to absorb oil price shocks, performing better with high or medium per capita GDP and economic growth rate, and either having a low reliance on oil or being a net exporter of oil
- *High-OPVI countries* – Low economic strength, low economic performance and high oil dependency

It should be noted that these OPVI scores and categories reflect the current position of these countries based on a limited set of variables. They do not consider future trends. Several countries, such as Iran and Malaysia, though currently among the least vulnerable, could be considered at future risk on account of their rapidly growing oil consumption relative to domestic supply. Similarly, Thailand and India could be at greater risk in the future given their persistently high dependence on imported oil. It should also be

Economic strength, economic performance and low-oil-growth form major aspects of a country's oil price vulnerability

Table 3-1 Ranking of countries based on weighted dimension scores and composite OPVI

Rank	Countries	OPVI	Strength	Performance	Low-oil-growth	Weighted Total Score
1	Iran	1.00	2.16	0.79	-0.15	2.81
2	China	0.78	0.87	0.50	0.40	1.77
3	Malaysia	0.72	1.06	0.51	-0.08	1.50
4	Bhutan	0.56	-0.20	0.25	0.70	0.75
5	India	0.49	-0.03	0.14	0.33	0.44
6	Papua New Guinea	0.46	0.81	-0.07	-0.45	0.30
7	Indonesia	0.45	0.32	0.03	-0.11	0.23
8	Thailand	0.44	0.23	0.17	-0.18	0.22
9	Mongolia	0.43	0.34	-0.23	0.07	0.18
10	Viet Nam	0.42	-0.18	0.53	-0.26	0.10
11	Myanmar	0.40	0.08	-0.27	0.20	0.01
12	Philippines	0.39	0.14	-0.13	-0.05	-0.04
13	Afghanistan	0.38	-0.24	-0.20	0.38	-0.06
14	Nepal	0.38	0.41	-0.47	-0.01	-0.07
15	Bangladesh	0.34	-0.08	-0.41	0.24	-0.25
16	Pakistan	0.34	-0.22	-0.17	0.14	-0.25
17	Lao PDR	0.31	-0.55	-0.25	0.40	-0.39
18	Fiji	0.28	-0.12	-0.11	-0.31	-0.55
19	Samoa	0.24	-0.05	-0.51	-0.17	-0.73
20	Sri Lanka	0.18	-0.81	0.00	-0.18	-0.99
21	Solomon Islands	0.18	-0.52	-0.20	-0.29	-1.01
22	Cambodia	0.17	-0.36	-0.53	-0.16	-1.05
23	Vanuatu	0.17	-0.30	-0.45	-0.32	-1.07
24	Maldives	0.00	-2.76	1.08	-0.16	-1.84

Least vulnerable
Medium
Most vulnerable

Table 3-2 Ranking of countries based on three dimensions

Countries	Strength	Performance	Low-oil-growth
Afghanistan	18	15	4
Bangladesh	13	20	6
Bhutan	16	6	1
Cambodia	20	24	15
China	3	5	3
Fiji	14	12	22
India	11	8	5
Indonesia	7	9	13
Iran	1	2	14
Lao PDR	22	18	2
Malaysia	2	4	12
Maldives	24	1	16
Mongolia	6	17	9
Myanmar	10	19	7
Nepal	5	22	10
Pakistan	17	14	8
Papua New Guinea	4	11	24
Philippines	9	13	11
Samoa	12	23	17
Solomon Islands	21	16	21
Sri Lanka	23	10	19
Thailand	8	7	18
Vanuatu	19	21	23
Viet Nam	15	3	20

noted that the index is relative to this group of countries, so even the least vulnerable countries on this list could be much more vulnerable than many countries outside the region.

The logic behind these rankings and classifications can be seen by a closer assessment. The Philippines, for example, is a borderline case and is categorized as a high-OPVI country because of its relatively high oil dependency, both in terms of intensity and share in primary energy. On the other hand, Viet Nam compares poorly to the Philippines in terms of the economic strength and low-oil growth dimensions; its economic performance is excellent and it is a net oil exporter, thus, it has a higher rank than the Philippines. On the OPVI scale Maldives is in last place even though it is first in terms of economic performance. Its rank is reduced mainly because of its low score on economic strength, a result of its highly negative balance of payments and budget balance positions as well as its high import dependence.

Influence of HDI on country vulnerability rankings

As explained above, the rankings of countries using the OPVI are obtained using macro indicators related to economic and energy variables. Mere economic variables cannot, however, capture the human or national welfare levels achieved by a country. The indicator used

Table 3-3 Categorization of countries based on OPVI

Low OPVI	Iran, China, Malaysia
Medium OPVI	Bhutan, India, Papua New Guinea, Indonesia, Thailand, Mongolia, Viet Nam, Myanmar
High OPVI	Philippines, Afghanistan, Nepal, Bangladesh, Pakistan, Lao PDR, Fiji, Samoa, Sri Lanka, Solomon Islands, Cambodia, Vanuatu, Maldives

for this purpose is the Human Development Index (HDI). An attempt has been made here, therefore, to incorporate the HDI as a ninth variable. The ranking of countries based on this OPVI is presented in Table 3-4 along with the rankings obtained earlier.

Clearly, the countries with higher HDI levels have improved their rankings whereas countries with poor HDIs have worsened their rankings. Maldives, which was ranked last on the OPVI based only on macro indicators, improves its rank to 13. On the other hand, India's rank falls from 5 to 9. Countries such as Fiji, Philippines, Sri Lanka, Thailand and Viet Nam improve their rankings, whereas all the South Asian countries (except Sri Lanka) along with Lao PDR, Myanmar and Mongolia drop in the ranking. Iran remains at the top because of its strong macroeconomic indicators. This is also the case with China and Malaysia, which interchange positions.

As the OPVI and earlier sections of this chapter have shown, a number of countries in the region are very vulnerable to oil price rises, and they could become even more vulnerable in the future. What can they do to reduce this vulnerability? That is the subject of the next chapter.

A number of countries in the region are very vulnerable to oil price rises, and could become even more so in the future

Table 3-4 OPVI ranking of countries with and without the influence of HDI

Countries	OPVI rank without HDI	OPVI rank with HDI
Afghanistan	13	23
Bangladesh	15	21
Bhutan	4	11
Cambodia	22	24
China	2	3
Fiji	18	10
India	5	9
Indonesia	7	6
Iran	1	1
Lao PDR	17	22
Malaysia	3	2
Maldives	24	13
Mongolia	9	12
Myanmar	11	15
Nepal	14	18
Pakistan	16	17
Papua New Guinea	6	8
Philippines	12	7
Samoa	19	16
Solomon Islands	21	19
Sri Lanka	20	14
Thailand	8	4
Vanuatu	23	20
Viet Nam	10	5

Least vulnerable
Medium
Most vulnerable

Endnotes

1 The analysis earlier had concluded that the variables in the 'Strength' dimension accounted for 33 percent of the variance; those in the 'Performance' dimension for 23 percent; and those in the 'Low-oil growth' dimension for 19 percent. The dimension scores were therefore weighted accordingly to produce the weighted total score shown in the last column of Table 3-1.

2 $$\text{Dimension index} = \frac{\text{Dimension value} - \text{minimum value}}{\text{Maximum value} - \text{minimum value}}$$

Options for reducing oil price vulnerability

4

What should countries do in response to rising oil prices? Clearly they will want to boost supplies and restrain demand. But they will also need to find ways of managing oil price risks while, at the same time, preparing for potential oil shocks. This chapter reviews some of the main options and the experience of the Asia-Pacific region in implementing them.

Rising oil prices can create a number of problems. They can, for example, increase inflation and put pressure on foreign exchange reserves. They can also create difficulties for poor households by pushing up the prices of kerosene and LPG, and for poor farmers through higher prices for fertilizers. This, in turn, creates problems for governments that wish to protect their citizens through subsidies. How can governments respond? This chapter outlines five strategic directions. The first pertains to managing the economic costs of oil price volatility and how this can be handled in the short run through a basket of fiscal and financial instruments. The second looks at the supply side, covering both domestic and other sources of oil. The third and fourth strategies both focus on reducing the demand for oil: one through reducing oil intensity, the other through diversifying to other fuels. The fifth strategy deals with emergency responses.

Managing oil price risk

Many governments have shielded consumers from the effects of oil price rises through a series of pricing measures that have regulated the 'pass-through'. These measures, which are summarized in Table 4-1, include the following:

Subsidies

Governments often subsidize petroleum products, commonly household fuels such as kerosene and LPG but also, in some cases, transportation fuels. This, however, can be very costly. Thailand, for example, introduced price ceilings for petroleum products in January 2004, most of which continued until October 2004, and ceilings for diesel until February 2005, resulting in a subsidy bill for that period of around US$2.2 billion (ESMAP 2006b). Indonesia had a similar programme, which in 2005 produced a subsidy bill of about US$9.9 billion. An IMF study concluded that for a range of countries subsidy expenditures could be higher than health and education expenditures combined (IMF 2006d).

On the other hand, the case studies in this report also point to the adverse consequences of completely withdrawing subsidies on household petroleum products, particularly kerosene, since this may push poor households back down the energy ladder to traditional fuels.

Governments will therefore want to ensure that subsidy programmes are well managed and accurately targeted for the poor. Malaysia, for example, in 2006 launched a smart-card scheme targeted at public transport operators and fishermen, giving them access to subsidies through a monthly quota based on vehicle category or boat size. Lessons may also be learned from outside the region. Brazil, for example, progressively limited subsidies on LPG to only low-income consumers. This proved very effective and between 1960 and 2004 penetration of LPG increased from 18 percent to 98 percent (Modi et al. 2005). Other options include giving fewer subsidies for petroleum-based fuels and more for the capital costs of installing renewable technologies, as explored in the next chapter. Of course, the most enduring solution would be to reduce levels of poverty so that subsidies would be unnecessary.

Tax adjustment

Because many retail petroleum products, especially transportation fuels, can be quite heavily taxed, governments can smooth the prices for consumers by adjusting the rates of taxation. This has been the main form of adjustment in Bangladesh, for example, and Lao PDR. Following the recent oil price rise, more governments have resorted to tax adjustments rather than subsidies.

Governments can try to offset the impact of price rises by compensating the poor in various ways

Price restraint

Some governments have passed the subsidy burden on to the private sector, requiring companies to absorb international oil price increases. In China, India and Sri Lanka, for example, governments have obliged companies in the downstream oil sector to sell at lower prices. Similarly, in Indonesia, Pakistan, the Philippines and Thailand, governments have used their influence on the oil sector to keep petroleum product prices low.

Compensation schemes

If prices go up or subsidies are reduced, governments can try to offset the impact on the poor by compensating them in various ways. Indonesia, for example, after reducing subsidies on petroleum products in 2005, redirected some of the savings to a cash transfer programme for the poor of about US$30 per household every three months, as well as to poverty reduction programmes in education, rural development and health. China too has, in some provinces, briefly introduced cash transfer schemes to help tide consumers over rising oil prices. Governments also may consider that other safety net programmes offer good opportunities for targeting. Sri Lanka, for example, has a food stamps programme that is substantially better targeted than those for kerosene subsidies (IMF 2006d).

A number of countries in the region have applied one or more of these pricing-related measures (Table 4-1). The guiding principles for these should be efficiency, equity, and effective revenue-raising, while also taking opportunities to reduce environmental impacts, for example, through higher taxes on gasoline for private cars.

Using financial tools

As well as being concerned about the level of prices, policy makers will also be worried about their volatility and the potential for sudden shocks. To cushion against these, governments and companies have at their disposal a variety of sophisticated financial products that they can buy and sell to enable them to offset the risks of sudden fluctuations. These derivatives take various forms, including 'forwards,' 'futures,' 'options' and 'swaps,' all of which can dampen the impact of price fluctuations. However, they are relevant largely in the short-term context, and all involve certain speculative risks of their own.

A number of African countries, including Mauritius and Cameroon, have used such market-based energy risk management tools. But countries in the Asia-Pacific region have seldom adopted these measures, probably because their oil markets have been dominated by state-owned oil companies and utilities. More recently, however, a process of deregulation has encouraged new risk management initiatives (Fusaro 2003). Some major corporate oil consumers in the region have also been using these tools. Airlines such as Cathay Pacific, Singapore Airlines and Malaysia Airlines use derivatives to hedge their jet fuel exposure. These measures are of course more appropriate for smoothing out prices and do not assist much with long-term price issues. It also seems that the use of such instruments is more relevant to major corporate consumers than to national governments.

In addition to market-based tools, governments also have a number of other options for coping with oil price volatility. These include:

Table 4-1 Price-based responses in selected countries

	Subsidies	Tax adjustment	Price restraint	Compensation schemes
Bangladesh		✓		
China	✓	✓	✓	✓
India	✓		✓	
Indonesia	✓	✓	✓	✓
Lao PDR		✓		
Malaysia	✓	✓		
Pakistan	✓	✓	✓	✓
Philippines		✓	✓	
Sri Lanka	✓	✓	✓	
Thailand		✓	✓	✓
Viet Nam	✓			✓

Source: ESMAP 2006a

- *Stabilization funds* – These can be used by both oil exporters and importers. Based on pre-determined rules, exporters will pay into the fund when prices are high and can withdraw from it when prices are lower. Importers do the opposite. Norway, for example, in 1990, established a State Petroleum Fund to transfer wealth from oil and gas reserves to a broad-based portfolio of international securities. As well as acting as a form of savings, this also distributes wealth across generations. Management of the fund is outsourced but operates under government guidelines. Oil importers have also used such funds to stabilize retail prices. Namibia, for example, has imposed on consumers an 'equalization levy' for every litre of diesel and petrol they buy – money which is transferred to a National Energy Fund. Within the region, Thailand established an oil price stabilization fund in 2004 to finance oil price subsidies. While the initial large demand upon the fund has subsided because of the subsequent removal of diesel and gasoline subsidies, the fund remains an important source of financing for LPG subsidies of about US$12.6 million a month (ADB 2005). India and the Philippines have had such funds, but these have now been suspended. Stabilization funds can be valuable, but they can also be difficult and expensive to operate and are probably best suited for addressing short– to medium-term oil price shocks.

- *Long-term contracts* – Countries may also shield themselves from short-term fluctuations in oil prices by engaging in long-term contracts based on prices that are either fixed or adjustable within agreed ceilings and targets. Most of the trade in natural gas uses such contracts, but they are less common in the oil sector where, even in long-term contracts, the prices are linked to market prices. At present, however, there seems to be a move away from long-term contracts even for natural gas and crude oil, so this does not seem like a useful immediate option.

Table 4-2 Priority policy actions towards managing oil price risk

Countries	Legislative and regulatory measures	Fiscal, financial and institutional measures	Direct public investment
Pricing of petroleum products	• Regulate pricing policies such that while the interests of the poor are protected, leakages to the non-poor are prevented. • Regulate policies for oil-intensive sectors such as fertilizers.	• Mandate pricing based fiscal measures to manage oil price risk.	• Promote investments to develop integrated transport plans to ensure effective utilization of petroleum products.
Targeting oil subsidies	• Mandate policies that prevent leakages of subsidies. • Explore options of substitution of the petroleum subsidies with capital subsidies to promote renewable forms of energy. • Explore policy options which enhance purchasing power of the people to ensure access and affordability of people.	• Use targeted subsidies on household fuels (LPG, kerosene) to shield consumers from the full impact of oil price rise. • Implement cash compensation schemes to cushion the impacts. • Ration subsidized fuels through a monthly quota (e.g., smart card scheme in Malaysia targeting transport operators and fishermen).	• Develop institutional arrangements and infrastructure for implementation of smart cards for disbursement of subsidies to eligible families.
Financial tools	• Promote the usage of the Oil Stabilization Fund, which can transfer the oil price benefits to the fund and from there to the budget when prices rise. • Promote usage of long-term, market-based energy risk management tools.	• Combine financial instruments such as forwards, futures, options and swaps (increasingly used to manage oil price risk) with caps, collars and floors. • Introduce compensatory financing to allow countries to borrow on concessional terms.	• Undertake investments in sectors that can enhance income levels of the people by ensuring livelihood opportunities. • Put in place institutional arrangements for the efficient adoption of various financial tools for oil price risk management.

Enhancing oil supply

Although the supply of oil is finite, governments in the region can take a number of measures to enhance supplies. These, which are summarized in Table 4-3, include the following:

Strengthening oil exploration and extraction

Higher prices can spur the search for new sources or encourage the exploitation of those hitherto unattractive. Some of the region's existing producers are now developing new fields. In Viet Nam, for example, exploration activities have been yielding results: in October 2004, a joint venture comprising American Technologies, Petronas, Singapore Petroleum and Petro Vietnam announced a 100-million-barrel oil discovery off the country's northeast coast. The Philippines too, though having only small reserves, in its Energy Plan 2005, stressed intensive promotion of oil and gas exploration. And the government of Sri Lanka is increasingly pinning its hopes on oil and gas discovery: In October 2005, it formed a new Ministry for Petroleum Resources Development to invite bids for oil and gas exploration (ESMAP 2006a).

Some of the region's existing producers are now developing new oil fields

A number of oil-producing countries have also been simplifying their procedures and dismantling national monopolies in order to encourage greater private investment, including foreign investment. Indonesia, for example, has been limiting the control over oil sector development that was previously the preserve of Pertamina, the state-owned oil company. And Pakistan has executed production sharing agreements with exploration companies based in Austria, France and Malaysia. These measures offer considerable potential for LDCs in particular, since as well as bringing in capital investment, they also free up state resources for investment in the social sector.

High oil prices have induced some regional countries who are not oil producers to redouble their efforts to discover resources, especially offshore. The main strategies in Sri Lanka and the Philippines, for example, involve oil and gas exploration.

Countries can also take advantage of new technology to expand options, enabling companies to carry out more offshore drilling and make better use of unconventional sources, as has been done with tar sands in Canada and very heavy oil in Venezuela. These newer resources may be more expensive to exploit, but higher oil prices are making them more viable. New technology can also boost production at existing sites where rates of recovery are quite low. Globally, the average recovery rate is 35 percent, but in India, for example, it is 30 percent, and in Iran only 24 to 27 percent.

Increasing refining capacity

Another important way of enhancing supplies of petroleum products is to increase the capacity of refineries, as has been happening in China, India, Malaysia and Singapore. But it is also important to ensure that new refineries can process heavy sour crudes, which are cheaper and more readily available, while meeting the demand for lighter products such as transportation fuels, and accommodating environmental requirements.

To refine heavier sour crudes, European and US refineries have been adding catalytic and hydro-cracking capacities. Asian refineries have also been doing so, but more slowly. China has been upgrading its refineries for this purpose, and in India, Reliance Petroleum is in the process of establishing a new 29-million-tonne refinery, capable of processing the heaviest and sourest of crude oils from the Middle East into high-quality refined products, primarily for export. This will benefit not only India but also the region's LDCs, which will have a new source of supply reasonably close to home and thus with lower transport costs. Building this kind of capacity is, however, expensive and time-consuming and has a high import requirement, so it will likely fall outside the reach of most of the poorer countries.

Diversifying sources of oil

Some economies in the regions that have sufficient demand can widen their range of supply sources, in three main ways:

- *Invest in foreign oil fields* – India and China, mostly through state-owned companies, have already been investing in oil extraction in other countries. The China National Petroleum Corporation, for example, has invested in a number of countries, including Kazakhstan and Myanmar (ESMAP 2006a).
- *Diversify import sources* – One way of reducing vulnerability to oil supply disruptions is to diversify sources of imports. For crude supplies, most Asian countries will continue to depend largely on the Middle East, which is geographically the closest, but they could also diversify to some extent to Russia, Central Asia and Africa. This would reduce risks and also increase competition (APERC 2003). Maintaining oil price stability will also depend on regional and international

cooperation among consuming countries, as well as on continuing dialogues between producers and consumers. Some importing countries have, for example, started negotiating price discounts or concessionary financing terms with oil producers. For example, Bangladesh, in March 2006, made an agreement with Kuwait and the United Arab Emirates to buy oil on concessionary terms. India has mooted the idea of limiting price volatility through an agreement between producers and consumers on a price band mechanism. Another option is to make bulk purchases: Honduras, for instance, recently announced such a government-supervised scheme. The Pacific Island Countries are currently discussing a joint procurement arrangement that could gain them price discounts on bulk purchases.

- *Cross-border trade* – There are also opportunities for diversifying sources of oil by tapping the region's own oil resources through regional cooperation and mutually beneficial trade with neighbouring countries. On the one hand, the region has many consuming countries, which need to ensure the security, stability and sustainability of their oil supplies. These include the large oil consumers, China and India, as well as relatively smaller consumers ranging from Pakistan, Sri Lanka and Thailand to the mainly traditional energy consumers like Lao PDR and Cambodia. At the same time, the region also has a number off crude oil exporters – including Myanmar, Malaysia, Indonesia, Papua New Guinea and Viet Nam. Both consuming and producing countries could therefore explore a common policy platform of Asian oil security, while bearing in mind the need to diversify sources of oil imports as well as sources of energy. This is especially important for LDCs, which have limited capacity to cushion themselves against supply bottlenecks and price barriers. Cross-border trade in oil could be promoted through mutually beneficial bilateral agreements. For this purpose, the oil sector could also learn from existing forms of regional cooperation for gas and electricity (Box 4-1).

Engaging in barter

The demand for oil is so large and persistent that many countries would do well to acquire it by exchanging their own exports directly. Bartering is a particularly useful option for countries that are short of US dollars, but other countries too can benefit from the reduced transaction costs.

Bartering of manufactured products, services or technical knowledge in exchange for oil is a particularly useful option

Countries could, for example, trade manufactured products or industrial crops for oil, arranging to get most grades of oil, most of the time, at the best available exchange ratios. They could also offer services. A number of oil-producing countries, especially those in Africa, lack the funds or knowledge to develop their infrastructure, while many Asian oil-consuming developing countries like China and India, which are struggling with high oil prices, can offer large pools of highly capable professionals and technical knowledge in exchange for oil.

Box 4-1 Energy cooperation: Examples from gas and electricity

Most energy resources yield optimal benefits when exploited by two or more nations, especially when they are relatively small and the resources are distributed across several countries. The hydroelectric potential of a river valley system, for example, can be exploited by several countries, and gas grids can connect several national markets. Such systems make better use of capacity and reduce costs.

There already exist some examples in the Asia-Pacific region. Bhutan and India have arrangements for hydropower, as do Lao PDR and Thailand, and following the discovery of 10 gas fields, Thailand and Malaysia have agreed on a Joint Development Area. In addition, for gas, Indonesia has agreements with the Philippines, Thailand and Singapore.

Now there is also an example for oil. Early in 2006, Timor-Leste signed a politically significant agreement with Australia to share equally the oil and gas revenues in a disputed territory that includes the Greater Sunrise gas field.

Transportation of liquefied natural gas over long distances requires dedicated reserves and significant investment in infrastructure. But these can bring substantial economic benefits, as with the 8,000-kilometre Trans-Asian gas pipeline system that links East Asian markets. In this context, ASEAN's Regional Power Grid and Trans-ASEAN Gas Pipeline (TAGP) are important initiatives that can promote cross-border trade and cooperation for greater regional energy security. The TAGP is expected to build on existing national grids and bilateral pipeline connections, which at present connect Indonesia and Malaysia to Singapore, Myanmar to Thailand, and the delivery of gas to Malaysia and Thailand from the Malaysia-Thailand Joint Development Area.

In fact, for a variety of economic and political reasons various nations are already exploring barter trade in oil[1]:

- *China* – The Yangpu Oil Barter Exchange is reportedly the world's first such exchange for oil and gas. The focus here is on putting together trades of oil for infrastructure.

- *India* – The Oil and Natural Gas Corporation has teamed up with the L. N. Mittal steel group to offer a range of services to Kazakhstan in return for oil exploration rights.

- *Republic of Korea* – The Korea National Oil Corporation has entered into an oil barter transaction with Nigeria, under which Korean conglomerate Daewoo will build a shipyard and a railway link in Nigeria.

- *Venezuela* – Some 90,000 barrels of oil a day are shipped to Cuba in return for more than 30,000 physicians, sports coaches and teachers. Venezuela has also struck a deal with Argentina to supply additional oil against shipbuilding expertise and farm machinery.

Restraining oil demand

Restraining in this context does not mean cutting demand at the cost of economic or social activity, but rather, minimizing wastage and concentrating the use of oil on purposes for which cheaper alternatives are not available. This has the further merit of reducing costs for businesses and households while slowing the depletion of conventional oil resources and reducing the impact on the climate.

Table 4-3 Priority policy actions towards enhancing oil supplies

	Legislative and regulatory measures	Fiscal, financial and institutional measures	Direct public investment
Strengthening oil exploration and extraction activities	• Include oil exploration in the mandate of the oil companies; for example, a part of their profits must be expended on exploration activities.	• Introduce fiscal incentives like tax rebates to oil companies to strengthen exploration activities. • Lend fiscal support to technological investments to enhance recovery rates from rigs; also allow them benefits of lower interest rates on institutional loans.	• Invest in infrastructure around sites of oil exploration and extraction and in establishing technical R&D centres.
Refining capacity to process sour crudes	• Encourage the establishment of refining capacity for sour crudes. • Regulate the conversion of excess capacity, if any, for the processing of lighter crudes into refining capacity for sour crudes.	• Introduce capital subsidies for sour crude refining facilities and duty exemptions for imported technology to be used in the refining facilities; also allow them the benefits of lower interest rates on institutional loans.	• Provide infrastructure to establish new refining capacity and provide initial direct investments in new refining capacity for sour crudes.
Diversifying sources of oil	• Create policy initiatives to encourage investments in oil fields abroad by domestic oil companies and directives to explore new sources of oil, for example, tar sands. • Sanction the formation of strategic alliances across countries/ country groups to gain access to more diverse sources of oil.	• Give tax benefits to companies investing in oil fields abroad. • Extend the facilities of accelerated depreciation to equipment used by oil companies extracting oil from unconventional sources such as tar sands and very heavy oil deposits.	• Establish technical centres for R&D into new sources of oil. • Invest in pipelines and transport systems for the transfer of oil from international oil fields.
Barter	• Bring about legislation allowing international barter trade in oil. • Define areas of comparative advantage in the economy that may serve the country in a goods and services exchange programme.	• Encourage the further development of non-oil sectors of comparative advantage, for example the services industry, through tax incentives. • Ease duty/ visa restrictions on the mobility of goods and services/ human capital associated with oil-related barter.	• Invest in establishing an oil barter exchange. • Carry out techno-economic feasibility studies to examine on an ongoing basis which products may be bartered in exchange for oil, at what terms, and with which countries.

This process has already been underway in the broader energy context, which includes oil. Between 1990 and 2002, energy efficiency improvements have helped reduce global energy demand by 20 percent (ENERDATA 2006). Over this period, 15 European countries on average improved the energy efficiency of final consumers by 10 percent. While between 1990 and 2003 their primary and final energy consumption increased by 0.9 percent per annum, their GDP grew twice as fast, demonstrating that economic activity had partially been decoupled from energy use. Around 10 percent of these gains came from structural changes in the economy toward less energy-intensive activities, often in the service sector.

Asia-Pacific countries too have been improving energy efficiency. China has been leading the way: between 1990 and 2003, energy use per US$ PPP GDP declined from 0.49 to 0.22 kilograms of oil equivalent (kgoe) (World Bank 2006). India too achieved a reduction over the same period, from 0.25 to 0.18 kgoe, and Sri Lanka from 0.14 to 0.11 kgoe. Their changes may be smaller than China's but are still impressive since these countries started from higher levels of efficiency. Many other countries in the region have begun stressing energy efficiency and energy conservation. Indonesia, for example, has developed a Blueprint for Energy Management, while the Philippines has adopted an Energy Plan to curtail the intensity of fossil fuel consumption and help achieve energy independence. China and India have also enacted laws to conserve energy and have established accompanying implementation mechanisms.

There are four broad strategies for achieving greater efficiency in oil use:

- *Making structural changes* – Shifting to less oil-intensive activities, from manufacturing to services, for example.

- *Reducing oil intensity* – Changing the patterns and practices of production and consumption to make them less oil intensive.

- *Improving technology* – Upgrading production equipment and making consumer devices more energy-efficient.

- *Substituting fuels* – Displacing oil with other fuels.

The first three options are discussed in detail in the sections below on transport, industry, agriculture and households. The issue of fuel diversification is discussed in two parts. The first part in this chapter concerns diversification using fossil fuels. The second part, which forms the next chapter, concerns renewable energy options.

The options for reducing oil intensity are summarized in Table 4-4.

Transport

Countries can develop strategies for reducing fuel consumption through, for example, inter-city freight transport plans, urban mobility plans that can involve inter-modal mass transit, and specific plans for targeted groups, such as youth and workers. They can also promote better use of land and 'smart growth' that reduces urban sprawl and the need for driving, while also reducing fuel wastage through real-time, congestion-based road pricing. All these methods also will have the benefit of improving air quality.

New mass transit plans and 'smart growth' that reduces urban sprawl can reduce fuel costs and consumption

Another set of options involves changing patterns and practices to reduce vehicle-kilometres travelled. These include adjusting fuel and vehicle prices, improving mass transit services and promoting car-pooling and the use of smaller and more efficient vehicles. The government of Philippines, for example, has halted the purchase of new vehicles, optimized office air conditioning and reduced official trips. Other options include promoting on-board fuel economy technology, encouraging telecommuting and motivating drivers to drive more efficiently.

In an example from outside the region, Honduras, in May 2006, introduced several new measures to save fuel costs. It changed fuel taxation to encourage fuel switching from gasoline with a research octane number of 95 to 87, and it ordered the 60,000 state-owned vehicles to use the cheapest fuel available and to circulate on alternate days depending on their license plates. Other ways to reduce energy intensity require better technology. These would involve more efficient vehicles, including hybrid cars as well as innovative structures and advanced materials such as lightweight steel and carbon-fibre composites. 'Intelligent highway systems' also can contribute, along with telematic systems for freight transport and more advanced technology in railways, airplanes and marine transport.

Some of these measures require major and potentially disruptive technological adaptations. To cushion the immediate impact on economic activity, these could be introduced in a phased manner. China, for example, is implementing fuel efficiency norms for passenger cars in two phases: Phase I was implemented in 2005/06, while Phase II will be implemented in 2008/09.

Industry

Many countries have been diversifying away from industries that are energy intensive, initially focusing on industries linked, upstream or downstream, to energy production. When it comes to energy-intensive products, they have been aiming to use a higher proportion of recycled materials. Within the electricity industry, some have been using a higher proportion of renewables and making efforts to manage peak electricity demand. They have also been taking measures to improve energy efficiency elsewhere while shifting from oil to other energy sources, particularly those like Lao PDR and Bhutan, which have considerable hydroelectric potential.

Industries may benefit from tax rebates for energy-efficient technologies, as well as subsidized energy audits

Some countries have also been trying to change consumption patterns, for example, through education campaigns that aim to reduce peak electricity demand. In Viet Nam in 2005 and 2006, government agencies were asked to reduce fuel purchase expenditures by 10 percent (ESMAP 2006b). Countries in other regions, such as Guatemala, Honduras and Tunisia, have adopted daylight saving time in summer to reduce electricity consumption. Moreover, in Tunisia the public sector is required to choose low-energy consumption equipment and carry out annual energy audits. Several other countries are providing tax incentives and publicity campaigns to promote the purchase of energy-efficient appliances or imposing a ban on the import and marketing of inefficient appliances (ESMAP 2006a).

Options for promoting more efficient use of energy include: offering tax rebates for energy-efficient technologies; raising taxes on energy guzzlers; introducing programmes for benchmarking and for appropriate labelling; improving building codes; and subsidizing energy audits. Industry and government can also negotiate voluntary agreements for improving energy efficiency and reducing energy-related greenhouse gas emissions.

It is especially important to ensure effective programmes for testing the energy efficiency of equipment and promoting energy efficiency standards. Some countries in the region have introduced these but need to improve enforcement.

Countries can also make better use of new technologies, to improve the efficiency of, for example, furnaces, boilers, burners, thermal insulation and steam networks, and to optimize and integrate various processes. Other options include thermal cascading, district energy schemes and better energy recovery.

Agriculture

Energy efficiency in agriculture can be increased by, for example, optimizing the use of oil-consuming agricultural machinery through cooperatives, reducing energy input per hectare and reclaiming marginal land for cultivation. There also exist possibilities for changing farming patterns and practices: encouraging farmers to operate tractors and pumps more efficiently and moving to night or drip irrigation. In the 1980s, Bangladesh imported from China many cheap but inefficient diesel irrigation pump sets, but following rural electrification, has encouraged farmers to switch to electric pump sets.

Households

Households can increase energy efficiency by working together. Many have micro-enterprises at home that they could combine as community enterprises. They could also consider community cooking.

Manufacturers have an important part to play in improving household energy use, by offering more efficient appliances

Manufacturers likewise have an important part to play in improving household energy use. They can offer more efficient appliances, including air conditioners, room heaters, electric irons, TV sets and motorized grinders. In many cases they do so voluntarily, but can also be obliged to follow regulations based on standards and specifications. All equipment should be screened before it goes on sale, so that consumers can make choices based on energy efficiency.

For this to work, consumers will need to be sensitized to the benefits of buying energy-efficient equipment that may be slightly more expensive but will bring long-term savings. In rural areas these will include more efficient stoves and better-designed kerosene lamps.

Policy tools and instruments

Across all these sectors governments have three main sets of instruments:

- *Legislation and regulation* – Laws, standards and specifications, mandatory quotas, targets and obligations.
- *Fiscal and financial measures* – Subsidies, taxes, duties, financial incentives and disincentives.
- *Direct public investment* – In social infrastructure, market infrastructure, technology, research and development, technology transfer, capacity building, and institutional and human resource development.

The choices will vary according to oil price scenarios and national circumstances, but some of the most important options are listed in Table 4-4.

While many of these measures will be useful for most countries, other approaches may be needed for the Pacific Island Countries. Most depend heavily on oil products as their main energy sources and have few options for producing biomass. Many are, however, blessed with solar and other indigenous energy resources. Where appropriate, certain islands with relatively high population densities could also look into the option of adopting systems of combined heat and power generation – heat recovered from thermal power plants can be tapped to desalinate water, for example, and for industrial

Table 4-4 Measures to reduce oil intensity

	Legislation and regulations	Fiscal and financial measures	Direct public investment
Transport	• Mandate relevant authorities to develop transport master plans. • Adopt minimum fuel-efficiency standards and mandatory efficiency labelling. • Set target dates and penetration rates for biofuels and other cleaner fuels.	• Remove price distortions and eliminate subsidies that mostly benefit the rich. • Introduce incentives for 'scrap and replace' programmes aimed at low-income households. • Provide financial assistance for urban mobility plans for various stakeholders. • Provide financial assistance to purchase fuel-efficient public transport vehicles. • Impose, on private vehicles, higher fuel taxes that reflect the social cost of travelling. • Set annual registration taxes for cars on the basis of engine size, weight and efficiency. • Offer incentives for procurement of new technologies.	• Strengthen existing institutions. • Set up observatories to gather relevant data and benchmarking. • Undertake 'well-to-wheel' analysis. • Launch driver-training and mass awareness programmes. • Support R&D to develop enabling technologies. • Support R&D and help manufacturers to improve production facilities.
Industry	• Oblige power utilities to buy electricity from, and sell to, the cogenerators. • Allow cogenerators to sell electricity and thermal energy to third parties.	• Give rebates for fuel-efficient appliances, by charging fees on inefficient ones. • Support energy audits for identifying oil saving measures. • Provide incentives and tax credits for investments in combined heat and power schemes. • Introduce time-of-use tariffs to avoid the use of oil-fired power plants during utility peak periods.	• Strengthen existing institutions. • Set up observatories to gather relevant data and to benchmark. • Support R&D to develop innovative processes, thermal integration and heat recovery.
Agriculture	• Mandate the use of an oil-saving fund to reduce oil demand in agriculture.	• Allocate funds for technology demonstration and deployment. • Provide incentives to develop infrastructure for producing fuel derived from biomass.	• Strengthen existing institutions. • Establish centres to train technicians who can assist farmers. • Support the development of rural-energy service companies.
Households	• Set minimum standard and develop labels for kerosene and LPG stoves and heaters. • Ask industry to produce fuel-efficient stoves and apply penalty clauses for non-compliance. • Introduce thermal regulations for new buildings in regions with cold climates.	• Remove price distortions and eliminate subsidies that benefit mostly the rich. • Allocate funds for technology demonstration and deployment.	• Strengthen existing institutions. • Support training of rural youth to provide and maintain efficient lighting systems. • Use communications media to educate rural populations about the scope for oil saving. • Provide R&D support to develop high-efficiency cooking stoves and reliable and cost-effective, energy-efficient electrical lamps.

processes. In addition, electricity utilities on the islands can introduce pricing measures to reduce peak demand and, where feasible, distribute energy-efficient appliances to households.

Diversifying fuels

Given that energy demands will continue to rise, particularly in developing countries, restraining demand for oil will have to be accompanied by efforts to switch in the medium and long term from oil to alternative energy sources, including large hydro, coal, natural gas and renewable energy technologies. These measures will, however, be subject to tradeoffs between the demands of efficiency, environmental protection, and equity.

Efforts must be made to diversify to oil alternatives such as hydropower, coal, natural gas and renewable energy technologies

Sustaining access to energy services and switching from oil to domestic energy resources is also dependent on accessing adequate capital and sometimes technology to expand domestic energy supply systems. Possible energy sector liberalization and associated trade in energy services may further support other domestic efforts.

Natural gas and coal

One of the most readily available options is natural gas. Between 2002 and 2030, the IEA (IEA 2004b) expects gas consumption in developing Asia to more than triple, from about 208 to 672 billion cubic metres (bcm). Most of the absolute demand increase will be in East Asia, although India's share will also increase significantly. At present natural gas is not generally used for power generation but is likely to be used more for this purpose in future: in fact, about half of the increase in gas consumption in Asia by 2030 could be for power generation and some 23 percent for industry. Most of the increase in the gas trade in Asia is expected to be in the form of liquefied natural gas.

The IEA expects gas flows into the Asia-Pacific region in 2030 to be dominated by those from the Middle East, including 57 bcm per year to the Republic of Korea, 44 bcm per year to India and 13 bcm per year to China (IEA 2004b). The other major flows into the region are expected to be from Russia, including 22 bcm per year to Japan and 19 bcm per year to China. The main sources within the region will be Indonesia, which will export 64 bcm per year to Japan, and Australia, which is expected to export around 40 bcm per year to Japan.

Asian countries are adopting natural gas combined cycle (NGCC) power generation systems. These have low levels of pollutant emissions and high efficiencies: advanced NGCCs incorporating air or steam-cooled gas turbine blades and compressor inter-cooling are able to provide efficiencies beyond 55 percent. To achieve even higher efficiencies, new materials will be needed that can withstand very high temperatures.

Another area in which natural gas will find wide application is the combined generation of heat and power, or 'cogeneration.' As gas pipelines get extended, cogeneration will be promoted for applications where both heat and electricity can be used on site, surplus electricity is exported to the grid and surplus heat is fed into a district heating network to meet industrial steam and commercial cooling needs. The main targets in recent years have been the new industrial or urban zones and airport complexes in countries like Malaysia and Thailand. Cogeneration can substantially reduce generation losses, with conversion efficiency of fuel to useful power and heat as high as 80 to 90 percent. Cogeneration also has significant potential to reduce CO_2 emissions.

A further option is to use hybrid cycles in which each cycle uses a different fuel. For example, a gas-fired plant can be integrated into a coal-fired facility. A heat recovery unit transfers heat from the exhaust of the gas turbine to the coal side of the process. This is more efficient and cost-effective than building separate units and is suitable for sites such as industrial estates that require large quantities of high-pressure steam (Box 4-2).[2]

Gas will also be used more for transport. To lower pollution in congested city centres many cities of the region are starting to use natural gas and liquefied petroleum gas as fuels for urban transportation.

For power generation many countries will also be making greater use of coal. In developing Asia, coal use for this purpose will almost quadruple by 2030. Compared with other fossil fuels, however, coal presents significant environmental challenges. Some of the near-term promising technologies for clean coal power generation are the use of better materials, higher pressures and temperatures, double reheating and reduction in condenser pressure. Technologies that are promising for higher power generation efficiency include supercritical pulverized fuel technology, atmospheric fluidized bed combustion,

Box 4-2 Dual-fuel hybrid cogeneration for an industrial estate in Thailand

Thanks to the progressive policies of the government of Thailand, which encourages cogeneration of heat and power by allowing buy-back of electricity by the state electric utility at a reasonable rate, cogeneration facilities have been established in various industrial estates in Thailand. One group of companies has already installed close to 2,000 MW of power generating capacity, capable of providing more than 900 tonnes of steam per hour for various industrial-processing units.

For example, in the Map Ta Phut industrial estate in Rayong, a combined-cycle cogeneration plant started operation in October 1996 with the capacity to generate 300 MW of electricity, primarily using natural gas with diesel oil as backup fuel. In addition to generating electricity, the facility provides 320 tonnes of high-pressure steam every hour to several petrochemical and downstream industries. The electrical efficiency of the combined cycle is more than 45 percent, whereas in cogeneration mode, the global efficiency is almost 70 percent.

To mitigate the risk and to avoid dependence on a single type of fuel, a new 'hybrid' technology was adopted in the next phase of the project. Hybrid cogeneration allows for fuel flexibility as both natural gas and high-quality and clean bituminous coal are used as fuels. The circulating fluidized bed (CFB) boiler technology used in hybrid block cogeneration is a proven clean coal technology that produces lower emissions of SO_2, NO_x, CO_2 and dusts than conventional technologies. The hybrid system's power generating efficiency is 43 percent, compared with the 41 percent that would have been obtained with a separate combined cycle gas turbine and a separate coal plant in condensing mode. The hybrid cogeneration plant generates 514 MW of electricity and provides 200 tonnes of high-pressure steam every hour.

Source: COCO 2000

pressurised fluidized bed combustion, integrated gasification combined cycle (IGCC) and hybrid combined cycle systems. The scope for IGCC development is substantial in rapidly growing economies like China and India that also have large coal reserves and do not have natural gas readily available.

The EIA (EIA 2004) expects Japan to remain the largest coal importer but to continue losing its share of the Asian import market to the Republic of Korea, and India. Japan has seen its share of Asian coal imports fall over the past two decades, from about 85 percent in 1980 to 46 percent in 2003. Over the next 20 years, coal imports are likely to increase substantially in Malaysia.

The Indian government has recently approved captive mining for production of gas through coal gasification and liquefaction. The underground coal gasification programme is aimed at the extraction of energy from coal seams that cannot otherwise be mined through conventional methods.

Renewable sources of energy

Renewable energy technologies currently supply 13 percent of the world's primary energy supply but up to 32 percent for Asia. Thanks to the increased use of renewables such as hydropower, wind, solar, biomass and geothermal, the share of renewables in developing Asia should rise if their generation costs become competitive with conventional fossil fuel resources.

The rapid pace of technological change is also creating opportunities for a broader range of small-scale and low-cost energy supply options that are affordable for the poorest, both for off-grid and utility-connected applications. The challenge lies, however, in using these resources for productive and income-generating activities, so that the poor can pay for these modern energy services that are essential for improving their quality of life. The cost-effectiveness of various technologies is explored in greater detail in Chapter 5.

The following sections highlight the types of fuel diversification likely to occur in different economic sectors.

Transport

As one of the largest consumers of petroleum products, this sector is unlikely to move away from oil very quickly, but there have been a number of developments. One option is to develop electricity-driven mass transit systems. Another is to switch to alternative-fuel automobiles, using LPG or CNG, ethanol or biodiesel blending, hybrid-electric, and hydrogen fuel from windpower. The focus of India's biofuel programme, for example, is diesel produced from oil-bearing seeds of several plants, including *Jatropha curcas*, and blended with high-speed diesel. Several other countries in the region, including Malaysia, Philippines and Thailand, have adopted targets – some mandatory – to increase the contribution of biofuels to their transport fuel supplies. Many Pacific Island Countries also see biofuels as an opportunity to revive and expand copra production for coconut oil as a fuel supplement, giving increased income to copra producers.

Delivered in the right manner, biofuels are very promising. But there are risks, and it will be important to safeguard the interests of the poor. There are genuine concerns that growing crops for biofuels may create greater competition for limited land, water and food. The challenges and opportunities presented by biofuels are considered in greater detail in Chapter 5.

Industry

Community-based development of rural energy systems offers a promising model

Fuel substitution options in the industrial sector include the replacement of petroleum chemical feedstock by biomaterials and the promotion of alternative fuels. An example of the former is the shift away from oil in the fertilizer sector, as in India, where for feedstock, there is a clear move away from naphtha to natural gas. In China, a similar shift is taking place, substituting oil with coal.

Other options include promoting the conversion of existing oil-fired plants to other fuels or multi-fuel firing, and exploring alternatives like biomass gasification or biogas power generation for decentralized power supply. For example, following the oil price hikes during 2005-2006, several industries in Thailand switched from oil to coal, biomass or agro-industrial residues. The change is, however, likely to be gradual because of the need, for most applications, to invest in new capital equipment.

Agriculture

Farmers who use petroleum products in agricultural machinery for irrigation and in threshing can in some cases switch to electricity made available through accelerated rural electrification programmes. Other options for fuel substitution include biomass liquid fuel for tractors and diesel pumps along with the use of hybrid systems such as solar photovoltaic-powered water pumps, with diesel as a backup.

Households

With growing rural electrification and urbanization, it will be important to reduce the use of petroleum products in power generation. One option, for both grid-based and decentralized systems is to switch to renewable sources. China and India, which have large coal reserves, also would benefit from making more use of clean coal technologies. Several countries are seriously considering expanding their nuclear power capacity, as witnessed by the recent US-India agreement and signs of ASEAN reconsidering its decades-old stance as a nuclear-free zone.

Because energy consumption patterns in households are closely linked to incomes, the replacement of oil by other fuels and energy sources bears upon poverty. In the initial stages of the transition from traditional biomass fuels and human or animal labour, poor households turn to petroleum products like kerosene and diesel. Measures to promote fuel substitution away from these will, therefore, need to be tailored to the poor's purchasing power.

A good solution for some rural areas in less developed countries is the development of renewable energy through community initiatives. Examples include rural electrification projects based on usage of solar energy in China, biomass gasification in Cambodia and micro-hydropower in India. The community-based development of rural energy systems in Nepal has been an effective model, operating within the government's decentralized structure through village and district development committees. Table 4-5 lists priority policy actions for fuel diversification.

UNDP's regional study on cross-border energy trade[3] recognises possible benefits from energy sector liberalization and associated trade in energy services, in the form of increased investment, which can enable the switch from oil to domestic energy resources. The following section incorporates some relevant findings from the study and highlights in more detail the possible benefits from these, touching upon the case of costly traditional domestic resources.

Trade in energy services

The impacts of trade in energy services in the form of capital and technology can be beneficial for importing countries in their attempts to switch from oil to domestic energy resources. Expanding the distribution networks and also building new infrastructure to supply new customers requires adequate capital. Foreign investment provides also the possibility to gain access to improved technology and management methods.

Energy services trade can be introduced as foreign participation in the domestic energy market regardless of whether the internal energy market has been liberalized. In a regulated

Table 4-5 Priority actions for fuel diversification

	Legislation and regulations	Fiscal and financial measures	Direct public investment
Transport	• Mandate the use of LPG and CNG in public transport system and taxis in urban areas. • Mandate oil companies to disseminate biofuels. This could comprise a fixed percentage of their total fuel distribution. • Mandate automobile companies to invest a part of their profit in the development of accessible and affordable forms of biofuels. • Restrict the use of liquid-fuel based transportation in cities.	• Use fiscal incentives like tax rebates to oil companies to disseminate biofuels. • Initially subsidize retail biofuel prices to promote its use; subsidies can eventually be withdrawn in a phased manner. • Extend low interest loans to agro-industrial ethanol firms. • Allocate funds to accelerate the development of mass-transit systems.	• Invest in R&D for the widespread application of biofuels in the transport sector. • Build capacity (financial, physical, human) for mass production of biofuels. • Support R&D to develop key enabling technologies, including hybrid vehicles. • Invest in the development of fuel cells and the production of hydrogen.
Industry	• Oblige power utilities to purchase electricity either from cogenerators or produced using renewable energy. • Mandate those producing electricity using renewable energy to sell to third parties. • Introduce Renewable Portfolio Standard for electricity providers.	• Extend tax credits to ensure acceptable financial returns for those willing to use biomass or agro-industrial residues for power generation or cogeneration. • Provide capital subsidies to help companies take up new technologies, already in the market, that can run under alternative sources of energy. • Provide technical and financial support for energy generation from agro-industrial effluents and municipal wastes.	• Invest in exploring alternatives, such as biomass gasification or biogas power generation. • Promote public investment in R&D for developing technologies that can be run on alternative energy sources.
Agriculture	• Promote pilot projects for usage of biomass liquid fuel for tractors and diesel pumps along with the use of hybrid systems. • Mandate agricultural machinery producing units to invest profits for renewable technologies, like solar water pumps.	• Subsidize renewable technologies for easy penetration in the agricultural sector. • Provide financing facilities from institutions under reduced rates to farmers.	• Invest in R&D to develop technologies to be used in the agricultural sector.
Households	• Promote decentralized (off-grid) electricity production for achieving complete rural electrification. • Promote more alternative sources of power, like hydroelectric, nuclear project, and clean coal technologies in thermal power plants.	• Provide capital subsidy to rural entrepreneurs or cooperatives for taking up bio-energy based power generation in decentralized rural areas. • Provide support for enhancing the productivity of energy plantation (biomass or biofuel). • Subsidize the promotion of renewable energy-based technologies.	• Invest in promoting off-grid-based technologies for harnessing renewable energies (solar thermal and photovoltaic, wind, biomass gasifiers, biogas power generation, etc).

market, an example could be an investment in an independent power plant. The foreign investment within the energy sector may reduce the need for government investment funds, which can then increase money for other types of expenditures, including those that target poor people. A liberalized market that allows entrepreneurs, including foreign ones, to operate rural concessions in areas not covered by the grid could help increase access rates to energy services in rural areas.

Improved technology and managerial methods, in turn, can improve quality of service, lower costs, and provide opportunities for improving access due to more cost-effective technological solutions within the energy sector. Moreover, these improvements can benefit energy consumers, including households, subsequently generating positive spin offs in the economy. Eventual lower costs of supply through improved efficiency should ultimately lower the cost of supply. These efficiency gains may be evident either in the form of lower prices for energy, or reduced government subsidies to the particular sector. Alternatively, gains could be passed to consumers in the form of higher spending in expanded access.

Cambodia provides an excellent example in its efforts to switch from expensive oil to cheaper alternative sources of energy via cross-border trade. In addition, efforts are being made to rely more on domestic sources of energy, developed with the help of foreign investments (Box 4-3).

Costly domestic resources

A common strategy in many countries is an effort to rely more on domestic energy resources. Nevertheless, replacing oil by other fuels and energy sources might not be the first option in those countries where the poor rely on traditional biomass fuels. In many cases, without trade an energy supply system would be costly and access to energy services would be restricted, either because prices are beyond the poor, or because the sector's resources are so stretched as to limit investment in supply to the poor. The initial stage of fuel diversification is then more likely to be toward petroleum products as was discussed in the context of fuel diversification at the household level.

Therefore, expansion of access to petroleum products via trade can help lower the pressure on biomass resources by reducing the use of fuelwood and charcoal, although the transition away from these fuels is often slow and influenced by a variety of economic and social factors.

Preparing for emergencies

Each country also needs to prepare for abrupt disruptions in oil supplies. This should involve measures to build strategic reserves as well as plans to make rapid and drastic cuts in oil consumption through rationing systems. Following the oil price shocks in the 1970s and 1980s, a number of countries like Bangladesh, India, Sri Lanka and Viet Nam introduced such measures as fuel rationing, fuel stamps and lifeline tariffs. Indeed, in India some of these measures like kerosene rationing and quotas at subsidized prices are still in place. Some of the available measures, which are summarized in Table 4-6, are as follows.

Building strategic reserves

Both governments and private companies can keep stockpiles of crude oil and oil products separate from operational ones. The cost of holding emergency stocks should be passed on to consumers through the market price. These costs can be high. For India, for example, the cost of building storage to stock 15 million tonnes of crude oil was estimated in 2004 at US$950 million (UNCTAD 2006). Governments can, however, reduce costs by holding stocks jointly with other countries (APERC 2000).

As well as using the stockpiles for emergencies, governments might also consider them as ways of managing consumption and also of helping to reduce worldwide demand. But it may not be feasible to use reserves as a buffer against price volatility, and they will clearly be of little use during long periods of constrained production. Instead, they should be seen more as short-term solutions.

Several Asia-Pacific countries have begun to develop strategic oil reserves. Japan has 171 days of consumption reserve, which would correspond to nearly 980 million barrels. India has begun to develop a strategic crude oil reserve expected to be pegged at 40 million barrels. The Republic of Korea has a reported reserve of 43 million barrels and Australia has 90 days of reserves in addition to over 200 days held in private reserves. Among the ASEAN countries, Thailand recently increased the size of its strategic reserve from 60 to 70 days of consumption. Singapore has an estimated storage capacity of 32 million barrels of crude oil and 65 million barrels of oil products. By 2008, China plans to have an 800-million-barrel strategic reserve stored at four facilities (Sakhuja 2005).

Box 4-3 Fuel diversification in Cambodia via cross-border trade and domestic resources

Electricity is quite expensive in the Cambodian capital Phnom Penh. It relies on oil-driven generators which make the price of electricity among the highest in the world. High electricity price has prompted the expansion of cross-border trade with its neighbours Viet Nam and Thailand. Phnom Penh will be supplied with electricity from Viet Nam starting in 2008, whereas eastern and southern provinces of Cambodia are being connected to Thai electrical grids. This fuel switch could reduce the price to half or even to one-eighth compared to the price before the switch. Further efforts are being made to diversify away from gasoline and diesel to alternative energy sources. Domestic hydroelectricity power generation, to be developed with the help of foreign investment, is envisaged for the future. Cooperation with Chinese companies is already bringing about a major change in Cambodia; local generators are giving way to nationwide grid connected hydroelectricity. While being relatively expensive due to high capital investment, hydropower should still be cheaper for consumers than electricity generated from oil.

Source: Sokha 2006; Sokha 2007

Table 4-6 Priority policy actions for preparedness for oil-related emergencies

	Legislative and regulatory measures	Fiscal, financial and institutional measures	Direct public investment
Building strategic reserves	• Estimate the number of days for which reserves are to be maintained and the kinds of products to be stocked. • Mandate oil companies to maintain reserves.	• Give fiscal incentives to oil companies for maintaining reserves through internalization of full costs of holding reserves. • Explore possibilities for reserves in other countries.	• Build storage reserves and facilities for transportation into and out of the reserves.
Rationing to ensure essential supplies	• Define what essential services would be catered to and the requirement for these services. • Regulate supplies to non-essential services through restrictions. • Implement driving bans and restrictions. • Use fuel allocation coupons as a last resort.	• Reduce/remove fuel subsidies accompanied by smart cards or cash transfers for poor households. • Impose fines for use of oil in non-essential services. • Give fiscal incentives for use of public transport system especially during off-peak periods.	• Create public campaigns to promote energy conservation. • Allow preferential access to infrastructure for oil savers, e.g. special lanes for car pools as opposed to solo cars. • Expand the public transport system.

An example of a multi-country strategic reserve within the framework of regional cooperation is the 1986 ASEAN Petroleum Security Agreement (APSA). This established an ASEAN Emergency Petroleum Sharing Scheme. In cases of critical shortage, total supply falls below 80 percent of normal domestic consumption, the oil-exporting members of ASEAN would provide emergency oil supplies. In times of broader crises affecting more than one ASEAN member state, the agreement calls for the distribution to be allocated initially in proportion to their respective normal domestic consumption and to exports for the 12-month period prior to the crisis. APSA has never actually been executed, although it nearly was in the early 1990s during the Gulf War (Giragosian 2004).

Rationing to ensure essential supplies

Even if a country can draw on an emergency stockpile, it will still need to restrain demand, both to conserve fuel and send a strong market signal. High prices may themselves restrain demand but may need to be supplemented by other measures such as establishing quotas for sectors that provide essential services (OECD/IEA 2004). But such rationing must be done with caution, bearing in mind possible fallouts:

- *Hoarding* – Panic buying may result in hoarding. This can be averted by keeping oil supplies tight, for instance, through an oil allocation scheme.
- *Economic downturn* – Rationing may curtail economic activity and affect the incomes of vulnerable groups.
- *Reduced mobility* – Restrictions on transport would constrain mobility. This may not only reduce economic activity through lost work days but also undermine social welfare by denying access to education or health care.

The transport sector does, however, offer many opportunities to restrain oil demand in emergency situations. As described earlier, these include increasing the use of public transport, encouraging car-pooling and telecommuting, changing work schedules, introducing driving bans and restrictions, and promoting 'ecodriving,' which includes modifying the driving style, for example, and adjusting tyre inflation to increase fuel efficiency. It should be noted, however, that in most developing countries of the region, these measures would generally only work in large cities.

Building strategic reserves and rationing are critical in preparing for abrupt disruptions of oil supply

All of these initiatives require countries to plan and adopt systems early so that when a crisis arises, measures can be put in place quickly. Preparing for oil emergencies either through access to strategic oil reserves or through rationing requires considerable advance preparations. Table 4-6 outlines some of the priority measures that would have to be undertaken.

In addition to the options listed in this chapter, countries will also want to consider diversifying the fuels they use, and in particular, making more use of renewable resources. This issue is addressed in detail in the next chapter.

Endnotes

[1] http://www.barternews.com/barter_happenings_around_the_globe.htm.

[2] COCO (The Cogeneration Public Company Limited). 2000. The Evolution of Energy Supply for Thai Industries, The Cogeneration Public Company Limited, Bangkok.

[3] Policy Study on Cross-border Energy Trade and its Impact on the Poor.

Options in renewable energy

5

The previous chapter reviewed five broad strategies for reducing oil-price vulnerability. One of these was to diversify to other fuels, and this chapter considers one of the most promising ways of doing so – making greater use of renewable energy technologies.

Earlier chapters have shown how rising oil prices have hit many poor communities and also put pressure on the budgets of those governments that have tried to protect them through subsidies. In response, a number of countries with the appropriate natural resources have been diversifying to other energy sources such as large-scale hydroelectricity, natural gas or coal.

But in recent years, countries all over the world have been exploiting a wider array and scale of renewable energy sources, particularly solar, wind, small-hydro, geothermal and biomass[1]. Investments in these renewable energy sources have recently been growing rapidly because of significant oil price increases and increasing concerns for climate change. These investments – mostly in developed countries – coupled with ongoing technology improvements and cost reduction policies and programmes, have made the cost of modern energy services from renewable energy technologies (RETs) increasingly competitive with oil-based systems.

As indicated in Chapter 4, renewable energy technologies currently supply 13 percent of the world's primary energy supply, whereas their share is as high as 32 percent for Asia (IEA 2007b). A regional study undertaken by UNDP identified several models introduced in the region that showcase successful examples of scaling up off-grid renewable energy technologies, particularly in the poorer countries of the region[2]. These models include household biogas in Nepal, solar photovoltaic (PV) home systems in Sri Lanka, Nepal and now Bangladesh, and micro-hydropower in Indonesia, Nepal and the Philippines. In almost all cases, these markets are the result of public-private partnerships. RETs are often ideal for rural or remote communities, providing them with sustainable energy services for heating, electricity generation, transportation and other mechanical power applications.

The rise of renewables

The strongest growth in RET use has been in grid-connected power facilities such as small-hydro, wind farms and biomass cogeneration facilities. However, the viability and competitiveness of RET-based power generation facilities depend on many site-specific factors, such as local renewable resource endowment and policy and programme support. Thus, some grid-based RET power generation facilities may be cost competitive with fossil-based systems in one country, but not in another. There can also be differences between subregions within a country. Nevertheless, in most areas off-grid RET-based power generation facilities are generally cost-competitive with similarly sized petroleum-based systems.

The cost competitiveness of RETs was analysed in a 2002 IEA study. Based on the experience of developed and developing countries, the IEA estimated the costs of generating electricity using biomass, solar, small-hydro, wind and geothermal technologies. Table 5-1 presents the findings, showing the ranges of investment and generating costs for 2002 with corresponding projections for 2010. These ranges are quite wide since the costs for renewables can vary greatly according to the type of system, the local physical environment and government policies.

Table 5-1 Range of investment and generating costs, 2002 and 2010

	Low investment cost (US$/kW)		High investment cost (US$/kW)		Low generating cost (cents/kWh)		High generating cost (cents/kWh)	
	2002	2010	2002	2010	2002	2010	2002	2010
Small hydropower	1,000	950	5,000	4,500	2-3	2	9-15	8-13
Solar photovoltaics	4,500	3,000	7,000	4,500	18-20	10-15	25-80	18-40
Biomass power	500	400	4,000	3,000	2-3	2	10-15	8-12
Geothermal power	1,200	1,000	5,000	3,500	2-5	2-3	6-12	5-10
Wind power	850	700	1,700	1,300	3-5	2-4	10-12	6-9

Note: The discount rate is 6 percent for all technologies, the amortization period is 15-25 years, and operation and maintenance costs are technology specific.
Source: IEA 2003

Small-hydro, thermal and wind systems are producing energy at costs within the retail consumer price

As Table 5-1 indicates, at the lower end of the cost spectrum a number of sources, such as biomass, small hydropower, wind and geothermal power plants, can, under optimal conditions, generate electricity at two to five US cents per kilowatt hour (kWh). These results were compared with conventional large-scale power generation facilities, based on coal, natural gas and nuclear energy. They show that renewables are on a par with wholesale electricity prices, and even at the higher end of the scale, small-hydro, geo-thermal and wind systems are producing energy at costs within the retail consumer price.

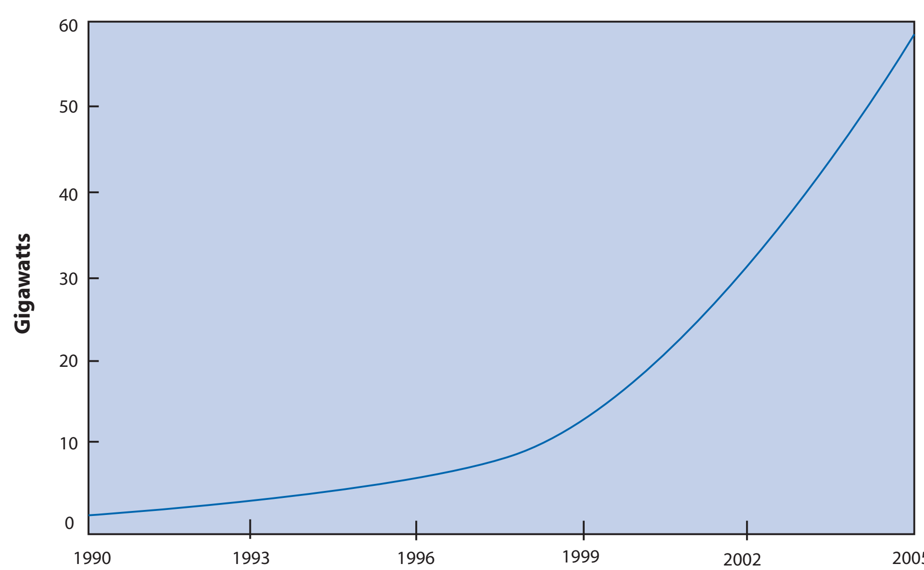
In terms of technology, the highest growth in RET investment is in solar PV and wind power systems (Figure 5-1 and Figure 5-2). But other renewable sources have been expanding too, as indicated in Table 5-2, which shows the total capacity added in 2005. Figure 5-3 shows the leaders in generating power from renewable resources other than large-hydro. In recent years some of the fastest growth has been in Asia, particularly China and India.

Renewables for grid systems

Renewable energy technologies can supply main and decentralized power grids, as the UNDP regional study on investments on renewable energy in Asia and the Pacific showed*. Much of this is coming from small hydropower installations which, compared with other renewable systems, provide AC electricity full-time and at greater power. The leader in this field is China – which has 60 percent of global capacity – but there is also significant progress in India, Indonesia, Nepal and

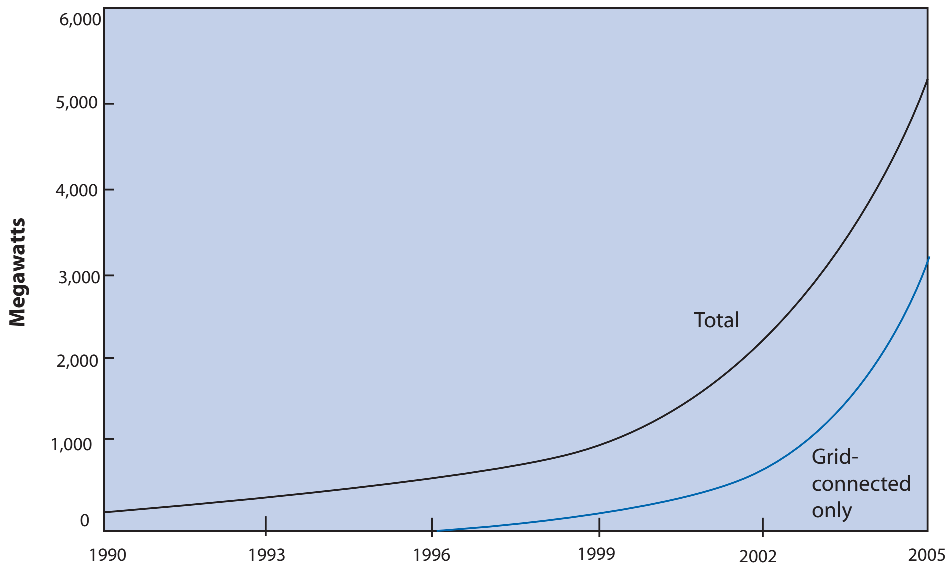
* Refer to Endnote 2.

Figure 5-1 Wind power, world capacity, 1990-2005



Source: REN21 2006a

Figure 5-2 Solar PV systems, world capacity, 1990-2005



Source: REN21 2006a

Sri Lanka. In these countries, micro-hydropower systems are usually developed as community-based energy systems and have often been able to provide energy services more equitably, as well as offer sufficient power for productive end uses in rural and remote areas. However, scaling up these community-based models remains a challenge.

Grids are also being fed by wind energy systems. In this case Asia's leader is India, which has 4.4 gigawatts (GW) of installed capacity. But China too is moving ahead; already it has 1.3 GW of wind electric capacity and is adding more quickly; its near-shore and off-shore capacity is estimated at many tens of gigawatts. The Philippines also has considerable potential and, in 2004, inaugurated a 25 MW wind farm, the first in the South-East Asian subregion. There are also opportunities for Pacific Island Countries, but apart from Fiji, which has one 10 MW plant, countries have yet to invest in grid-connected wind systems.

The other main source for grid electricity from renewable energy is biomass. Cogeneration systems, using agricultural wastes such as bagasse, rice husk, wood wastes and palm-oil empty fruit bunches, can generate heat and power simultaneously very efficiently and have payback times of only 2-4 years. Indonesia, The Philippines, Sri Lanka, Thailand and Viet Nam have all installed such grid-connected biomass power production facilities.

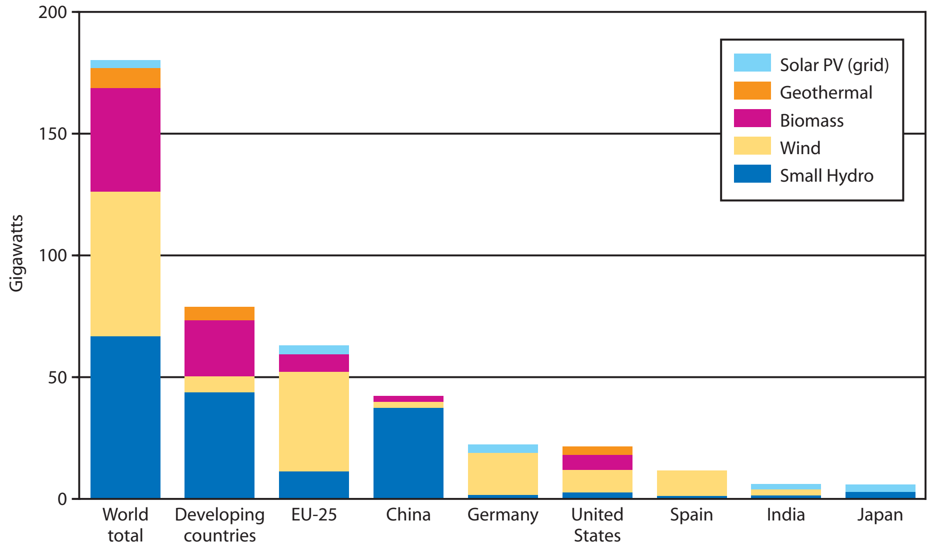
China is leading in micro-hydropower, while India is a leader in wind energy systems

Table 5-2 Global capacities for renewable energy in power generation, 2005

Power generation		Added during 2005	Total at end of 2005	Growth rate of existing in 2005
Large hydropower				
Small hydropower				
Wind turbines		12-14 GW	750 GW	1.5-2.0 %
Biomass power		5 GW	66 GW	8%
Geothermal power		11.5 GW	59 GW	24%
Solar PV, grid-connected	(GW)	2-3 GW	44 GW	---
	(homes)	0.3 GW	9.3 GW	3%
		1.1 GW	3.1 GW	55%
		200,000	650,000	---
Solar PV, off-grid	(GW)			
	(homes)	0.3 GW	2.3 GW	15%
		>270,000	2,400,000	---

Source: REN21 2006a

Figure 5-3 Leading countries in using renewable energy for power generation, 2005



Note: Excludes large hydropower
Source: REN21 2006a

Off-grid and mini-grid systems

Feeding electricity from larger-scale renewable systems into national grids is helping many countries reduce their dependence on expensive imported oil. But in developing countries, electricity flowing through the national grid does not reach many rural areas, particularly those remotely located.

For off-grid or mini-grid scenarios, most renewable energy systems are cheaper than gasoline or diesel generators

In these rural and remote areas, gasoline- or diesel-powered generator sets (gensets) are operated by utilities or local governments and in some cases by private operators for local electricity supply. These are stand-alone systems typically 5 kW or less in capacity, providing electricity needed for irrigation, agro-processing such as grain milling, and for nearby households. Where electricity demand is higher due to larger agro-processing and off-farm livelihood activities, the solution is to install bigger diesel generators, providing up to 500 kW to power 'mini-grids,' village- or district-level electricity networks. In addition, nearby households connect to such systems. Even so, few poor rural households can be found connected to these mostly oil-based mini-grids as the electricity generation costs, driven primarily by fuel costs, remain unaffordable.

Can renewable sources provide electricity more cheaply in these circumstances than petroleum-based generators? This can be difficult to judge since the cost of generation varies considerably depending on the technology, location and the ways they are used. To address this question, a study in 2005 commissioned by the World Bank made an economic assessment of the relative costs of various electricity-generating technologies, including both renewable energy- and fossil-based systems (World Bank 2005b). It considered different operating conditions – full-time and limited operating hours, in both mini-grid and off-grid configurations – and different time periods. This made it possible to compare the levelized[3] economic costs of electricity generation using different technologies over a broad range of deployment modes and demand levels, both present and future.

Table 5-3 Forecast decreases in capital costs for various technologies, 2004 to 2015

Generating technology	Decrease in capital cost
Geothermal, biogas, pico/micro hydro, diesel/gasoline genset	0% to 5%
Biomass gasifier	6% to 10%
Solar PV, wind, PV-wind hybrids	11% to 20%

Source: World Bank 2005b

The study also anticipated that over the period 2004 to 2015 the prices of these technologies would fall as a result of technological innovation and mass production, though by differing amounts corresponding to the maturity of each technology (Table 5-3). To allow for the range of circumstances in which the technologies could be operating, the costs were estimated for a 'low,' 'most-probable,' and 'high' cost trend, calculated over three different time periods (2005, 2010 and 2015). On this basis, the World Bank study concluded that for off-grid or mini-grid systems, most renewable energy systems could indeed work out cheaper than gasoline or diesel generators.

Future oil price scenarios

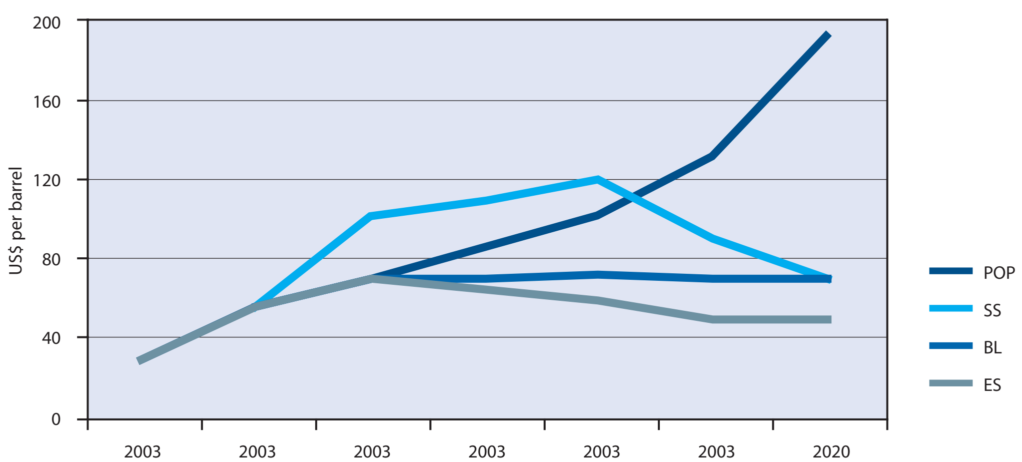
The picture can change, however, according to the level of oil prices and their variation over time. To address this, therefore, it is important to consider potential future oil price scenarios. For this report we have selected four, which have been discussed in detail in chapter 6:

- *Baseline (BL)* – Oil prices remain between US$ 65-75 per barrel.
- *Supply shock (SS)* – A supply crisis suddenly pushes prices beyond US$100 per barrel in the short to medium term, but over the long term, prices decline to their previous levels.
- *Peak oil price (POP)* – This assumes that the world is reaching peak oil production. Prices rise gradually toward US$100 per barrel and increase exponentially thereafter.
- *Energy security (ES)* – Concerns for both energy and environmental security lead to reduced oil demand, so prices fall back to a lower equilibrium at around US$50 per barrel.

The rationale for choosing these four scenarios is presented in greater detail in the next chapter. The crude oil prices that they imply are indicated in Figure 5-4. The corresponding prices for gasoline and diesel are indicated in Table 5-4.

The following is a cost comparative analysis of generation costs of RETs vs oil-based generator sets, which are calculated based on assumptions. The assumptions can be found in Appendix E.

Figure 5-4 Oil price levels in different scenarios, 2003-2020



Note: Figure based on UNDP REP-PoR unpublished Oil Prices Scenario Study

Table 5-4 Price projections for gasoline and diesel in various scenarios, US$ per barrel, 2007, 2009 and 2011

	Baseline	Supply shock	Peak oil price	Energy security
Gasoline				
2007	71	99	71	71
2009	71	108	84	67
2011	71	118	99	62
Diesel				
2007	73	102	73	73
2009	73	111	86	68
2011	73	122	102	63

Note: Table based on UNDP REP-PoR unpublished Oil Prices Scenario Study

Off-grid competitiveness

To consider the competitiveness of renewable energy in these four scenarios we have looked at: pico-hydro[4], solar PV, wind power and a solar PV-wind hybrid. The four systems are profiled in Table 5-5, which shows their lifespan, their capacity, and also their capacity factor, which is the ratio of the actual output over a period of time to the output, had it operated at full capacity. The capacity factor is considerably lower than 100 percent, due primarily to intermittent inputs of water, sunshine or wind, though the solar PV and wind systems include storage batteries.

Comparison with gasoline gensets – The cost of electricity from these systems was then compared with those for a 300 W gasoline genset under the three oil price scenarios. The results vary according to the type of renewable energy technology. Using the lower cost estimates, all are cheaper than using gasoline gensets for all oil price scenarios (Figure 5-5). Even using the most probable cost estimates, wind, small-hydro and hybrid systems remained cheaper under all scenarios. But solar PV worked out to be more expensive, except under the *supply shock* scenario, and, in later years, except for both *supply shock* and *peak oil price* scenarios (Figure 5-6). The same results are obtained if the higher estimates of generation costs for renewables are compared with the generation cost for gasoline genset (Figure 5-7). A 10-year project life span was assumed in analyzing the generation costs of the various technologies.

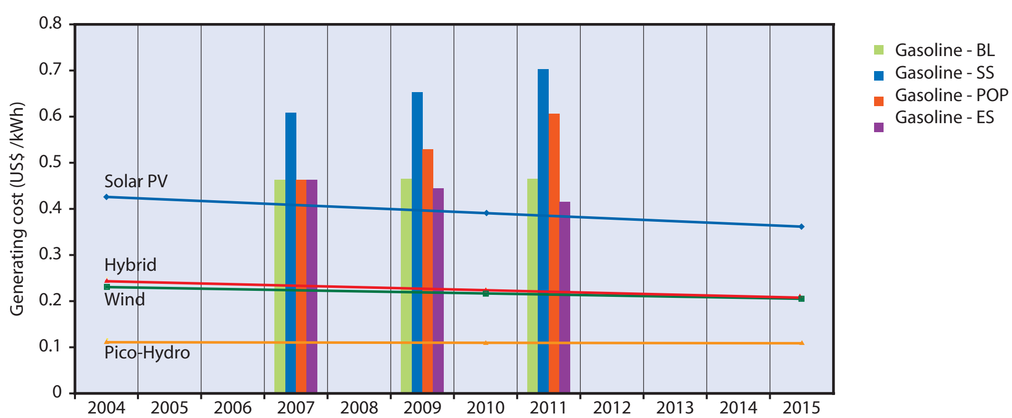
Diesel gensets – The cost of power from renewable technologies was compared with that of a 15 kW diesel genset capacity. As with gasoline, the results showed that the renewable technologies were cheaper than diesel gensets for all oil price scenarios based on the lower cost estimates (Figure 5-8). Using the most probable cost estimates, however, while wind, pico-hydro and hybrid systems remained cheaper, solar PV could

Table 5-5 Four off-grid renewable energy systems

	Lifespan	Capacity	Capacity factor
Pico-hydro	5 years	300 W	30%
Solar PV	20 years	300 W	20%
Wind power	20 years	300 W	30%
Solar PV-wind hybrid	20 years	300 W	30%

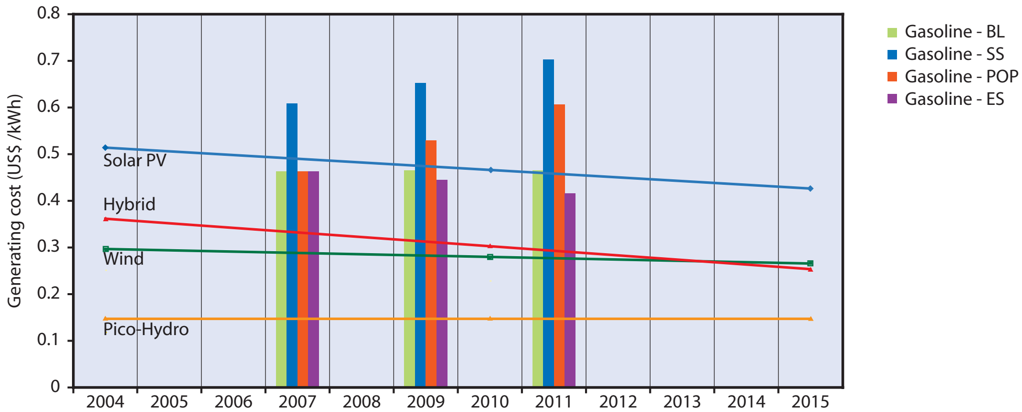
Note: For this report, pico-hydro systems are those generating up to 300 W, micro-hydro from 300 W to 100 kW, etc.
Source: World Bank 2005b

Figure 5-5 Cost comparison of off-grid renewable systems versus gasoline gensets, lower cost trends, 2004-2015



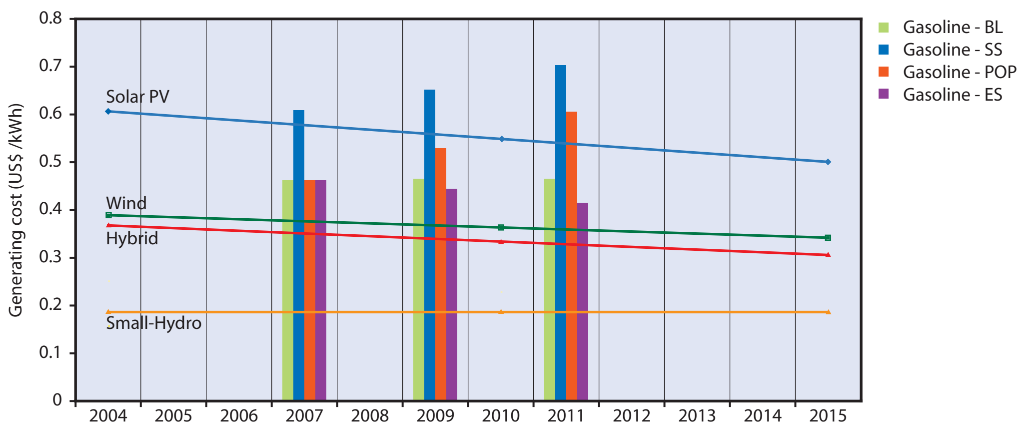
Note: REP-PoR estimates based on the World Bank (2005) study *Technical and Economic Assessment: Off-Grid, Mini-Grid and Grid Electrification Technologies* and unpublished UNDP regional study, *Impact of Rising Oil Prices on the Poor and the Implications for the Achievement of the MDGs*.

Figure 5-6 Cost comparison of off-grid renewable systems versus gasoline gensets, most probable cost trends, 2004-2015



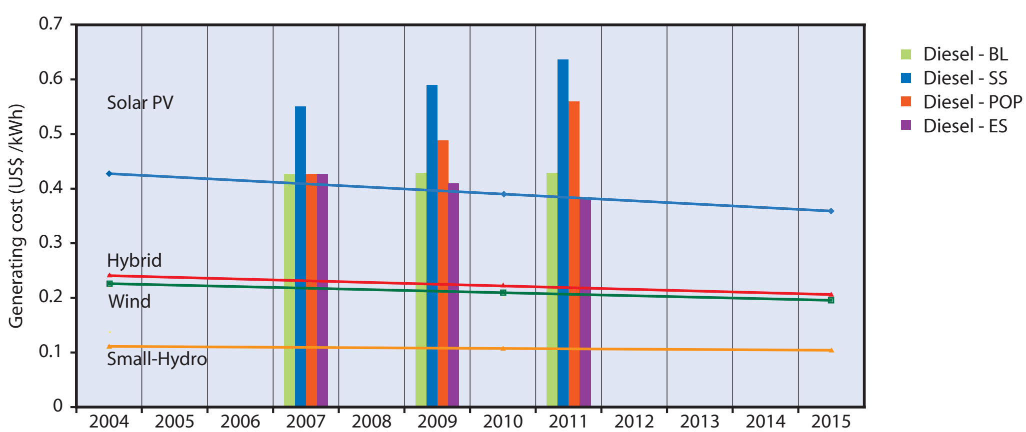
Note: REP-PoR estimates based on the World Bank (2005) study *Technical and Economic Assessment: Off-Grid, Mini-Grid and Grid Electrification Technologies* and unpublished UNDP regional study, *Impact of Rising Oil Prices on the Poor and the Implications for the Achievement of the MDGs*.

Figure 5-7 Cost comparison of off-grid renewable systems versus gasoline gensets, higher cost trends, 2004-2015



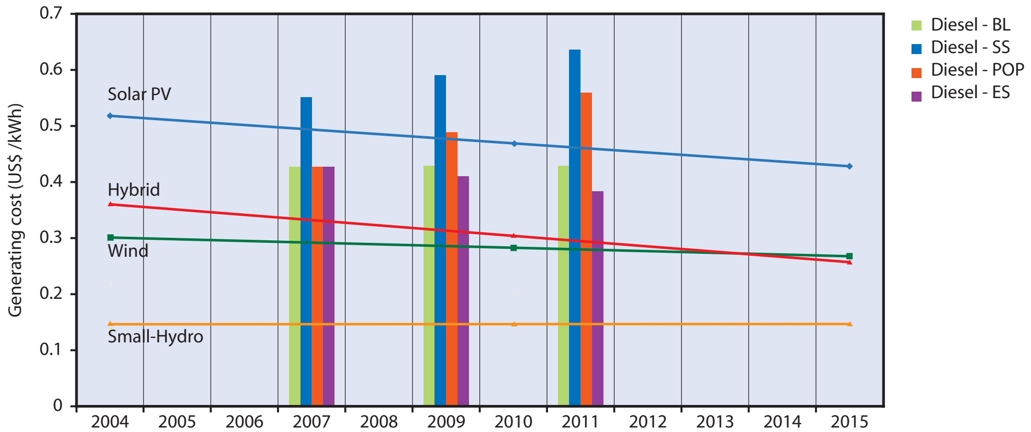
Note: REP-PoR estimates based on the World Bank (2005) study *Technical and Economic Assessment: Off-Grid, Mini-Grid and Grid Electrification Technologies* and unpublished UNDP regional study, *Impact of Rising Oil Prices on the Poor and the Implications for the Achievement of the MDGs*.

Figure 5-8 Cost comparison of off-grid renewable systems versus diesel gensets, lower cost trends, 2004-2015



Note: REP-PoR estimates based on the World Bank (2005) study *Technical and Economic Assessment: Off-Grid, Mini-Grid and Grid Electrification Technologies* and unpublished UNDP regional study, *Impact of Rising Oil Prices on the Poor and the Implications for the Achievement of the MDGs*.

Figure 5-9 Cost comparison of off-grid renewable systems versus diesel gensets, most probable cost trends, 2004-2015



Note: REP-PoR estimates based on the World Bank (2005) study *Technical and Economic Assessment: Off-Grid, Mini-Grid and Grid Electrification Technologies* and unpublished UNDP regional study, *Impact of Rising Oil Prices on the Poor and the Implications for the Achievement of the MDGs*.

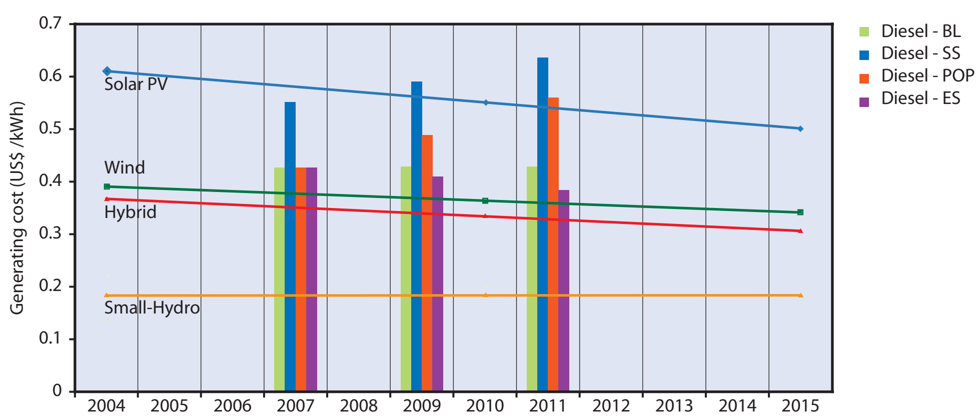
be more expensive, except under the 'supply shock' or 'peak oil' scenarios (Figure 5-9). Using the higher cost estimates, all three renewables remained cheaper than diesel genset, and solar PV becomes the most expensive option at present, in 2007 (Figure 5-10). In 2009, it becomes cheaper than diesel genset under the 'supply shock' scenario, and in 2015 it becomes cheaper under both the 'supply-shock' and 'peak-oil' scenarios.

Mini-grid competitiveness

Several of the above-mentioned renewable options are suitable for powering mini-grids. Seven of these are profiled in Table 5-6. With the same methods as for the off-grid systems, using both lower and most probable cost estimates across the four oil-price scenarios, these systems have been compared with a potential fossil fuel competitor, a 100 kW diesel genset.

At the lower cost estimates, six of the options proved cheaper than diesel gensets across all four oil price scenarios (Figure 5-11). The exception was solar PV, which was significantly more expensive. For the most probable cost estimates, five of the systems were still cheaper than diesel gensets (Figure 5-12). This time the exceptions were again solar PV systems, joined by PV-wind hybrids, which were more expensive except in scenarios where the crude oil price is above US$70 per barrel. For the higher cost trend, solar PV, as expected, remains the most expensive system (Figure 5-13). PV-wind hybrid and wind almost equal the cost for diesel gensets in 2009 under the 'peak oil price' scenario, but the cost is lower than for diesel under this scenario in the year 2015.

Figure 5-10 Cost comparison of off-grid renewable systems versus diesel gensets, higher cost trends, 2004-2015



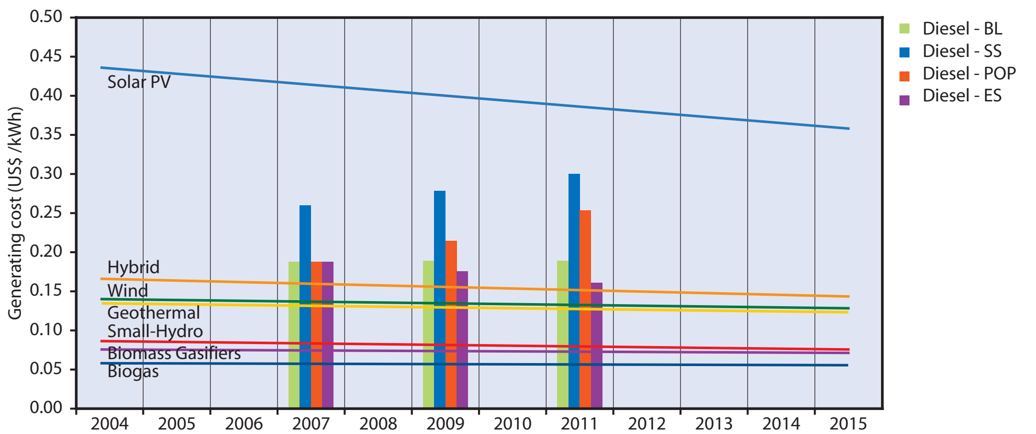
Note: REP-PoR estimates based on the World Bank (2005) study *Technical and Economic Assessment: Off-Grid, Mini-Grid and Grid Electrification Technologies* and unpublished UNDP regional study, *Impact of Rising Oil Prices on the Poor and the Implications for the Achievement of the MDGs*.

Table 5-6 Seven mini-grid renewable energy systems

	Lifespan	Capacity	Capacity factor
Micro-hydro	15 years	100 kW	80%
Solar PV	20 years	100 kW	20%
Wind power	20 years	100 kW	30%
PV-wind hybrid	20 years	100 kW	30%
Biopower – biomass gasifiers	20 years	100 kW	80%
Biopower – biogas	20 years	60 kW	80%
Geothermal	20 years	200 kW	70%

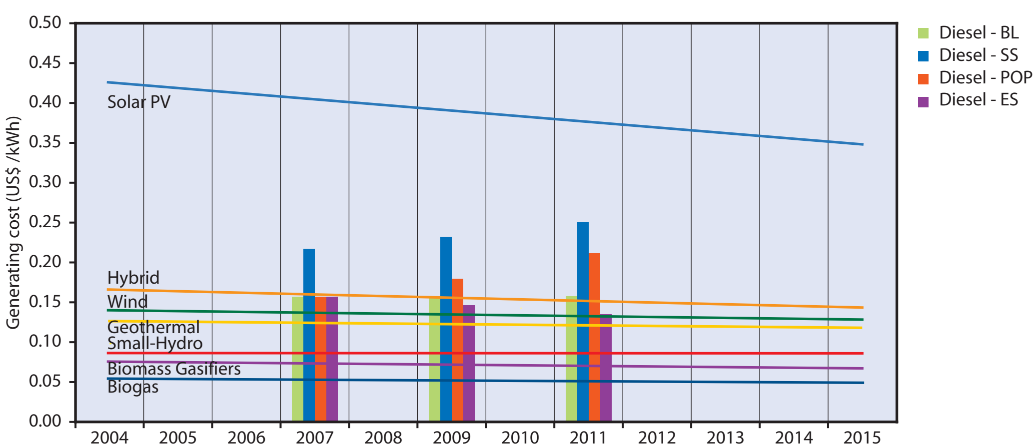
Source: World Bank 2005b

Figure 5-11 Cost comparison of mini-grid renewable systems versus diesel gensets, lower cost trends, 2004-2015



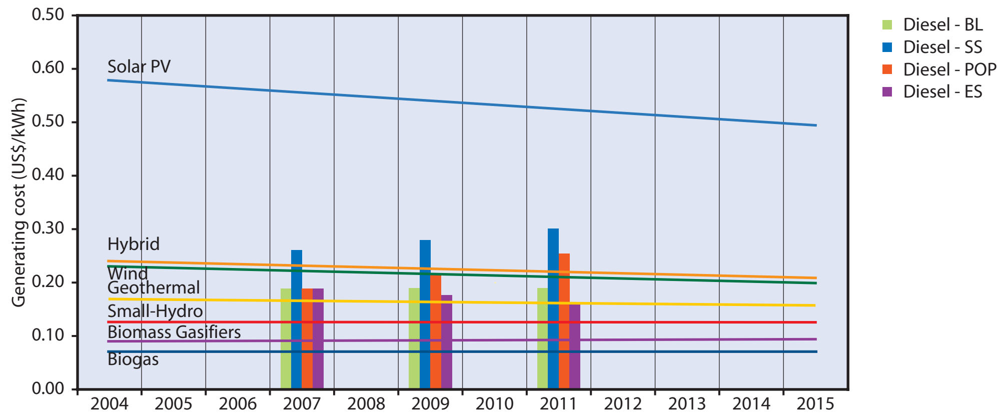
Note: REP-PoR estimates based on the World Bank (2005) study *Technical and Economic Assessment: Off-Grid, Mini-Grid and Grid Electrification Technologies* and unpublished UNDP regional study, *Impact of Rising Oil Prices on the Poor and the Implications for the Achievement of the MDGs*.

Figure 5-12 Cost comparison of mini-grid renewable systems versus diesel gensets, most probable cost trends, 2004-2015



Note: REP-PoR estimates based on the World Bank (2005) study *Technical and Economic Assessment: Off-Grid, Mini-Grid and Grid Electrification Technologies* and unpublished UNDP regional study, *Impact of Rising Oil Prices on the Poor and the Implications for the Achievement of the MDGs*.

Figure 5-13 Cost comparison of mini-grid renewable systems versus diesel gensets, higher cost trends, 2004-2015



Note: REP-PoR estimates based on the World Bank (2005) study *Technical and Economic Assessment: Off-Grid, Mini-Grid and Grid Electrification Technologies* and unpublished UNDP regional study, *Impact of Rising Oil Prices on the Poor and the Implications for the Achievement of the MDGs*.

Table 5-7 Global use of renewable energy for heating, 2005

		Added during 2005	Stock at the end of 2005	Growth rate of existing in 2005
Biomass heating		n/a	220 GWth	---
Solar collectors for hot water and space heating, glazed	Power	13 GWth	88 GWth	---
	Surface area	19 million m^2	125 million m^2	---
	Number of homes	7 million	46 million	---
Geothermal heating		2.6 GWth	28 GWth	9%
Biomass cooking stoves in use	Total, all types	n/a	570 million	---
	Improved	n/a	220 million	---
Household-scale biogas digesters in use		n/a	21 million	---

Note: n/a = not available
Source: REN21 2006a

Renewable energy use is viable for income generation, increasing agricultural production and powering rural industrialization

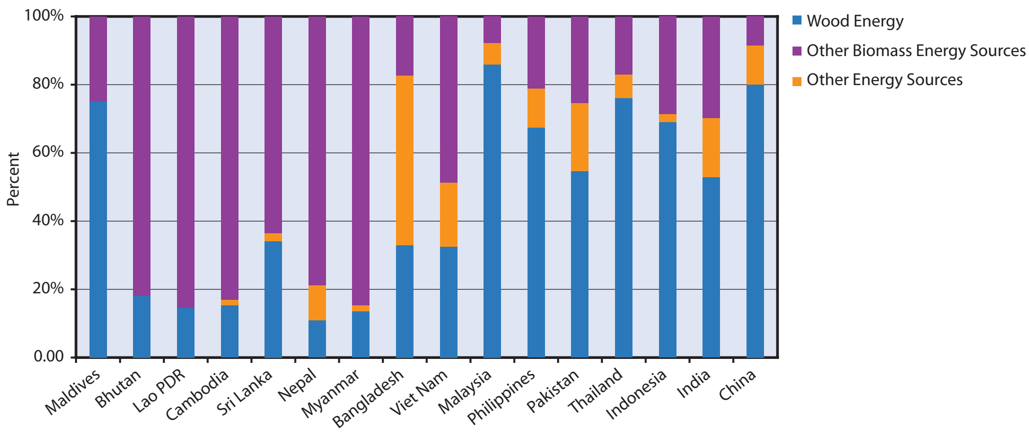
These results have considerable significance for remote and underdeveloped rural communities, since they underline the viability of renewable energy for use both in the household and for income generation. RETs can be used to increase agricultural production by providing affordable energy for irrigation, grain milling and other crop processing activities that can be intensified with the use of electricity. Electricity can also be used for diversifying and increasing rural production by making possible operations of hatcheries, aerated fish farms and refrigeration systems for storage and preservation of agricultural produce. Electricity likewise can be available to power small electric motors in small and micro rural-based off-farm enterprises, paving the way for rural industrialization. If agriculture and rural economic development programmes are successful in reducing poverty, that success can be enhanced and strengthened with the use of RET-based electricity supply.

Heating

Table 5-7 shows the main types of heating systems in use globally. Traditional biomass dominates, but modern biomass heating is moving ahead, solar heaters are becoming more common, and more use is being made of geothermal energy.

Traditional biomass is the main heating source for most developing countries, especially in rural areas. It also remains significant in urban areas, particularly for poor households. In the

Figure 5-14 Biomass heating in developing countries of Asia



Source: Heruela 2001

developing countries of Asia and the Pacific, this is the largest overall source of energy for heating (Figure 5-14), used mainly for cooking. Woody biomass and agricultural wastes are the main sources within the category of biomass fuels for heating.

Biomass is a renewable energy source, though it may not actually be renewable in places where high commercial demand leads to unsustainable collection. The bulk of traditional biomass energy use involves inefficient stoves that waste energy and fill houses with smoky fumes that are a hazard to health, particularly for women and young children. Dirty, inefficient technologies and unsustainable resource management practices pose problems with continued and expanded use of biomass.

Kerosene, LPG, or piped natural gas, and in some areas, coal, are the modern alternatives, but these fuels, unless subsidized, remain costly for many poor households.

Modern biomass heating

Modern biomass energy systems, coupled with sustainable biomass resource management practices, can be competitive with petroleum fuel-based cooking and heating. Modern biomass energy systems include improved stoves, boilers, kilns and ovens. They also include biogas systems. Recently, there has been a revival of biomass gasifiers and their direct use for heating, led primarily by India and China. These biomass heating technologies are used not only in households but also in enterprises and institutions for large-scale cooking and other heating applications.

Efforts to develop and modernize biomass heating have so far concentrated largely on improving the devices in which the biomass is burned or combusted – particularly household stoves, furnaces and kilns, and boilers – along with efforts to make biomass production more sustainable through forest management, integration of fuelwood production in farm systems and use of agricultural wastes.

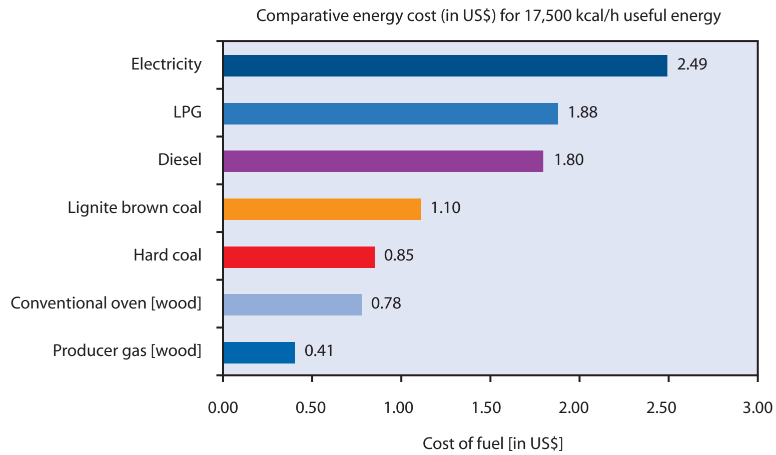
An alternative to burning the biomass, particularly cow dung, is to use it to generate biogas through anaerobic digestion. Biogas is a low heating-value gaseous fuel composed of methane and carbon dioxide that can substitute LPG and kerosene for cooking and other heating applications.

Another alternative is to use a 'gasifier', in which biomass is only partially combusted, to generate producer gas. Producer gas (composed of hydrogen, carbon monoxide and carbon dioxide) is another low heating-value gaseous fuel that can be used for high temperature heating applications. All types of biomass, including cut twigs and branches, can be used to generate producer gas. This means that users need to trim only parts of trees and thus can harvest biomass more sustainably. The resulting fuel is quite cheap. In India for example, it is less than one-tenth of the price of grid electricity and is cheaper than logs, coal and petroleum products (Figure 5-15).

The poor can extensively use modern biomass energy technology, including improved combustion devices, biogas systems and gasifiers

Two of the most successful countries in biogas applications are China and Nepal, both of which have developed the technology to commercial stages. Nepal provides 75 percent subsidies for family-scale biogas plants. By 2005, China had 17

Figure 5-15 Producer gas compared with other fuels for heating, India, 2004



Note: Figure converted to US$ [US$1 = INR 41]
Source: Mande 2005

million biogas users, but India too is now making biogas a priority and has 4 million household-scale plants.

The poor can make extensive use of modern biomass energy technologies, including improved combustion devices, biogas systems and gasifiers. Within the household, they can use them for cooking, space or water heating with less indoor air pollution.

Modern biomass technologies can replace petroleum fuels or save use of biomass fuels in large-scale commercial cooking, or other heating applications in food service establishments. They can also be used for process heating in small, medium and micro- enterprises such as those found in South Asian countries (see Table 5-8). Millions of similar enterprises can be found in other parts of the Asian continent. If proper policy and programme support are in place, poor households can own and operate these types of small establishments and enterprises, which can help lift them out of poverty.

While promoting the modern use of biomass as substitute for oil products, Asia-Pacific countries need to take into consideration several factors (IEA 2007c):

- The need to produce biomass in a manner that is considered sustainable and renewable.
- The energy needed to transport the many forms of low-bulk and energy density biomass.
- The quality and moisture content of biomass to ensure efficient conversion.
- The selection of appropriate conversion technologies and size of plant to match the supply.
- The market for the bioenergy carriers – as heat, electricity, gaseous fuels, or solid fuels as pellets.

Solar thermal systems

As a result of high petroleum prices, solar thermal systems have now become cost competitive. These include solar driers used in post-harvest and other agro-processing applications as well as solar water heaters for household and commercial applications.

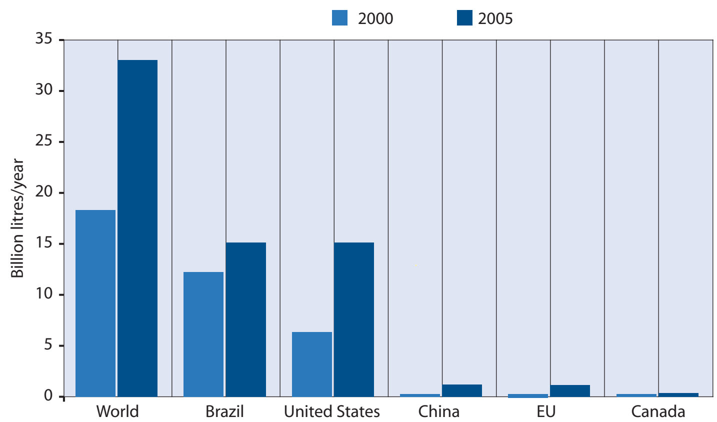
Solar water heating is a long-established technology but has recently become much more popular. Between 2001 and 2004, the global

Table 5-8 Small, medium and micro enterprises in South Asia using biomass heating

Bangladesh	Nepal	Sri Lanka
Bread industry	Beaten rice industry	Bakeries, hotels and eating-houses
Hostels and training institutes	Mustard oil industry	Coconut processing
Sweetmeat industry	Roadside hotels and restaurants	Rubber processing
Tea stalls	Sweet shop industry	Tea processing
Yarn twisting and dyeing industry	Wood dyeing industry	Brick and tile making

Source: FAO 2006

Figure 5-16 Global bioethanol production, 2000 and 2005



Source: REN21 2006a

market for solar water heaters grew by 50 percent (Sawin 2004). China has long been the world leader in their production and use and by the end of 2003 accounted for 55 percent of global capacity, with 40 million solar water heaters (Palz 2006).

Nepal also has embraced solar water heating. Since the 1970s more than 100 small workshops in Kathmandu have been manufacturing such heaters, and many new houses of higher-income households have solar collectors built into their design. This technology is, however, less common in other countries in the Himalayan region where it would be equally applicable, but where commercialization strategies focusing on urban households have not been as organized and effective as in Nepal.

More efforts have to be made to integrate solar water heaters into overall poverty eradication strategies so that the poor can benefit from this technology. Solar water heaters are mainly designed for piped domestic water supplies. Most poor households, particularly those in rural areas, do not even have easy access to a domestic water supply, still less a running domestic water supply. As a start, solar water heaters can best be used to provide low-cost water heating for health clinics and other social service facilities for the poor.

Biofuels

Transport

The transport sector is one of the largest consumers of petroleum products and is unlikely to move away from full dependence on oil quickly. Nevertheless, technological advances in the design of automobiles now offer significant opportunities to use biofuels.

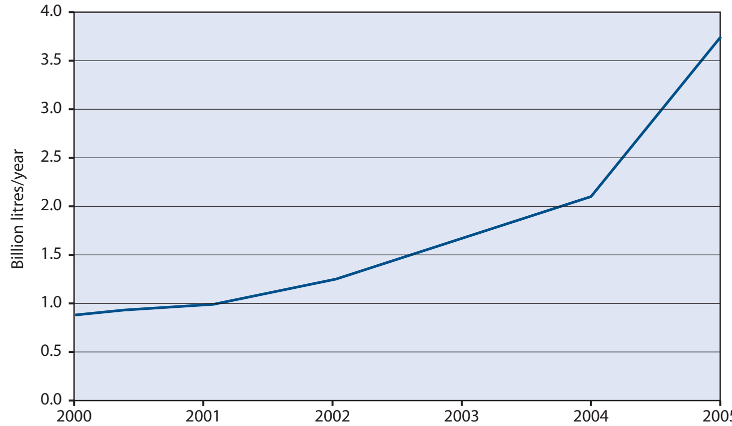
These consist largely of ethanol to replace gasoline in spark-ignition engines and methyl esters to replace diesel in compression engines. Ethanol (or bioethanol) comes mainly from corn or sugarcane, though it is also produced on a smaller scale from sugar beets and wheat. Biodiesel is presently derived from vegetable oils such as rapeseed, soy, palm, coconut and, soon, jatropha.

Significant opportunities exist to use biofuels, such as ethanol and biodiesel, for which output is expanding rapidly

Figure 5-16 shows the trends in the production of bioethanol, for which output in 2005 reached 33 billion litres. Figure 5-17 shows the trend for biodiesel, for which output is expanding even more rapidly, though from a smaller base; by 2005 it had reached almost 4 billion litres. Even so, the 33 billion litres of bioethanol produced in 2005 were equivalent to only 1.2 percent of the worldwide production of gasoline by volume – and an even smaller proportion, about 0.8 percent, in terms of transport distance travelled, because of its lower energy content.

Why the rapid growth? The largest producers, Brazil and the US, launched their major national ethanol biofuel programmes more than three decades ago in the wake of the first world oil shock. But biofuel production has accelerated in recent years not just because of rising oil costs and efforts to achieve energy security, but also because of environmental concerns about increasing urban air pollution and, more recently, worries about the rise in greenhouse gas emissions from the burning of fossil fuels.

Figure 5-17 World biodiesel production, 2000-2005



Source: REN21 2006a

Leading biofuel producers

The main producers of biofuels are indicated in Table 5-9. For bioethanol the dominant producer has been Brazil, which makes the fuel from sugarcane, though the United States, which makes it mostly from corn, has now caught up. In Asia the principal producers are China and India, and they are also in the forefront of biofuels development. In India, a rejuvenated sugar ethanol programme calls for the availability of E5 gasoline (gasoline with 5 percent ethanol) in most of the country, and there are plans to raise this to E10 and then E20. In China, the government is making E10 blends mandatory in five provinces that account for 16 percent of the nation's passenger cars. In Japan, the government has permitted low-level ethanol blends in preparation for a possible blending mandate, with the intention, by 2030, of replacing 20 percent of the nation's oil demand with either biofuels or gas-to-liquid fuels made from natural gas.

In South-East Asia, Thailand, eager to reduce the cost of oil imports while particularly supporting cassava growers, has mandated an ambitious 10 percent ethanol mix in gasoline starting in 2007. For similar reasons, to support coconut growers, the Philippines will mandate 2 percent biodiesel and 5 percent ethanol. In both Malaysia and

Table 5-9 World biofuels production by country, 2005

Country	Fuel ethanol (billion litres)	Biodiesel (billion litres)
Brazil	15	-
United States	15	0.25
Germany	0.2	1.9
China	1.0	-
France	0.15	0.6
Italy	-	0.5
Spain	0.3	0.1
Canada	0.2	0.1
India	0.3	-
Columbia	0.2	-
Sweden	0.2	-
Czech Republic	-	0.15
Poland	0.05	0.1
Denmark	-	0.1
Austria	-	0.1
Slovakia	-	0.1
EU Total	0.9	3.6
World Total	33	3.9

Source: REN21 2006a

Indonesia, an increasing proportion of national diesel fuel requirements are to be met from palm oil.

A number of countries are also developing 'second-generation' biofuels from a wider range of plants and are making better use of the whole plant, as well as ensuring that the primary source of energy for the production and subsequent distribution of the products is based on biofuel. In this case, on an energy basis, the projected greenhouse gas (GHG) emissions per litre of biofuel at the fuel pump can be less than one-tenth of those for an equivalent amount of gasoline or diesel.

One of the newer crops being widely promoted for biodiesel production worldwide, including Asian countries, is jatropha. This is a drought-resistant perennial type that can be planted even in wastelands, is easy to establish and grows relatively quickly. The seeds have an oil content of 37 percent and can even be burned in a simple diesel engine without being refined[5]. Jatropha could therefore be a very valuable crop for poor communities living on marginal land. Consequently, there have been substantial social and political pressures to promote its use in India and other developing countries in the region as a means of poverty reduction, after fully assessing their socioeconomic viability and environmental impacts.

The costs of production

Biofuel production costs depend on a large number of factors, including the technology involved, economies of scale, the price of the feedstock materials and competition for land uses. As a result, they vary among producers (Table 5-10). For bioethanol in 2005, for example, the prices per litre of oil equivalent ranged from US$0.30 in Brazil to US$1.0 in Germany. For biodiesel the prices are generally higher, between US$0.60 and US$0.80 per litre of petroleum diesel equivalent. Just as Brazil, with a huge local market and decades of experience, has

Table 5-10 Minimum production costs of biofuels

	Minimum production costs Per litre fossil fuel equivalent	**Source, Date**
Reference: Fossil fuels for diesel/gasoline (very rough world average estimate)	**Approx. 45 US¢** (excl. distribution cost, sales margin, etc.)	Rough average cost (at a crude oil price of 60 US$ per barrel)
Bioethanol Brazil	**30 US¢**	Estimates based on BMELV/FNR/GTZ 2005*
Biodiesel Brazil	Production costs (based on production costs for vegetable oil of approx. 200 US$ per tonne): **30-35 US¢** Opportunity costs (based on market prices for vegetable oil of approx. 400 US$ per tonne): **45-50 US¢**	Estimates based on BMELV/FNR/GTZ 2005*
Ethanol China	**60-80 US¢**	Estimates based on BMELV/FNR/GTZ 2005*
Pure Vegetable Plant Oil Germany (rapeseed)	**65 US¢**	FNR 2006**
Ethanol Tanzania	**60-70 US¢** (estimates)	Estimates based on BMELV/FNR/GTZ 2005*
Ethanol India	**60-70 US¢**	Estimates based on BMELV/FNR/GTZ 2005*
Pure Vegetable Plant Oil Madagascar (Jatropha)	**70 US¢**	GTZ 2006***
Biodiesel India (Jatropha-based)	**60-80 US¢**	Estimates based on BMELV/FNR/GTZ 2005*
Biodiesel Tanzania (Jatropha-based)	**70-80 US¢**	Rough estimate, based on regional experience
Biodiesel Germany (rapeseed-based)	**90 US¢**	FNR 2006**
Ethanol Germany (sugar-based)	**100 US¢**	FNR 2006**

* BMELV/FNR/GTZ 2005, Liquid Biofuels for Transportation: Potential and Implications for Sustainable Agriculture and Energy in the 21st Century. Regional Studies for Brazil, China, India and Tanzania
Note: The figures given are rough estimates based on the BMELV/FNR/GTZ study, but also taking into account regional and sectoral experience. As large-scale biofuel production in most countries has not been realized yet, the figures indicate estimated production costs that could be achieved in the medium-term.
** FNR (Fachagentur für nachwachsende Rohstoffe) 2006, Biokraftstoffe: eine vergleichende Analyse, available at http://www.fnr.de
*** GTZ, 2006, Project report on the Jatropha potential of the SAVA Region in Madagascar

Source: Reproduced from GTZ 2007

emerged as the global low-cost producer of bioethanol, so it seems likely that other countries will become dominant producers of biodiesel. Newer producers will thus find it more difficult to compete internationally, though will probably subsidize production for local consumption in order to reduce oil imports and establish domestic industries for the long term (ESMAP 2005).

Competitiveness of biofuels

One of the key issues is the extent to which biofuels will be able to compete in the future with petroleum-based products. Figure 5-18 compares the current prices of biodiesel with diesel, using the four oil-price scenarios presented earlier. These are the expected prices of diesel after refining, but without distribution costs or taxes. This shows that Brazil, at US$0.45 per litre of oil equivalent, would be capable of producing competitive biodiesel under all the scenarios, but that other countries whose prices at present are currently above US$0.70 per litre of oil equivalent would be competitive only under the supply shock and peak price scenarios.

Costs of producing biofuels are likely to decrease, making it easier for countries to move to large-scale production and use

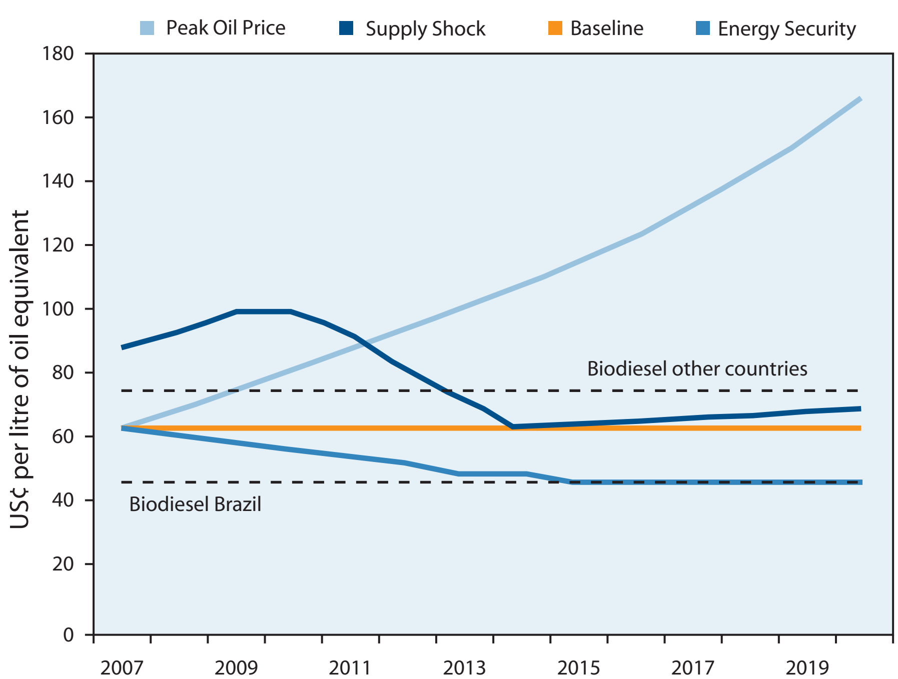
There are some concerns that as the demand for biofuels rises, this will push up the prices of vegetable oils. From January 2006 through mid-2007 there were substantial increases in the prices for soya oil, sunflower oil and especially palm oil, for which the price increased from US$ 425 to US$775 per tonne (Figure 5-19). This could inhibit long-term investments in biodiesel production even as investment in the production of the feedstock crops increases.

Nevertheless, it is likely that over time the costs of producing biodiesel fuels will decrease with increased yields per hectare, improved efficiency in harvesting and conversion, improvements in technology, and increased scale of production. This was the experience with sugar cane-based ethanol in Brazil and corn-based ethanol in the United States, and the same is expected to apply to biodiesel production as well.

The prices that consumers pay can, of course, be very different. Governments often provide subsidies for the production of biofuels to make them more competitive. In India, for example, if bioethanol at current production costs were to be subsidized to make it the same price as gasoline, this would require a subsidy of US$0.25 per litre, or US$200 million per year (Table 5-11).

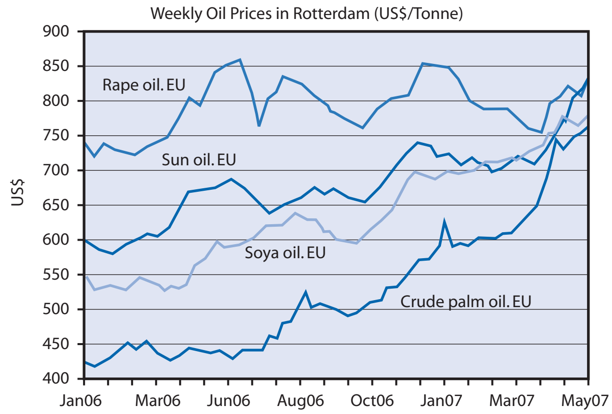
Another issue relates to taxes. For fiscal incentives, governments have typically taken one of two approaches. One is to provide fiscal assistance to make the retail prices of biofuels no higher on average than those of petroleum fuels. The other is to make biofuels cheaper than pure

Figure 5-18 Comparison of diesel and biodiesel prices, 2007-2020



Note: Figure based on REP-PoR oil scenario study

Figure 5-19 Weekly prices for vegetable oils at Rotterdam, January 2006 - May 2007



Source: GTZ 2007

Table 5-11 Fiscal implications of biofuels programmes

Country	**Fuel consumption** (Data source: http://www.wri.org, based on IEA data)	**Fossil fuel sales prices incl. fuel taxation** (November 2006)	**Fossil fuel production costs** (excl. distribution cost, sales margin, etc.)	**Minimum biofuel production costs** per litre fossil fuel equivalent	**Cost difference** between fossil fuel production costs and biofuel production costs	**Total amount of subsidy for a 10% blend*)**
Germany						
Gasoline Diesel	33.2 bn litres 28.1 bn litres	155 US ¢ (Super) 138 US ¢	45 US ¢ 45 US ¢	100 US ¢ (Ethanol) 90 US ¢ (Biodiesel)	55 US ¢ 45 US ¢	US$1,825 mn US$1,265 mn
China						
Gasoline Diesel	48.3 bn litres 37.3 bn litres	69 US ¢ (Super) 61 US ¢	45 US ¢ 45 US ¢	60-80 US ¢ (Ethanol) 60 US ¢ (Biodiesel)	15-35 US ¢ 15 US ¢ s	US$725-1,690 mn US$560 mn
United Republic of Tanzania						
Gasoline Diesel	33.2 bn litres 28.1 bn litres	104 US ¢ (Super) 99 US ¢	45 US ¢ 45 US ¢	60-80 US ¢ (Ethanol) 70-80 US ¢ (Biodiesel)	15-25 US ¢ 25-35 US ¢	US$3-6 mn US$15-21 mn
India						
Gasoline Diesel	33.2 bn litres 28.1 bn litres	101 US ¢ (Super) 75 US ¢	45 US ¢ 45 US ¢	65-70 US ¢ (Ethanol) 60-80 US ¢ (Biodiesel)	20-25 US ¢ 15-35 US ¢	US$204-255 mn US$368-858 mn

* Note: The energy content of biofuels is normally lower than that of their fossil counterparts. The estimation of the total amount of subsidy assumes that 10% of the fossil fuel volume is substituted by biofuels. The needed volume of biofuels will be higher.
Source: Reproduced from GTZ 2007

petroleum fuels. This can be important as a way of encouraging consumers to try new fuels, though a 'permanent' tax reduction will raise serious questions about the long-term viability of the industry. Nevertheless, Brazil has shown that subsidies can pay off. Over the period 1976-2004, Brazil offered large subsidies and reaped the benefits, as ethanol production substituted for oil imports worth US$61 billion, or as much as US$121 billion if the estimate includes avoided interest payments on the debt that could have been incurred by importing oil (WWI 2006).

Benefits and costs

In addition to the economic and fiscal considerations, countries also need to consider the social costs and benefits of moving to large-scale production and use. The benefits include:

- *Lower imports* – Successful large-scale domestic biofuels industries will offset petroleum imports and improve the balance of payments.

- *Greater energy security* – Biofuels offer a way not just of diversifying supplies but also of making countries less dependent on oil imports.
- *Less greenhouse gases* – Used on a significant scale, biofuels could lower greenhouse gas emissions.
- *Less vehicle emissions* – Liquid biofuels in mixtures with gasoline and diesel will reduce vehicle emissions and help improve air quality in Asia's cities.
- *More jobs* – Cultivation of biofuel feedstock creates additional employment and income for rural workers, especially for crops such as jatropha that use land not suitable for food production. The ethanol industry is credited with providing more than 200,000 jobs in the United States and half a million direct jobs in Brazil.
- *Disposal of waste* – Converting biomass residues, such as forest products, wood waste, grease and used vegetable oil into biodiesel fuels will help dispose of waste.

On the other hand, large-scale production of biofuels can have serious economic and social costs

- *Higher food prices* – The modest current levels of production have been pushing up the prices for many food commodities, and this trend is expected to continue. In the US, for example, corn futures in March 2007 rose to their highest level in 10 years. Several Pacific Island Country governments have opted to have staple foods such as cassava, taro and yam taken out of the fuel markets so that rural people will not be confronted with strong food price increases if demand for these crops for biofuels increases (Cloin 2007).

- *Deforestation and other ecological impacts* – Already there are signs of environmental damage as higher prices encourage the conversion of tropical forests to monocrops such as palm oil, with attendant loss of biodiversity and habitat, expanded use of water, nutrient runoff and loss of watersheds. This is already a serious problem in some Asian countries. Indonesia has recently become the world's third-largest greenhouse gas emitter as a result of its clearing of peat bogs for expansion of plantation agriculture and the use of peat for power generation.

- *Water shortages* – Large-scale production of biofuels will require expanded use of fresh water. The poor are likely to be affected the most.

- *Bad working conditions* – While many more workers may be employed cultivating feedstock crops on plantations, they can suffer from poor working conditions and low pay.

If the developing countries of the Asia-Pacific region are to take advantage of the opportunities afforded by biofuel, they will therefore need to proceed carefully, examining not just the macroeconomic and fiscal issues, but also the costs and benefits for the environment and for poor communities.

Reducing significantly GHG emissions from the transport sector by fully replacing the petroleum fuels with biofuels is likely to take several decades. In the meantime, sustainable use of biofuels should be assured, which will require:

- A comprehensive life-cycle analysis, from crop production of feedstock to processing of biofuel products, to assess the relative energy and carbon emissions impacts,
- Development of technical fuel standards in the use of biofuels and warranties for vehicles using biofuels,
- A harmonized set of biofuel standards for fostering both trade and investment, and
- A comprehensive and internationally accepted assessment methodology to evaluate social and environmental impacts of biofuel projects, including land use.

Table 5-12 lists potential initiatives that could be pursued to address these concerns. (USAID 2007)

Financing experiences in making renewable energy affordable

Most renewable energy systems are capital intensive and require initial financing. In the private sector, financing generally falls into three categories: debt or equity financing for businesses, and financing for consumers to enable them to buy systems. In addition, there is the option of 'carbon finance' through the Clean Development Mechanism. UNDP's regional study on private investment on renewable energy,[7] which builds on an analysis made by the Expert Group on Renewable Energy (UNDESA 2005), noted several possible interventions as entry points for financing mechanisms and promoting larger investments and affordability of renewable energy.

Table 5-12 Scaling-up biofuels development for transport

	Policy Regulatory	Inst Design and Capacity	Market Development	Tech Transferred and Demonstration	Financing	Carbon Market	Capacity Building	Knowledge Management
Promote national legislation and policy/research road maps for biofuels	✓	✓		✓	✓			✓
Establish regional technical standards for biofuels to enable trade	✓	✓						
Regional standards for sustainable biofuel production	✓	✓						
Promote best practices network on biofuel production from different feed stocks				✓			✓	✓
Provide biofuel business support (e.g. private-public partnerships, investment fairs, project preparation TA)		✓	✓		✓			
Facilitate technology transfer in advanced ethanol and biodiesel production			✓	✓				
Facilitate technology transfer in flexi-fuel vehicle technology, fuel infrastructure management and product quality enhancement			✓	✓				

Source: USAID 2007

Countries must take care that biofuel production does not result in higher food prices, deforestation and water shortages

Debt finance

High interest rates, short maturities and low debt-to-equity financing can make renewable sources more expensive than conventional power, at least in the short term. To overcome such obstacles, these new systems will require long-term 'patient' financing, whose interest rates reflect additional benefits in the form of environmental protection and energy security.

To address some of the barriers to financing renewable energy infrastructure projects, the World Bank, Kreditanstant Für Wiederaufbau, DEG[5] and other development finance institutions are putting in place a variety of instruments to improve access to long-term financing. These include currency swaps to reduce foreign exchange risk, two-step bridging mechanisms to allow project refinancing, lease-financing arrangements to reduce off-take risk and various other approaches.

Some Asia-Pacific countries have also established specialized institutions to provide loans. The Indian Renewable Energy Development Agency (IREDA), for example, has approved more than 1,700 loans to a range of projects in wind energy, biomass power, solar energy and small-hydro development. Since its establishment in 1987, IREDA has invested almost US$1 billion in this sector and has a pipeline loan commitment of another US$1.5 billion.

World Bank/GEF projects have also begun investments in renewable energy technologies through financial institutions. In Sri Lanka they provide credits to the Development Finance Corporation of Ceylon (DFCC) for financing small-hydro, solar PV, village hydro and biomass systems. DFCC provides credit to intermediary financing institutions, a total of nine at present, including those using micro-finance.

Equity finance

With a few exceptions, the business community in most countries does not consider renewables a suitable target for mainstream investment. And those alternative investors who are interested find it difficult to access sufficient funds to expand operations.

Innovative financing can result in larger investments in renewable energy, including new debt and equity investments, end-user finance and carbon finance

To help fill the gap, a number of budding international social and environmental venture capital funds have emerged to provide seed capital. The US-based E+Co, for example, is an independent company that provides business development services and modest loans or equity investments, aiming to demonstrate to public- and private-sector investors the advantages of local clean-energy enterprises. One example is a project for biogas production using the biomass waste from one of Thailand's largest cassava processors. E+Co has invested US$197,500, with leveraged co-financing of US$ 3.4 million from equity investors and banks. The factory is now displacing 8 million litres of heavy fuel oil each year, while generating 30,000 MWh of electricity.

Another example is the international non-profit organization Winrock International which, along with network members in Indonesia and the Philippines, has provided seed capital for pre-investment support and cost-share investments. Since 1998, Winrock's Nepal programme, for example, has been able to leverage more than US$5 million in equity investment in the small hydropower sector.

New types of finance instruments are also now available, including 'quasi-equity,' which can combine some forms of preferred shares with subordinated debt and the option to be bought out later.

End-user finance

Households or communities that want to install renewable energy technologies can get finance from various sources, including retailers, commercial bank loans and microcredit. Or they can lease the equipment or pay fees for services. Retailers who want to build a large-scale credit-backed sales operation will usually look to a banking institution. Thus far, however, this is happening only on a small scale. Banks are certainly making loans in unprecedented numbers for household appliances, motorcycles, cars and homes across many countries in Asia and the Pacific, largely in urban areas and based on salaried incomes. Mainstream banks have not, however, been financing renewable energy systems.

Across the region, microfinance organizations too have only just started lending for solar home systems or biogas. Prominent examples include Grameen Shakti (Box 5-1) and Bangladesh Rural Advancement Committee (BRAC) in Bangladesh and Sarvodaya Economic Enterprises Development Services in Sri Lanka, all of which benefit from lines of credit from the World Bank and the Global Environment Facility. In other countries without long traditions of micro finance, it has been more difficult to raise the funds. However, organizations such as the Triodos Bank of the Netherlands have been providing loans to microfinance institutions to on-lend to their customers for energy systems.

For the poorest households, usually the most successful way of providing finance for energy is by combining this with income-generation activities. One example is Wahan Dharak, a rural cooperative society in Maharashtra, India, which for a daily fee provides micro-enterprises with solar lanterns.

Carbon finance

Another potential source of finance is the Clean Development Mechanism (CDM) which emerged from the Kyoto Protocol. This allows emitters in developed countries to buy emission rights by funding projects that help reduce carbon dioxide emissions in developing countries. In Asia, as of August 2007, the market for CDM projects was dominated by India (42 percent) and China (42 percent), with smaller volumes of registered and pipeline projects in Malaysia (4 percent) and a number of other countries (12 percent) (UNEP Risoe 2007).

Most CDM transactions aim to reduce emissions of HFC (hydrofluorocarbon) gases from industry, of nitrous oxide from agriculture and of methane from landfill projects. However, the trend is shifting gradually toward renewable energy which, as of July 2007, accounted for 53 percent of CDM projects. Renewable energy CDM projects are largely concerned with biomass (32 percent), hydro (28 percent), and wind (25 percent), with smaller amounts from geothermal, biogas, tidal and solar. Asia and Pacific developing countries account for 58 percent of the CDM project pipeline, with 284 projects in India alone and around 60 in China (UNFCCC 2007).

For CDM projects, renewables have the disadvantage of having high initial costs and being quite high-risk. And for household projects, it can also be difficult to provide 'emission reduction units' on a sufficient scale. Buyers typically purchase a minimum of 30,000 tonnes of CO_2 per year, which would need a project with 120,000 solar home systems to make it worthwhile to develop into a CDM project.

Switching to renewable energy to benefit the poor

The ranges of renewable energy technologies that can compete with oil-based systems are now much wider, particularly if the targeted applications are in remote and rural areas. Because these are the areas where most of the poor reside, renewables have the potential to provide them with more cost-competitive energy services, including those needed for livelihood activities. Table 5-13 shows some of these. Village lighting, for example, which today might use a diesel generator, could instead, depending on local conditions, be powered by pico-hydro, wind generators or photovoltaic systems. Heating or drying energy needs may be supplied by biomass or solar heaters/dryers.

Nevertheless, not all these services are likely to be introduced at once. As rural development proceeds, patterns of energy use will change, allowing more opportunities for the introduction of more types of renewable energy technologies. Table 5-14 illustrates this as a broadly three-stage scenario, with types of rural energy demand changing and increasing between the different stages and the types of renewable energy technologies getting more varied and sophisticated. The period from 2007 to 2020 will probably cover until the early phase of stage 3.

Renewables – the benefits to the poor

Those who stand to gain most from renewable energy technologies are those currently not served by the national electricity grid and who have difficulty accessing petroleum supply. In summary, the benefits include:

Village lighting could depend on pico-hydro, wind generators or photovoltaic systems

Savings on household expenditure – Households without electricity will spend less on kerosene for lighting, on dry-cell batteries for sound equipment, and on car batteries for televisions. A range of studies have reported savings of 20 percent to 50 percent. In Bangladesh, for example, one study found that non-electrified households were spending US$1.50 per month

Table 5-13 Switching to renewables, matching tasks to technologies

Type of rural energy service	Maximum demand	Fossil fuel supply system	Renewable energy system	Demand characteristics
Village lighting	10 kWh/day	Diesel generator	Wind generator	6 - 10 p.m. daily
Village lighting	10 kWh/day	Diesel generator	Photovoltaics	6 - 10 p.m. daily
Household lighting	1 kWh/day	Gasoline generator	Photovoltaics	6 - 10 p.m. daily
Cold storage	240 kWh/day	Diesel generator	Wind generator	Cut-in factor 0.67
Cold storage	240 kWh/day	Diesel generator	Photovoltaics	Cut-in factor 0.67
Refrigerator	2.4 kWh/day	Kerosene refrigerator	Photovoltaics	Cut-in factor 0.67
Water pumping (domestic use)	50 m^3/day	Diesel pump	Wind pump	a) 182.5 day/year b) 365 day/year
Water pumping (domestic use)	50 m^3/day	Diesel pump	Photovoltaics	a) 182.5 day/yr b) 365 day/yr
Crop drying	200 MJ/day	Traditional drying	Solar drier	a) 8 batches b) 30 p. a.
Sterilization	50 MJ/day	Kerosene sterilizer	Solar sterilizer	100 litre auto clave - 4 cycles/day
Cooking	65 MJ/day	Kerosene cooker	Biogas plant	Average 1.83 m^3/day
Water pumping (irrigation)	60 m^3/Hr	Diesel pump	Biomass gasifier plant	3,000 Hr/year
Rural electrification	2,400 kWh/day	Diesel generator	Mini-hydro	Utilization 40%
Mechanical power	120 kWh/day	Diesel engine	Micro-hydro	1,800 Hr/year
Water pumping	50 m^3/day	Diesel pump	Photovoltaics	3,000 Hr/year
Water pumping	60 m^3/Hr	Diesel pump	Photovoltaics	1,200 Hr/year

Source: Oelert et al. 1987

Table 5-14 Stages in the introduction of renewable energy technologies

		Stage 1 – Present	Stage 2 – Medium-term	Stage 3 – Long-term
ENERGY DEMAND SCENARIOS	*Energy users*	Rural households Traditional agriculture production Crop production Livestock Forestry Fisheries Post-harvest processing	Rural households Traditional agriculture production Crop production Livestock Forestry Fisheries Post-harvest processing	Rural households Traditional agriculture production Crop production Livestock Forestry Fisheries Post-harvest processing
	Energy uses	Heating Lighting Mechanical applications	Heating Lighting Transport Other small mechanical power uses Other small electrical power uses	Heating Lighting Transport Refrigeration Large heating applications Other small and large mechanical power uses Other small and large electrical power uses
RENEWABLE ENERGY SUPPLY SCENARIOS	**Energy resources**	**Energy conversion and end-use technologies**		
	Human & animate power	Human- and animal-driven devices	Human- and animal-driven devices	…..
	Fuelwood Crop wastes	Traditional stoves	Gasifiers; charcoal and fuel briquettes; improved stoves	Solid/liquid/gaseous biomass fuels in improved stoves; engines; boilers and co-generation systems
	Animal dung	Traditional stoves	Biogas systems; improved stoves	Gaseous biomass fuels in improved stoves and engines
	Hydro	…..	Waterwheels; small decentralized hydro; and large grid-connected hydro	Small decentralized hydro; large grid-connected hydro; hybrid power plants
	Energy crops	…..	……	Solid/liquid/gaseous biomass fuels in improved stoves; engines; boilers and co-generation systems; hybrids
	Wind	…..	Windmills; decentralized wind power systems	Decentralized systems; grid-connected wind farms; hybrids
	Solar	Direct traditional solar drying	Improved solar driers; decentralized PV systems	High efficient thermal systems; decentralized PV systems; local PV-based grid systems; hybrids

Source: UNESCAP 2003

on kerosene, while electrified households were spending less than half of this (Barkat et al. 2002). Similarly in Nepal, the introduction of micro-hydro-based electricity caused a 50 percent reduction in expenditure on kerosene and dry-cells.

Savings on time and effort – The use of biogas and improved biomass cookstoves can significantly reduce household workloads, by eliminating the time spent collecting and processing fuelwood, as well as reducing the time for cooking and cleaning. Some households can save four to eight hours per day. Improved stoves can heat two pots at the same time, and biogas will heat them more quickly (Anderson 1992; ESMAP 2003; Liu 1992). The availability of cheaper renewable energy-based electricity allows the use of household appliances that help save women's time in domestic food processing and other household chores – though with the availability of electric light, women's workload can increase in the evenings.

Higher-quality services – For some households, the main advantage of renewable energy is that it increases the quality and quantity of services. In Indonesia, for example, solar PV lighting systems are generally more expensive since households spend more on monthly payments for the system than they save from using less kerosene. But they are willing to pay for the vastly superior quality of lighting, coupled with the elimination of fire hazards and toxic fumes. Use of improved biomass stoves eliminates indoor air pollution, making the kitchen a cleaner place in which to work. (Modi 2005)

Working at home – The other main advantage of extending the range of energy sources is that it can allow people to run micro-businesses from home, including handicrafts making, embroidery, food processing and woodworking (Matly 2003). However, complementary policies and programmes should also be in place to support ownership and develop the skills of the poor so they can manage these micro-enterprises. Also, while the poorest households might not be using electrical devices for home production, they may still be able to benefit from lighting. In Nepal, for example, women can undertake handicraft work at night (Mahat 2004 and the HELP Programme).

Other income generation – But most income benefits from new energy sources tend to be outside the home, for agriculture and various small businesses. Farmers, for example, can use electricity to power irrigation systems that double or triple agricultural productivity and enable them to diversify into other crops. They can also use electrical equipment for cold storage, refrigeration, vacuum packing and sealing, and so reduce post-harvest losses. In Cambodia, some villages use battery-powered lanterns outdoors for frog hunting, a significant source of income (Cecelski 2002). Similarly, small businesses that can use machinery for sewing and tailoring or wood-working may be able to produce higher-quality goods. And better lighting allows them to work beyond daylight hours and employ more people. The new energy sources can also cut costs. In Nepal, for example, some agro-processing mills used to run on diesel and used NPR 1,700 (US$1.0 = NPR70.0) worth of it per month. After the introduction of micro-hydro power, their monthly power bills amounted to a few hundred rupees.

The renewable energy industry – Although most of the income benefits come from expanding power options for many small businesses, the renewable energy industry itself also employs a significant number of people. China and India, for example, are building a strong manufacturing base for solar PV panels and wind turbines. China is also a major manufacturer of small hydropower equipment and solar water heaters. Indeed, Asia now has around 60 percent of global PV production.

Other countries too are grasping the opportunities for manufacturing solar cells, through companies such as SunPower in Philippines and First Solar Inc. in Malaysia. Indonesia also has a large export-oriented solar-PV manufacturing base that makes DC lights, controllers and other components. Bangladesh too has a major manufacturer, Rahima Frooz, which supplies the deep-discharge, lead-acid batteries needed for solar home systems.

Benefits of renewable energy include savings on household expenditure and on time and effort, as well as higher-quality services

Although these enterprises can be quite capital-intensive, others provide more employment. Biogas systems and improved cookstoves, for example, mostly use local materials and employ local artisans and masons. The skills required for manufacturing, installing and repairing these systems can easily be mastered by poor people with little training and education. The Nepal Biogas Support Programme, for example, has resulted in the employment of 11,000 people. The Appropriate Rural Technology Institute in India also employs a large number of people.

Micro-hydropower systems typically use imported generators and controllers but are then manufactured locally. Bangladesh, India, Nepal and Sri Lanka all have industries to manufacture electronic battery-charge controllers for solar home systems. Overall, the value-added in solar home systems can be quite high even in countries that do not make solar panels because of the work needed for installation.

Still, to ensure that renewable energy manufacturing will benefit the poor, governments will need to introduce and monitor explicit policies on guaranteeing fair employment practices and just wages.

Energy plays an essential role in achieving all eight Millennium Development Goals

Renewable energy and the MDGs

Although the MDGs do not specifically mention energy, energy plays an essential role in their achievement. Table 5-15 discusses the direct and indirect role that energy can play in achieving each of the eight MDGs.

Table 5-15 Renewable energy and the Millennium Development Goals

MDGs	Relevance of renewable energy
1. Eradicate extreme poverty and hunger	Energy inputs, such as electricity and fuels, are essential to generate jobs, industrial activities, transportation, commerce, micro-enterprises and agriculture outputs. Most staple foods must be processed, conserved and cooked, requiring heat from various fuels.
2. Achieve universal primary education	To attract teachers to rural areas, electricity is needed for homes and schools. After-dusk study requires illumination. Many children, especially girls, do not attend primary schools, because they have to carry wood and water to meet family subsistence needs.
3. Promote gender equality and empower women	Lack of access to modern fuels and electricity contributes to gender inequality. Women are responsible for most household cooking and water-boiling activities. This takes time away from other productive activities as well as from educational and social participation. Access to modern fuels eases women's domestic burden and allows them to pursue educational, economic and other opportunities.
4. Reduce child mortality	Diseases caused by unboiled water, and respiratory illness caused by the effects of indoor air pollution from traditional fuels and stoves, directly contribute to infant and child disease and mortality.
5. Improve maternal health	Women are disproportionately affected by indoor air pollution and water- and food-borne illnesses. Lack of electricity in health clinics, little illumination for night time deliveries, and the daily drudgery and physical burden of fuel collection and transport all contribute to poor maternal health conditions, especially in rural areas.
6. Combat HIV/AIDS, malaria and other diseases	Electricity for communication such as radio and television can spread important public health information to combat deadly diseases. Healthcare facilities, doctors and nurses all require electricity and the services that it provides (illumination, refrigeration, sterilization, etc) to deliver effective health services.
7. Ensure environmental sustainability	Conventional modes of energy production, distribution and consumption have many adverse effects on the local, regional and global environment, including indoor, local and regional air pollution, local particulates, land degradation, acidification of land and water, and climate change. Cleaner energy systems are needed to address all of these effects and to contribute to environmental sustainability.
8. Develop a global partnership for development	The World Summit for Sustainable Development called for partnerships between public entities, development agencies, civil society and the private sector to support sustainable development, including the delivery of affordable, reliable and environmentally sustainable energy services.

Source: UN-Energy 2005

A policy framework for renewable energy favourable to the poor[8]

Conventional energy systems tend to have low capital costs, but significant operating costs. For renewable systems the picture is reversed: Capital costs are high, but over time these are offset by low operating costs. Added to this are the environmental benefits, the prospect of increased employment, reduced import dependence and reduced burden on foreign exchange.

However, the marketplace does not account for any of this value creation. Nor does it regard the rural poor as good credit risks, seeing off-grid systems as high-risk, low-return propositions. In the past, some governments have responded with large subsidies in the hope that this would attract the private sector into the market. But it now seems unlikely that this on its own will do much to deliver energy services to the rural poor.

Instead of withdrawing to let private markets develop on their own, a better approach would be to work alongside local communities and the private sector to remove barriers and reduce risks. Among the policies that have proven their ability to advance renewables are:

- *Create supportive policy and institutional frameworks* – In most countries, energy is principally a private business, but providing energy access for rural areas has traditionally been considered a government responsibility. Indeed, governments already subsidize the extension of electricity grids and provide the poor with subsidized petroleum fuels. They could similarly give support for renewable energy technologies, while linking these with wider rural development and poverty eradication initiatives. Governments could also support reliable assessments of renewable resources so as to encourage investment.

- *Promote private sector involvement* – Supplying rural energy services often means dealing with a large number of small transactions dispersed over a wide area. This problem can be addressed with innovative financing mechanisms. These include microcredit, whether from the energy company or its dealers, or from micro-finance institutions or community-based organizations. These can be linked with specially designed credit lines through larger financial institutions, potentially backed by the government. The new financing mechanisms also include micro-rental or fee-for-service approaches, where all or part of the equipment remains the property of the company, and customers make regular payments for its use. One example is a utility-style concession in which a concessionaire owns the system, charges a monthly fee and is responsible for the service.

- *Level the playing field* – Higher oil prices are creating major problems for countries that subsidize those fuels, threatening economic growth if the subsidies are kept in place and encouraging consumer outrage if they are not. Conventional energy sources also impose external costs on the environment and human health. These can be internalized with levies and taxes, as some countries in Europe are doing through carbon taxes to internalize the cost of greenhouse gas emissions. Just as many of the costs of conventional energy are not internalized, markets and policies often fail to internalize the myriad positive externalities – improvements in health care, education, communications and employment – that can result from bringing electricity to underserved areas. Community leaders, local residents and project developers should seek to explicitly identify such benefits. Identifying the costs and benefits would also benefit from reliable methodologies for quantifying externalities.

Capital costs of renewable systems are high, but are offset by low operating costs, environmental benefits and increased employment

- *Nurture micro-enterprise* – Renewable energy technologies can spur the creation of micro-enterprises by engaging local people, particularly the poor, in harnessing energy and in providing energy services. Renewable energy fights poverty most effectively when linked with income generation in both producing and using the energy, though the energy also has to meet essential human needs for cooking, lighting, heating and water supply.

Countries must create supportive policy and institutional frameworks for renewables and promote private sector involvement

- *Integrate projects around local needs and capacity* – Renewable energy services must be coupled with existing development activities for water, health, education and entrepreneurship, which it can also make more effective. In particular, they should address the requirements of women, by offering security and income, reducing labour and improving health by reducing indoor air pollution.

Food security, rural development and land use concerns of biofuel development must be addressed

Biofuel development to benefit the poor

Biofuels are very promising if delivered in the right manner; but with the ever-increasing demand for transport fuels, there are genuine concerns that biofuels may create greater competition for limited land and biodiversity, water and food. From the point of view of benefits for the poor, biofuels present a number of challenges and opportunities which have to be examined carefully and balanced.

The rapid growth in the demand and production of liquid biofuels and its impacts, particularly on food security, rural development, land use and the environment, can be both positive and negative. Development or expansion of existing liquid biofuels policies and programmes, particularly in making biofuels development work more effectively for poverty eradication, should be evaluated and assessed with considerations of these aspects:

- Attention on biofuels should not be limited to sugar and starch crops for the production of ethanol and vegetable-oil plants for the production of biodiesel. A comprehensive sustainable bioenergy programme should cover all sources:
    - Sustainable production of trees and other woody biomass from forests and non-forest areas for solid biofuel production.
    - Agricultural residues for heat and power generation through direct combustion, co-generation, biogas generation and gasification.
    - Cellulosic sources available for second-generation biofuel technologies from the agriculture and forestry sectors.
- All end uses of these bioenergy sources should be considered, such as heat and electricity, including non-transport uses of liquid biofuels – liquid biofuels are too focused on private urban transport use.
- Establishment of clear linkages between bioenergy development and food prices, food security, rural economics, trade, employment, biodiversity and climate change. Such linkages have to be assessed at the local, national and global levels.
- Promotion of active entry of small-scale farmers into bioenergy conversion stages and upward movement in the market supply chain.
- Promote engagement of SMEs in seeking production models of varying scales to allow them to be more competitive, using cooperatives, for example.

The exercise in expanding and strengthening biofuels programmes so that the poor get a greater share of the benefits should start with an evaluation and assessment of current experiences and policies. This can include models and practical tools currently used in national, regional and international organizations in areas such as land use planning, biofuels potential evaluation and impacts on food security and commodity prices.

In most developing countries there is a need to strengthen the decision-making capacities so as to tap the above-mentioned opportunities whilst avoiding potentially important negative impacts in various fields linked to rural livelihoods, equitable economic development and the environment.

The benefits of renewable energy services for the poor

In summary, renewable energy technologies offer great potential for providing energy services to the rural poor, especially those not connected to electricity grids. At specific locations and oil price levels, they are likely to be cheaper and cleaner than fossil fuel alternatives or both off-grid and mini-grid systems, making it possible for poor communities not just to improve their living conditions, but also their income-earning opportunities. However, the upfront costs can be high, requiring innovative financing methods and government support.

Biomass energy, particularly biofuels, can substitute for oil imports and will steadily become more competitive. Governments need to be aware of the social, economic and environmental impacts of biofuel production and hence put policy measures in place. The recent rapid increase in biofuel production has triggered concerns about its negative impacts on food supply and prices. Using food crops, such as corn, to produce ethanol will push up the prices of corn and corn-derived food items. This has already happened. There is also concern about using up land for biofuel feedstock production.

Indeed, there is increasing concern that current biofuel development trends, instead of helping achieve poverty eradication in rural areas, could instead exacerbate food insecurity. There are also environmental concerns about the impacts of monoculture biofuel feedstock plantations and the conversion of forests to such plantations.

Even if the above concerns are addressed, programmes for biofuel production will also need to deal with age-old rural and agricultural development issues such as land tenure, land reform and and other means of facilitating the direct participation of the rural poor in biofuel production. These issues need to be properly dealt with, assuring fair and equitable sharing of profit and income with the poor, who will be involved either as direct owner-growers in small farms, as farm workers or tenants in large plantations, or as labourers in biofuel processing plants. Designing an appropriate mix of policy and programmes is emerging as a challenge that national governments cannot afford to ignore.

Box 5-1 Grameen Shakti: Financing solar home systems[9]

Grameen Shakti is the largest single installer of solar home systems in Bangladesh. This is a non-profit company which uses a innovative financing system based on experiences from Grameen Bank's microcredit program. It links renewable energy technologies with income-generating activities and provides efficient services at the local level through renewable energy entrepreneurs. It also carries out awareness-raising campaigns to establish new renewable energy businesses and create employment opportunities.

At present Grameen Shakti can sell equipment to customers on microcredit at affordable instalments because it gets support from the Global Environment Fund and the World Bank, which provide finance through the Infrastructure Development Company Limited. Users pay an initial deposit and then repay their loans over two to three years. This generates a cash pool, which is recycled to make further loans. This will enable the scheme to continue when the subsidy eventually ceases in 2008.

This has generated electricity for lighting and communications, especially for charging mobile phones and TV, and has increased employment opportunities.

Grameen Shakti also has started a network of technology centres throughout the country to manage local installation and maintenance. It emphasizes the importance of technicians who know local customs, working through local branches, and has trained 2,000 (mainly female) technicians. It aimed to install 100,000 systems by 2006 and 1,000,000 by 2015.

Endnotes

1 In its Annual Statistical Review of World Energy, both BP and IEA exclude large hydro from their definition of renewable energy.

2 Unpublished UNDP Regional Study entitled "Regional Mapping of Options to Promote Investments in Alternative Energy Sources for the Poor".

3 Levelization involves calculating a stream of equal cash flows whose net present value is equal to a given stream of variable cash flows. The levelized cost of energy is the levelized annual cash flow, usually calculated in constant dollars, divided by the annual amount of energy produced.

4 For this report pico-hydro systems are those generating up to 300W, micro-hydro from 300W to 100Kw, etc.

5 [http://www.jatrophabiodiesel.org/]

6 See Endnote 2 above.

7 DEG – "Deutsche Investitions – und Entwicklungsgesellschaft mbH" is a member of KfW Bankengruppe – a German financing institution.

8 Adopted from REN21 2006b.

9 [http://www.ashdenawards.org/technical_summary06_bangladesh]

Policies for an era of uncertain oil prices

6

What can the countries of the region do to protect themselves in an increasingly uncertain energy environment? This chapter considers how they can respond to different oil price scenarios, looking in particular at the options for China, India, Indonesia and Lao PDR. It also explores ways all countries can secure energy and power for the poor, and proposes a new regional compensatory finance facility as a means to help Least Developed Countries and low-income countries to address crises due to oil price rises.

The two previous chapters have set out five broad strategies for coping with higher oil prices. In summary, these were:

1. *Managing oil price risk* – Covering such issues as pricing policies, targeted subsidies and financial tools.
2. *Enhancing oil supply* – Including strengthening oil exploration and extraction, building refining capacity, diversifying sources of supply and engaging in barter.
3. *Restraining oil demand* – Increasing efficiency in transport, industry and agriculture.
4. *Preparing for emergencies* – Building strategic reserves and planning for rationing.
5. *Diversifying fuels* – In some cases this may mean using more coal, but for many countries the opportunities will lie in renewable resources.

This chapter suggests a ranking of these strategies and their sub-strategies according to their potential to meet various objectives: increasing country-level and household energy security, increasing income generation, alleviating human poverty and minimizing environmental impacts. The strategies were also assessed in terms of their cost and the time required for implementation. A process for prioritizing sub-strategies under different oil price scenarios for case study countries is illustrated in Figure 6-1. Those with the highest potential to meet the various objectives listed above have the highest ranking (refer to Appendix F for methodology). Where sub-strategies have equal importance, they are given equal ranks, so although there are 18 sub-strategies in Table 6-1, there are only seven ranks. Which of these strategies should take priority will depend very much on national circumstances, which are discussed in subsequent sections of this chapter. For ease of interpretation, the strategies are grouped into three priority classes: high, medium and low (Table 6-2). Sub-strategies with ranks 1 to 3 are grouped as high priority, sub-strategies with rank 4 as medium priority, and those with ranks 5 to 7 as low priority.

Clearly, the most appropriate policy mix will change depending on what happens to oil prices. To arrive at a more precise sequence, it is useful to consider different possible scenarios. As introduced in Chapter 5, the four proposed in this report are: *baseline*, *supply shock*, *peak oil price* and *energy security*.

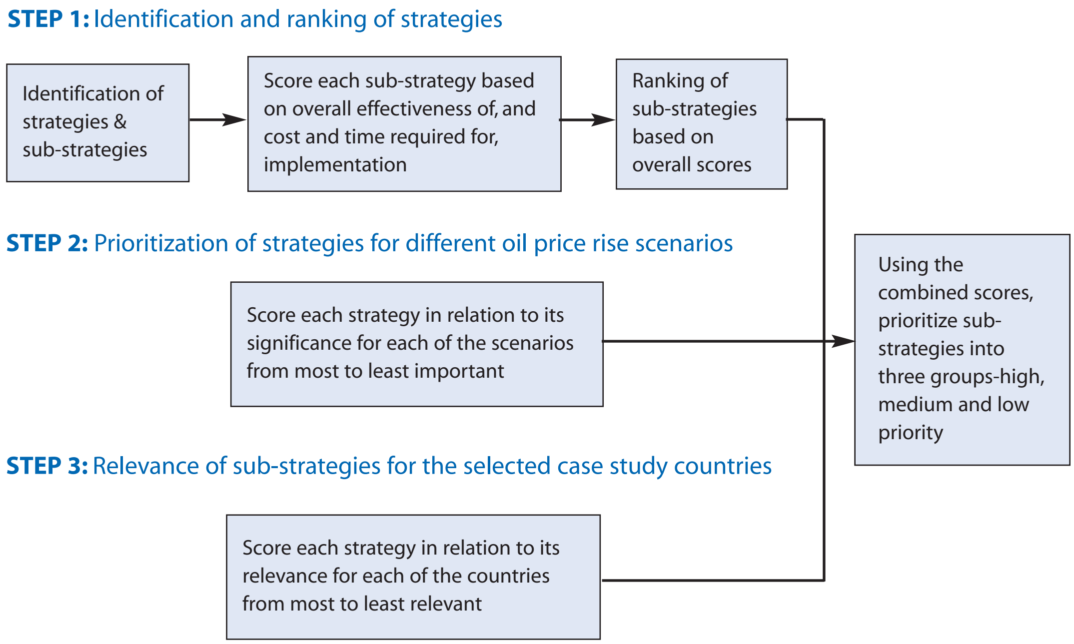
Baseline (BL)

This is derived from the oil market scenario presented by the IMF (IMF 2005) which is consistent with those of the IEA, OECD and OPEC. It assumes that future oil market developments are likely to be in two phases. First, until 2010, high oil prices will keep the oil market broadly in balance, with incremental oil demand being met mostly by high non-OPEC production. From 2010, as non-OPEC production peaks, there are likely to be calls on OPEC to increase output. Subject to short-term reversible spikes, oil prices will range between US$65 and US$75 per barrel. The oil intensity of economies will remain constant, or decline at current rates as a result of substitution mainly by natural gas and coal, which will be offset by continued growth in aggregate demand. This scenario assumes an average constant price of US$70 per barrel.

Supply Shock (SS)

This scenario considers an abrupt drop in oil supply. This could be due to geopolitical events, such as armed conflicts in the Middle East, or a rise in political tension over supply terms in

Figure 6-1 Process for prioritizing sub-strategies under different oil price scenarios for case study countries



An appropriate policy mix must be achieved to protect countries in an increasingly uncertain energy environment

Central Asia or Latin America. Or the shock could come from a natural disaster, such as a hurricane in the Gulf of Mexico. Whatever the cause, there could be damage to the infrastructure for oil production, refining and transportation that will cause large and unexpected short-term supply shortfalls. The challenges will be to deal with short-term supply shortfalls, which may be large and unexpected. As a result, oil prices per barrel will spike steeply to US$100, plateau at around US$120, and in later years decline to the initial level of US$70. Over the medium term till 2011, as a result of the supply shortfall, countries will reduce their oil intensities. As supplies resume normal levels, they will probably increase intensities again, but not to the same levels as before, due to the greater substitution of oil by natural gas, coal, nuclear power and renewable energy.

Table 6-1 Ranking of strategies and sub-strategies for addressing oil price rises

Strategy	Sub-strategy	Rank
Oil price risk management	Pricing of petroleum products	1
	Managing/targeting oil subsidies	1
	Financial tools	2
Enhancing oil security	Strengthening oil exploration	4
	Refining capacity to process sour crudes	4
	Diversifying sources of oil	6
	Barter	7
Restraining oil demand	Oil efficiency in transport	2
	Better land-use planning to reduce transport demand	5
	Improve public transport	4
	Improve oil efficiency in industry	4
	Improve oil efficiency in agriculture	6
Fuel diversification	Biofuels in transport	4
	Oil substitution in agriculture	4
	Oil substitution in transport	5
	Oil substitution in industry	7
Emergency preparedness	Rationing	1
	Strategic reserves	3

Table 6-2 Potential prioritization of various sub-strategies

--Priority	Sub-strategies
High	Pricing of petroleum products Managing/targeting oil subsidies Rationing Financial tools Improve public transport Strategic reserves
Medium	Oil efficiency in transport Improve oil efficiency in industry Biofuels in transport Oil substitution in agriculture Strengthening oil exploration Refining capacity to process sour crudes
Low	Better land-use planning to reduce transport demand Oil substitution in transport Improve oil efficiency in agriculture Diversifying sources of oil Barter Oil substitution in industry

Note: The sub-strategies are ranked in general priority sequence. The precise order may not, however, be significant.

Peak Oil Price (POP)

This scenario reflects the Hubbert's Peak theory, according to which, with no new major discoveries and the declining productivity of existing fields, world oil production will start to peak in 2007. There will be a temporary supply plateau until 2011, resulting from a more efficient supply infrastructure, but subsequently – supply will decline irreversibly by 2.5 percent annually. Oil prices will surge toward the mid-point of the peak and thereafter rise faster than the decline in supply due to a potential rise in geopolitical conflicts and speculation. Since this outcome is predictable, countries will be able to make some structural adjustments, encouraging oil substitution, technological improvements and greater energy efficiency. In this scenario, oil prices will increase gradually from their current level of around US$70 to US$100 per barrel in 2011, the mid-point of the peak. Thereafter, prices per barrel will rise more steeply, to US$130 in 2015 and US$190 in 2020. Until 2011, the oil intensity of economies will remain constant or decline at current rates of substitution, with natural gas and coal, but then decline at a faster rate as the impact of new fuels and technologies and structural changes begin to assert themselves.

Energy Security (ES)

Concerns for both energy and environmental security lead to reduced oil demand, so prices fall back to a lower equilibrium at around US$50 per barrel. The imperative for energy security will have been prompted by recent steep price rises. Those for environmental security will have been prompted by measures to reduce, among other things, greenhouse gas emissions. As a result, for fuel and for power generation, oil will be substituted over time by other conventional fuels, natural gas and clean coal, as well as by nuclear power and renewable energy. This will run parallel to improvements in energy efficiency and structural changes to reduce oil intensity. In this scenario, the oil price will decline from its current value of US$70 to US$50 per barrel by 2015, and then remain constant at a new supply-demand equilibrium.

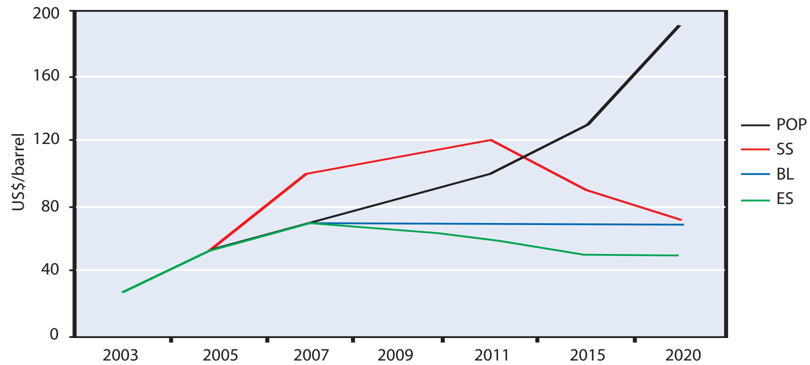
By definition, these scenarios are speculative and none of them consider, for example, the potential for a major economic slowdown as occurred with the last oil price rise. They do, however, allow for a consideration of extreme highs and lows and modulations in between. The prices they imply for crude oil are indicated in Table 6-3 and Figure 6-2, and those for oil products are in Table 6-4.

Table 6-3 Oil price levels in different scenarios, US$ per barrel

	2003	2005	2007	2009	2011	2015	2020
Baseline	28	54	70	70	70	70	70
Supply Shock	28	54	100	110	120	90	70
Peak Oil Price	28	54	70	84	100	130	190
Energy Security	28	54	70	65	60	50	50

Note: Prices are for the average nominal price of Brent, West Texas Intermediate and the Organization of Petroleum Exporting Countries Basket

Figure 6-2 Oil price levels in different scenarios



Note: Figure based on REP-PoR oil scenario study

Governments will need to respond differently to baseline, supply shock and peak oil price scenarios

Given these scenarios, which strategies should governments adopt? Clearly, the scenarios to which they need to immediately respond are the first three – baseline, supply shock and peak oil price). The long-term strategy is, however, to move to an energy secure scenario. In order to bring prices to a lower level, many conscious policies need to be pursued. While some such policies might be inherent to the first three scenarios, these by themselves will not be sufficient to engineer a lower oil intensity. In the early years under the energy security scenario, it is possible that prices get reduced due to a drop in absolute demand, meaning curtailment of consumption. But in later years, lower prices can be sustained without compromising demand

Table 6-4 Projections of prices of selected petroleum products in various scenarios, US$ per barrel

Year	Baseline	Supply Shock	Peak Oil Price	Energy Security
Gasoline				
2007	71	99	71	71
2009	71	108	84	67
2011	71	118	99	62
Naphtha				
2007	64	90	64	64
2009	64	98	76	60
2011	64	108	90	55
Kerosene				
2007	77	108	77	77
2009	77	118	91	72
2011	77	129	108	67
HSD				
2007	73	102	73	73
2009	73	111	86	68
2011	73	122	102	63
LPG/propane				
2007	159	214	159	159
2009	159	231	184	150
2011	159	250	214	141

growth only through conscious policies on efficiency and fuel substitution. Table 6-5 presents the ranking based on the significance of the strategies for each scenario from 1, the least important, to 5, the most important. Not surprisingly, when it comes to the supply shock, emergency preparedness jumps into first place. Along similar lines, the strategies are also ranked in terms of their relevance to the case study countries with 1 having the least relevance and 5 the most relevance (Table 6-6).

While these listings give an overall sense of priorities, these and the priorities for their component sub-strategies will depend very much on national circumstances and opportunities. Integrating the merit-based ranking of sub-strategies (Table 6-1), the priorities of these sub-strategies with respect to scenarios (Table 6-5) and their relevance to case study countries (Table 6-6) leads to the prioritized country-specific recommendations. The following sections therefore consider the policy recommendations for each of the four countries studied in depth: China, India, Indonesia and Lao PDR.

Table 6-5 Priority of strategies during each oil price scenario

	Managing oil price risk	Enhancing oil supply	Restraining oil demand	Fuel diversification	Emergency preparedness
Time frame	*Short-term, medium-term*	*Medium-term, long-term*	*Short-term, medium-term, long-term*	*Short-term, medium-term*	*Short-term, medium-term*
Baseline	5	2	4	1	3
Supply Shock	4	1	3	2	5
Peak Oil Price	5	1	4	3	2

Table 6-6 Relevance of strategies for each of the case study countries

Sub-strategy	China	India	Indonesia	Lao PDR
Pricing of petroleum products	4	5	3	3
Managing/ targeting oil subsidies	3	5	3	2
Financial tools	1	3	2	1
Strengthening oil exploration	5	3	5	N/A
Refining capacity to process sour crudes	5	3	5	N/A
Diversifying sources of oil	4	4	3	3
Barter	2	2	1	5
Improve public transport	5	5	5	5
Better land-use planning to reduce transport demand	3	2	3	3
Improve oil efficiency in transport	4	5	5	5
Improve oil efficiency in industry	2	2	4	N/A
Improve oil efficiency in agriculture	1	1	4	N/A
Biofuels in transport	3	4	3	1
Oil substitution in agriculture	2	3	3	4
Oil substitution in transport	2	1	2	N/A
Oil substitution in industry	2	1	2	N/A
Rationing	5	4	5	2
Strategic reserves	3	3	3	5

China

China has been somewhat shielded from higher oil prices by its strong economic performance and its access to alternative energy sources, notably coal. Because of its sheer economic power, China ranks as one of the least vulnerable countries on the OPVI. The other low-OPVI countries, Iran and Malaysia, cannot necessarily follow the same strategies, though they can gain some indications.

In the short run, China can further strengthen its petroleum pricing and distribution measures and subsidies

Baseline

China already has strong petroleum pricing and distribution measures that are backed by subsidies targeted to fishermen, farmers and state-owned forestry enterprises and that extend to oil refining companies. It has also imposed a special oil income levy on companies producing crude oil locally on prices over US$40 per barrel, and then used the revenue to subsidize vulnerable groups and other public welfare purposes. In the short run, China will benefit from strengthening these measures. It could then take steps to reduce demand through oil efficiency measures, particularly in the transport sector, as well as diversify to other fuels. To shield consumers during periods of oil price rise, in addition to targeted subsidies, it can also explore measures such as smart cards and cash transfers. Also, it can continue with plans for a strategic reserve. Over the medium-term, the focus would have to be on enhancing oil supply.

Supply Shock

In this case, the task will be to prepare for the emergency. The priorities will be to build on strategic reserves while establishing quotas for oil-consuming sectors. This scenario would also require a system of rationing, as well as cash grants to vulnerable groups. This could involve compensation for LPG usage, and the introduction of smart cards and vouchers for petroleum product consumption. This scenario would also require a continued emphasis on pricing and distribution policies, along with measures to improve efficiency in the transport sector, including the introduction of biofuels, while bearing in mind the implications for land use and the potential socioeconomic impacts. China could also expand its use of barter by exchanging its own commodities or export items directly for oil. In this direction, China has already established the Yangpu Oil Barter Exchange, reportedly the world's first for oil and gas.

Table 6-7 China – sequence of priority strategies in different oil price scenarios

Baseline	Supply Shock	Peak Oil Price
Pricing of petroleum products Managing/targeting oil subsidies Oil efficiency in transport Improve public transport Strategic reserves Strengthening oil exploration	Pricing of petroleum products Managing/targeting oil subsidies Oil efficiency in transport Improve public transport Strategic reserves Better land-use planning to reduce transport demand	Strategic reserves Pricing of petroleum products Rationing Managing/targeting oil subsidies Oil efficiency in transport Improve public transport
Refining capacity to process sour crudes Better land-use planning to reduce transport demand Rationing Financial tools Improve oil efficiency in industry Diversifying sources of oil	Financial tools Strengthening oil exploration Refining capacity to process sour crudes Rationing Improve oil efficiency in industry	Strengthening oil exploration Refining capacity to process sour crudes Better land-use planning to reduce transport demand Financial tools Improve oil efficiency in industry Oil substitution in transport
Improve oil efficiency in agriculture Oil substitution in transport Barter Biofuels in transport Oil substitution in agriculture Oil substitution in industry	Biofuels in transport Oil substitution in agriculture Diversifying sources of oil Improve oil efficiency in agriculture Oil substitution in industry Barter	Diversifying sources of oil Biofuels in transport Oil substitution in agriculture Improve oil efficiency in agriculture Oil substitution in industry Barter

High | Medium | Low

Peak Oil Price

This scenario allows time for structural adjustments, fuel substitution, technological improvement and greater energy efficiency. China has already been moving along this path, and is exploring technology options to enable fuel switching, such as coal for oil in fertilizer manufacturing. In the transport sector, the government is already considering ways to promote fuel efficiency and the use of alternative fuels, as with hydrogen for mass transit. Another existing programme valuable in this scenario would be ethanol blending with appropriate tax incentives. As a beginning, the government is making 10 percent ethanol blending mandatory in five provinces that account for 16 percent of the nation's passenger cars. China would also benefit from continued investments in foreign oil fields.

Along with the several initiatives underway in China, the government could also take a number of supporting measures. These include:

- *Tariffs and rebates* – Reduce import tariffs and export rebates to ensure a steady domestic supply of petroleum products and steady government earnings against sudden volatility in oil prices.
- *Diversify sources of supply* – Improve the climate for investment in the oil and gas sectors, while acquiring exploration and development rights in oil fields abroad.
- *Fuel efficiency* – Promote efficiency in the transport sector to curb increasing demand.
- *Alternative energy development* – Develop liquefied coal and nuclear energy programmes while removing barriers to the development of geothermal sources.

India

The recent oil price rises did not have a large macroeconomic impact in India, mainly because of the country's strong economic performance, large foreign exchange reserves and extensive use of coal. There were, however, micro-level impacts on the poor that can provide pointers to the necessary corrective measures. Table 6-8 shows those that would be appropriate to the various oil price scenarios. India belongs to the medium-OPVI group, so these measures could also provide guidelines appropriate for other countries in that group.

India's priority can be to move to a system of market-determined pricing of petroleum product

Table 6-8 India – sequence of priority strategies in different oil price scenarios

Baseline	Supply Shock	Peak Oil Price
Pricing of petroleum products Managing/targeting oil subsidies Improve public transport Oil efficiency in transport Financial tools Strategic reserves	Pricing of petroleum products Managing/targeting oil subsidies Improve public transport Oil efficiency in transport Financial tools Oil substitution in transport	Pricing of petroleum products Managing/targeting oil subsidies Strategic reserves Rationing Improve public transport Oil efficiency in transport
Rationing Better land-use planning to reduce transport demand Improve oil efficiency in industry Diversifying sources of oil Strengthening oil exploration Refining capacity to process sour crudes	Strategic reserves Better land-use planning to reduce transport demand Improve oil efficiency in industry Biofuels in transport Rationing Diversifying sources of oil	Financial tools Oil substitution in transport Better land-use planning to reduce transport demand Improve oil efficiency in industry Biofuels in transport Diversifying sources of oil
Oil substitution in transport Improve oil efficiency in agriculture Biofuels in transport Oil substitution in agriculture Oil substitution in industry Barter	Improve oil efficiency in agriculture Strengthening oil exploration Refining capacity to process sour crudes Oil substitution in agriculture Oil substitution in industry Barter	Strengthening oil exploration Refining capacity to process sour crudes Improve oil efficiency in agriculture Oil substitution in agriculture Barter Oil substitution in industry

High (first row group) | Medium (second row group) | Low (third row group)

Baseline

In this scenario, the priorities would be to manage oil price risk while preparing for possible oil price spikes. For managing oil price risk, India would need to rationalize pricing strategies and use targeted subsidies, perhaps supplementing these with hedging instruments and establishing an oil price stabilization fund. For dealing with sudden oil price spikes, it could stockpile oil reserves. The next priority for India would be to restrain demand by improving the public transport system and using oil more efficiently.

The transport sector accounts for 100 percent of gasoline consumption and about 65 percent of diesel consumption, and such initiatives could result in significant positive outcomes.

Supply Shock

Even in this scenario, the priority strategies would be to rationalize pricing, transmitting high prices and targeted subsidies from the international to the domestic market as a way of curbing demand. During international oil price negotiations, the government, as it has suggested, could attempt to manage crude oil prices by allowing prices to float within an agreed price band. Overall, the ranking of strategies is similar to that for the baseline. The only exception is a higher priority for fuel diversification, which is already happening to some extent, since urban pollution is forcing a shift to compressed natural gas and liquefied petroleum gas for public vehicles. The government could also strengthen its ethanol-blended gasoline programme. The 5 percent ethanol blending is an ongoing programme; however, there are plans, depending on ethanol availability, to raise this requirement to 10 percent, and then 20 percent blending. Other measures would include stockpiling reserves and rationing.

Peak Oil Price

As for the supply shock scenario, in the peak oil price scenario, the priorities will be to reduce oil demand, while also aiming to reduce the fiscal and financial burden imposed by high oil prices. Along with oil price risk management strategies, it will also be vital to prepare for emergencies. Curtailing the demand and managing the price levels would have to be supported by building up strategic reserves and using rationing to stimulate greater efficiency in distribution. Since the peak oil price scenario implies long-term and irreversible changes, the aim should be to reduce demand by improving efficiency in the use of oil and substituting it with other fuels, including biofuels, particularly in public transport by using hybrid-fuel vehicles.

In general, the Government of India could take the following measures to meet the growing energy demand:

- *Pricing* – Move to a system of market-determined pricing of petroleum products.
- *Import pricing* – The Import Parity Pricing formula must be revisited to ensure that the Indian refining industry enjoys a margin that is rational and fair to producers and consumers.
- *Excise duties* – Duties should be based on a sliding scale that would fulfil the following objectives: ensure revenue earnings for the government in a period of rapid changes in international prices; safeguard consumers from the multiplying effect of an ad valorem duty; make the government responses to international oil prices more transparent.
- *Liquid petroleum gas* – Since international prices of LPG are cheaper than those of kerosene, the production of kerosene could be phased out. For this purpose the government can emphasize the health benefits of LPG in the form of reduced indoor pollution, while directly subsidizing LPG for certain classes of consumers. It could, for example, introduce LPG debit cards jointly with financial institutions and oil companies.
- *Solar lighting* – Since most kerosene in India is used for low-quality lighting, the government could provide highly subsidized solar lanterns to all unelectrified households – and at a fraction of the cost of the kerosene subsidy.
- *Energy efficiency* – India's government can promote energy efficiency measures across all sectors. This could include fiscal incentives for fuel-efficient vehicles, the use of biofuels for public transport and greater use of rail for freight movement.

Indonesia

Indonesia can reduce oil dependence while promoting cleaner oil-based fuels such as LPG

Indonesia has traditionally been an oil-rich country and has only recently become a net oil importer. It exhibits all the features of a developing economy, including high dependence on traditional fuels. The overall aim should be to reduce oil dependence while promoting cleaner oil-based fuels such as LPG. Table 6-9 outlines priority measures for different oil price scenarios.

Baseline

In this scenario, the focus should be on reducing oil demand for transport. This should include disincentives for the use of personal transport, for example, through progressive taxation for family cars, with higher rates for second and third vehicles. The government should continue with its efforts to encourage carpooling and car sharing and improve the quality and quantity of public transport. Fiscal measures could include removing gasoline and diesel subsidies, except for public transport, while imposing taxes on fuels for personal transport and using that revenue to invest in public transport. At the same time, Indonesia could make better use of its oil reserves by improving the climate for investment in the oil and gas sectors and offering incentives for the development and implementation of improved oil recovery technologies and for extraction from marginal fields.

Supply Shock

This would require emergency preparedness, building strategic reserves and reducing oil demand through rationing and for other regulations. This will have to be accompanied by the selective use of financial instruments to tide the country over during short-term oil price volatility. Given that the urban poor have few alternatives to oil products such as kerosene and LPG, the government would also need to introduce a system of rationing to secure supplies, particularly for cooking.

At the same time, Indonesia could also make better use of coal, improving the infrastructure and investing in research and development in clean coal technology. Small industries and parts of the service sector could replace diesel and kerosene with coal briquettes.

Peak Oil Price

This scenario should prompt faster exploration of alternatives to oil. Public transport, for example, could make greater use of electricity and, in particular, natural gas, which would entail constructing pipelines to transmit gas from the fields to the cities. This would also improve access to natural gas for households. These measures would have to go hand-in-hand with those for oil conservation, as outlined for the baseline scenario. Faced with dwindling oil resources, the country could also invest more in the development of biofuels. Existing diesel-based decentralized electricity generation in remote locations in particular would benefit from a switch to biofuels. The peak oil price would also allow time for the development of the country's geothermal potential. Although a geothermal law has been

Table 6-9 Indonesia – sequence of priority strategies in different oil price scenarios

Baseline	Supply Shock	Peak Oil Price
Improve public transport	Improve public transport	Strategic reserves
Pricing of petroleum products	Pricing of petroleum products	Rationing
Managing / targeting oil subsidies	Managing / targeting oil subsidies	Improve public transport
Oil efficiency in transport	Oil efficiency in transport	Pricing of petroleum products
Strategic reserves	Improve oil efficiency in industry	Managing / targeting oil subsidies
Improve oil efficiency in industry	Financial tools	Oil efficiency in transport
Financial tools	Improve oil efficiency in agriculture	Improve oil efficiency in industry
Improve oil efficiency in agriculture	Strategic reserves	Financial tools
Strengthening oil exploration	Better land-use planning to reduce transport demand	Improve oil efficiency in agriculture
Refining capacity to process sour crudes	Strengthening oil exploration	Strengthening oil exploration
Better land-use planning to reduce transport demand	Refining capacity to process sour crudes	Refining capacity to process sour crudes
Rationing	Biofuels in transport	Better land-use planning to reduce transport demand
Diversifying sources of oil	Rationing	Biofuels in transport
Biofuels in transport	Oil substitution in transport	Oil substitution in transport
Oil substitution in transport	Oil substitution in agriculture	Oil substitution in agriculture
Oil substitution in agriculture	Oil substitution in industry	Diversifying sources of oil
Oil substitution in industry	Diversifying sources of oil	Oil substitution in industry
Barter	Barter	Barter

High | Medium | Low

passed, there are several regulatory problems, especially taxation, that some investors consider a barrier.

Irrespective of trends in oil prices, Indonesia would benefit from addressing:

- *Subsidies* – Design and implement targeted subsidy schemes for LPG or piped gas, particularly for poor urban households.
- *Transport* – Improve oil efficiency through the design and promotion of public transport systems based on gas or electricity.
- *Coal* – Invest in improvements in the utilization of coal.
- *Renewables* – Promote renewable sources of energy such as geothermal, solar, micro-hydro and wind.

Energy strategies for Lao PDR require long-term perspectives, emphasizing biofuels, alternative energy for transport, and biomass

Lao PDR

As a low-income country with a relatively low penetration of modern energy, Lao PDR is in a unique position to frame its energy policy to maximize its people's long-term welfare. In general, Lao PDR prices its petroleum products so as to closely track international oil price trends, but also uses temporary tax and duty exemptions to cushion the populace from the impact of rising oil prices. The country may also consider adopting targeted subsidies for vulnerable sections, for the poor in remote rural areas and for mass transportation companies. The recommended priority policy options across the oil price scenarios are indicated in Table 6-10. Lao PDR is a high-OPVI country, so its strategies need to have long-term perspectives. The strategies under all the scenarios thus focus on restraining oil demand.

Baseline

The challenges are likely to come from sudden oil price spikes. This calls for emergency preparedness, for which the only available strategy is rationing. Lacking its own refining capacity, Lao PDR cannot consider stockpiling oil reserves to tide the country over during spike periods. The long-term aim should be to reduce oil demand by improving efficiency in public sector transport and other transport. Lao PDR will also need to speed up its development of indigenous sources of energy, particularly hydropower, and other renewable sources of energy.

Supply Shock

Since Lao PDR uses petroleum products primarily for transportation, in this scenario it will need to enforce measures for fuel efficiency and conservation. This could include restrictions on use of motorized transport while enhancing the provision of public transport. These options could be supported with fiscal and regulatory measures such as high road taxes and parking charges for privately owned vehicles. Incentives should also be provided for the use of biodiesel and electric-powered vehicles, particularly using jatropha oil, of which the country plans to produce 6 million litres annually by 2010. Also, the Ministry of Energy and Mines proposes to build two sugar factories to produce 80,000 tonnes of bioethanol annually by 2010.

For a least developed country it is difficult and expensive to implement technological improvements. However, since Lao PDR imports automobile parts for domestic assembly, or automobiles in their entirety, it can restrain the rate of growth in oil demand by setting stringent fuel efficiency criteria on imports.

Peak Oil Price

As with the other scenarios, the list of priorities is topped by measures to restrain demand, improve efficiency and promote public transport. This would need to be accompanied by appropriate pricing strategies and rationing measures to streamline the demand for petroleum products. For fuel diversification, Lao PDR has already initiated a programme on biofuels, which could become one of the prioritized strategies.

For power generation it can also use wood chips and rice husks as localized energy sources as well as coal. Hydropower is particularly important, since this can not only help fulfil the country's requirements for power generation, but also, through exports to neighbouring countries, produce revenue that can be earmarked to finance oil imports. To achieve this, however, Lao PDR would need to collaborate closely with the more advanced nations as well as multilateral aid and funding agencies, which should be able to offer support to vulnerable communities in remote areas.

To prevent poor households from switching back to solid fuels, the government could consider providing targeted subsidies for modern fuels as well as cash compensation schemes for the very poor. Poor households that still have to switch back could, however, be supplied with improved cooking stoves and smoke hoods.

Other policy options could include the issuing of smart cards and vouchers for petroleum product consumption, as well as engaging in barter for oil

Table 6-10 Lao PDR – sequence of priority strategies in different oil price scenarios

Baseline	Supply Shock	Peak Oil Price
Improve public transport Pricing of petroleum products Oil efficiency in transport Rationing Managing/targeting oil subsidies Better land-use planning to reduce transport demand	Improve public transport Pricing of petroleum products Oil efficiency in transport Managing/targeting oil subsidies Rationing Better land-use planning to reduce transport demand	Rationing Improve public transport Pricing of petroleum products Oil efficiency in transport Strategic reserves Managing/targeting oil subsidies
Financial tools Barter Strategic reserves Biofuels in transport Diversifying sources of oil Improve oil efficiency in industry	Biofuels in transport Financial tools Barter Strategic reserves Improve oil efficiency in industry Oil substitution in transport	Better land-use planning to reduce transport demand Biofuels in transport Financial tools Barter Diversifying sources of oil Improve oil efficiency in industry
Improve oil efficiency in agriculture Strengthening oil exploration Refining capacity to process sour crudes Oil substitution in transport Oil substitution in agriculture Oil substitution in industry	Diversifying sources of oil Improve oil efficiency in agriculture Oil substitution in agriculture Oil substitution in industry Strengthening oil exploration Refining capacity to process sour crudes	Oil substitution in transport Improve oil efficiency in agriculture Oil substitution in agriculture Strengthening oil exploration Refining capacity to process sour crudes Oil substitution in industry

High | Medium | Low

in exchange for indigenous resources, such as minerals, and forest-based products like medicinal herbs. Barter trade can be a viable option for Lao PDR, since the country is extremely rich in mineral endowments, such as bauxite, copper and gold. It would also be desirable to develop coal deposits for industrial purposes.

In general, Lao PDR will benefit from an emphasis on:

- *Biofuels* – Develop liquid biofuels to substitute oil in the transport sector, bearing in mind possible adverse affects.
- *Transport* – Adopt alternative electricity- and biofuel-based systems, particularly for public transport.
- *Power* – Generate power from alternative sources, including hydro and biofuels.
- *Biomass* – Explore biomass gasification options for use in industrial applications.

Recommendations for other countries, based on their OPVI scores

The recommendations made for the four focus countries could also be extended to other countries in the region, with similar OPVI scores. Each country's policies, however, will need to be matched to its own energy and economic situations. Therefore, the proposals suggested for the four countries should only be considered broad pathways that will require further fine tuning at the national level.

All countries will benefit from measures to cut oil demand and should review oil price policies to prevent subsidy leaks to the non-poor

As indicated in Chapter 3, most countries in the region have been classified for OPVI into the low,

Table 6-11 Categorization of countries based on the OPVI

Low OPVI	China, Iran, Malaysia
Medium OPVI	Bhutan, India, Indonesia, Mongolia, Myanmar, Papua New Guinea, Thailand, Viet Nam
High OPVI	Afghanistan, Bangladesh, Cambodia, Fiji, Lao PDR, Maldives, Nepal, Pakistan, Philippines, Samoa, Solomon Islands, Sri Lanka, Vanuatu

Strategies to safeguard the poor from high oil prices must encompass transport, agriculture, health, education and infrastructure

medium or high categories (Table 6-11). Countries in the low-OPVI category could thus consider the strategies suggested for China, those in the medium category that of India and Indonesia, and those in the high category that of Lao PDR. Much will depend, however, on the source of vulnerability; those for which it derives from overdependence on oil rather than from economic fragility will need to concentrate more on fuel diversification.

All countries would, however, benefit from measures to cut oil demand and should review their oil price policies to prevent subsidies from leaking to the non-poor. In addition, in the supply shock and peak oil price scenarios, they would of course need to prepare for emergencies. China is a special country, and no country, even if it is categorized as a low-OPVI country, can simply pursue the same strategies as China. The prioritized sub-strategies for China can at best serve as guidelines for other countries in the group, such as Iran and Malaysia. However, sub-strategies under fuel diversification and restraining demand are universally applicable.

This may not be the case with countries like India and Indonesia, which are classified as medium OPVI, nor Lao PDR, which is classified as high OPVI. In terms of the need for variety of solutions, countries like India and Indonesia are comparable to Thailand and Viet Nam. Both these countries can follow India and Indonesia in prioritizing their strategies.

The ranking of sub-strategies for Lao PDR could form the basis for many other countries in the high-OPVI group. Countries like Bangladesh, Nepal and Cambodia can adopt the prioritization suggested for Lao PDR without much modification. Each is endowed with one or the other energy resources; for example, Nepal with hydro, Bangladesh with natural gas and Cambodia with crude oil and natural gas resources. All these countries should, like Lao PDR, give a high priority to sub-strategies like improving public transport, increasing energy efficiency and pricing petroleum products more effectively. All these countries should have effective mechanisms for implementing targeted subsidies and rationing in order to shield the poor from the impact of steep price rises.

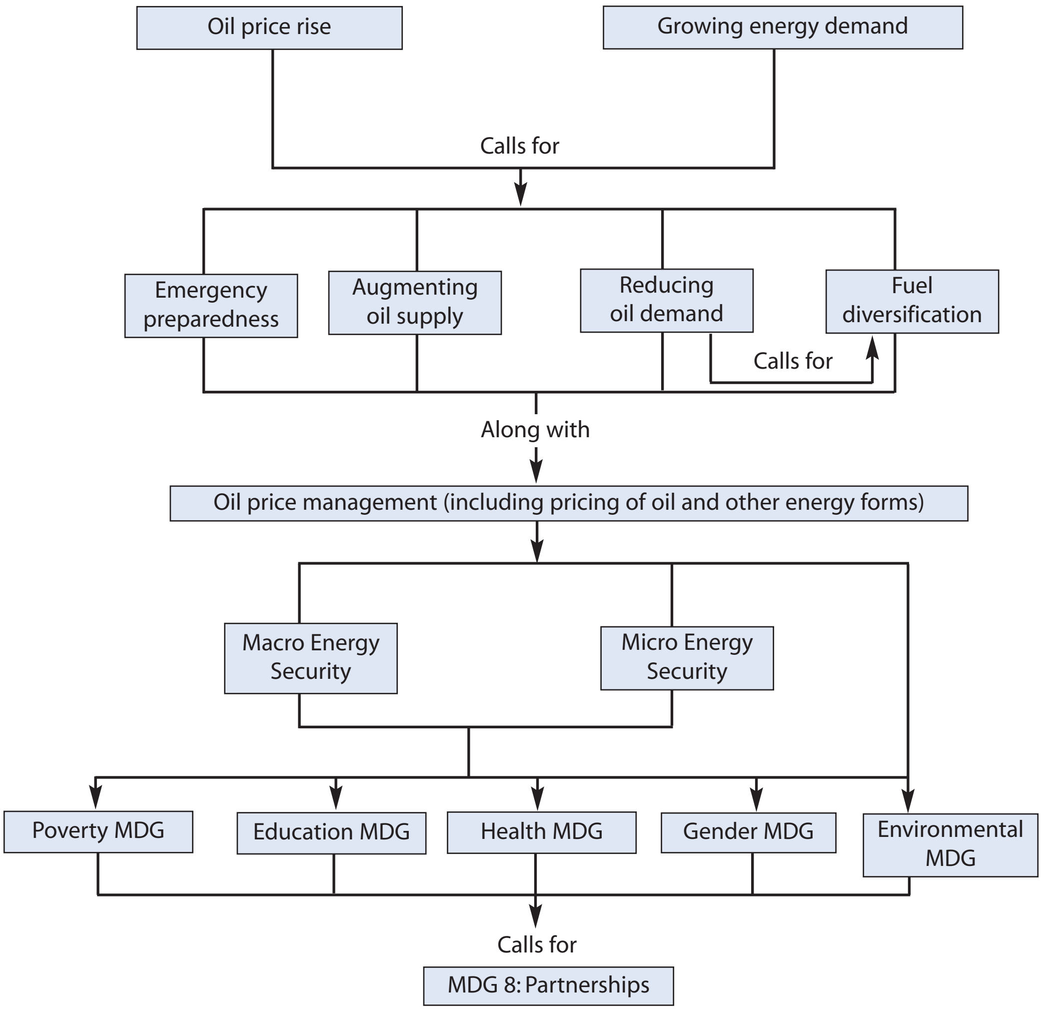
Safeguarding the interests of the poor

As highlighted in earlier chapters, rising oil prices have had a serious impact on the poor, causing some rural households to revert either completely or partially to biomass fuels, and in the case of China, from LPG to coal. The urban poor, however, do not generally have the option to switch to biomass so are likely to face increasing energy poverty. In addition, higher transport costs may reduce access to essential services such as health and education, and in some cases farmers will face higher prices for fertilizers. Some of the overall strategies to safeguard the poor are summarized by sector in Table 6-12. The ways in which these and other strategies fit together for

Table 6-12 Sectoral strategies to safeguard the poor from higher oil prices

Sectors	Strategies
Transport	• Subsidize and enhance the services of public transport forms. • Better facility planning in urban areas to reduce transport demand.
Agriculture	• Subsidize electricity for irrigation purposes to low-income consumers so that dependence on oil for running pump-sets reduces. • Strategically develop the infrastructure for markets/cooperatives so that farmers do not have to travel long distances to sell their agricultural produce. • Promote transport pooling among farmers to reduce their transportation costs to nearby nodal centres.
Households	• Target LPG subsidies at low-income consumers. • Reduce/remove subsidies on kerosene, subject to availability of alternative fuels. • Provide cash transfers for specific purposes, like primary education (e.g., Indonesia) to cushion the impact of rising oil prices. • Promote the use of renewable energy-based lanterns and cooking devices, improved biomass cookstoves and community-based biomass gasifiers for electricity generation.
Social sector (health, education, infrastructure)	• Improve provisions for health care, education and service facilities in both rural and peri-urban areas to reduce travel costs. • Better roads to reduce travel costs through lower energy consumption. • Make adequate provisions for basic infrastructure services like water and sanitation, electricity etc., to improve the standard of living of the poor and make them less vulnerable to the impacts of increasing oil prices.

Figure 6-3 Connecting oil price policy measures with the Millennium Development Goals



supporting the Millennium Development Goals are illustrated in Figure 6-3.

Cooking fuels

For cooking fuels the poor can be supported in a number of ways. One is to increase their access to wood resources through sustainable management, and the second is to improve their fuelwood stoves as well as solar or biogas-powered cookers. The third would be to enable them in the short term to make more use of other petroleum products, especially LPG and in some cases piped natural gas, which would be of particular benefit to women who are burning biomass fuels in traditional stoves in poorly ventilated kitchens.

Subsidies

Subsidies can be offered through a number of mechanisms. These include cash transfers to eligible beneficiaries through coupons or bank transfers or through smart debit cards. Each of these options has its strengths and weaknesses. A coupon system requires the entitlements to be well defined and needs a sound administrative system not vulnerable to fraud. Bank transfers are neat in theory but logistically complex when there are large numbers of accounts to be serviced, and can also be expensive for the beneficiary in transaction costs.

The aim of subsidy programmes should be to provide poor households with clean energy options

Smart cards are an attractive option in some cases, since as well as aiding disbursement, they can also maintain a data bank on the beneficiaries, their consumption patterns and transaction histories. But they are only practical for countries that have the technological capacity. Those such as India that already have some e-governance structures and institutions may be in a position to consider smart cards, but other countries may have to rely on cash transfers.

The aim of subsidy programmes should be to provide poor households with clean energy options. This means that they should be used, for example, to promote LPG rather than kerosene as an alternative to traditional fuels. However, all subsidy programmes have to guard against the danger that black marketers will corner supplies – which will require legislative reforms and the strengthening of institutional capacities for monitoring and enforcement.

Transport

Some compensation for rising transport costs could be provided through smart cards or other mechanisms to provide poor households with access to public transport at subsidized rates. However, other solutions lie outside the energy sector and include moving services and workplaces closer to communities or, as has happened in China, resettling communities closer to services. Journey times, and thus costs, could also be cut, resulting from better rural road infrastructure coupled with improved systems of public transport.

Liquid biofuels

International actions should focus on supporting alliances, pro-poor policies, research and producer-consumer dialogues

Liquid biofuels, bioethanol and biodiesel, are particularly relevant for emerging Asia, which by 2050 is expected to witness a fivefold increase in the use of fuels for transport. Biofuels can bring clear benefits in terms of improved energy security as well as opportunities for boosting rural agricultural production and employment. Strategically used, they can also contribute to a modest reduction in the growth in greenhouse gas emissions from road transport.

Biofuels can be very useful for remote mountainous and island communities, providing them with greater energy security and lower fuel costs for boats, mini-trucks and agricultural equipment, while also serving as routes for disposal of waste products. But there are caveats. They may initially be more expensive to the end user than petroleum-based fuels, though are expected to become cheaper over time. Moreover, diverting land to the production of crops for biofuels may also cut food production and drive up food costs. There are also environmental implications from the conversion of tropical forests to palm-oil monocrops.

Some of the fuel-food tradeoffs can be averted, by combining food and energy production, for example, or growing energy crops only on more marginal lands, and by intensifying research to improve crop productivity. But overall, it is clear that while liquid biofuels hold significant promise, they should be developed with caution.

Income generation

Some interventions, such as the introduction of decentralized renewable energy systems, can also help the poor by providing them with new sources of energy for productive activities, particularly in communities in rural areas that have high population densities. UNDP's Rural Energy Development Programme in Nepal offers a good example of how a focused initiative centred around the use of small-scale renewable energy technologies can contribute to poverty reduction while, at the same time, help to reduce the impacts of the oil price rises. Biomass-based systems, in particular, offer huge potential to diversify agricultural and forestry activities, improve food security and reduce poverty. Many Asian countries, such as India and Viet Nam, are converting bagasse into process heat and electricity and in some cases supplying electricity to the grid. Solid biofuels and biogas also have tremendous potential for income generation.

Recommendations for international action

In pursuing the recommendations, countries in the region should also be able to rely on support from bilateral and multilateral development agencies, whose efforts could be focused on the following areas:

Alliances – Helping countries develop strategic alliances to identify new sources of oil as well as to develop alternatives to oil.

Institutional frameworks – Helping countries develop institutional frameworks at the local, national and regional levels to promote integrated approaches to the energy sector.

Pro-poor policies – Helping countries integrate pro-poor policies in the energy sector with policies in other sectors – such as road, transport and communication infrastructure, health and education services, water supply, agriculture and forestry, and small- and micro-enterprise development.

Indicators – Frame and encourage the use of development indicators relevant to energy security at both national and household levels so as to measure the impacts of oil prices on income and on human poverty.

Mechanisms – Help governments to establish some of the necessary mechanisms, such as oil price stabilization funds, innovative compensation and subsidy schemes, and microcredit facilities to assist the poor in acquiring more energy-efficient technologies and appliances.

Research – Facilitate research into comparative assessments of alternatives to oil, especially biofuels, clean-coal technologies, renewable energy technologies and nuclear power, as well as on techniques to enhance the recovery of oil and find new sources of oil.

Finance – Develop financing options under existing schemes, such as the CDM, to provide a fillip to the development of bioenergy and other mechanisms, such as a compensatory finance facility, outlined in the next section, to assist least developed and low-income countries.

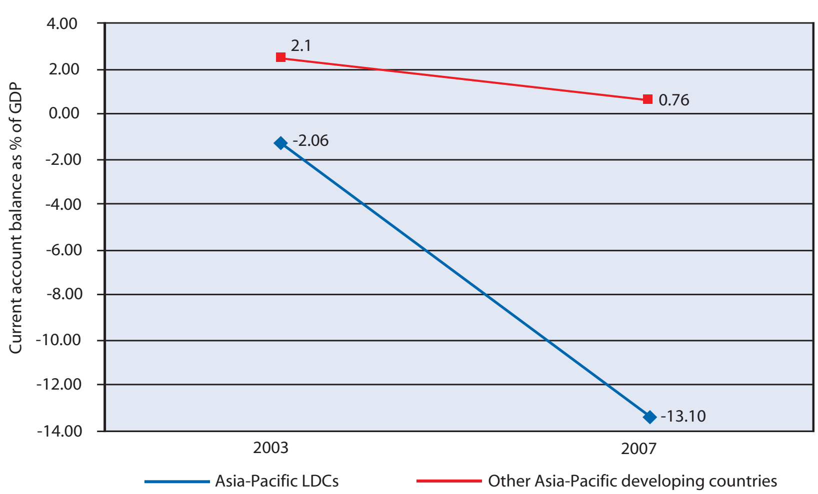
Producer-consumer dialogues – Enable producer-consumer dialogues towards moderating oil prices. The Indian government has, for example, suggested the concept of a price band negotiated between cartels of oil exporters and importers. The idea would be to allow the free play of market forces within a negotiated price band outside of which either exporters or importers, or both, would suffer beyond their desired levels of tolerance.

Proposal for a regional compensatory oil finance facility

A key finding of this report is that high oil prices will affect the least developed countries and low income countries (LDCs and LICs) of the region the most. These countries have modest economic growth, high indebtedness, low foreign reserves and balance of payments at the margin. If oil prices remain high or rise further, these countries will struggle to finance their growing oil import bills. Prolonged liquidity problems will force many countries to resort to external borrowings, the rise in debt and debt service costs squeezing their capacity to invest in critical economic, social and infrastructural development. All this, in turn, can only worsen the plight of their poor and critically undermine their prospects for achieving the MDGs.

The high financial vulnerability of Asia-Pacific LDCs is evidenced by a more than six-fold worsening of their average current account deficits from -2 percent in 2003, the beginning of the oil price rise, to -13 percent in 2007 (Figure 6-4). In comparison, the current account

Figure 6-4 Average current account balances of Asia-Pacific developing countries, 2003-2007



Source: IMF 2007

Even if oil prices come down in the short-term, there is no assurance that a new uptrend will not occur

surpluses of other developing countries in the region declined at only half the rate. Between 2003 and 2006, current account deficits worsened in eight of the twelve LDCs, with the Pacific Island Countries (Kiribati and Solomon Islands in particular), Maldives and Lao PDR the worst affected.

The prospect of persistent oil price highs, and the continued financial woes of poorer countries, is heightened by global economic imbalances caused by a massive US current account deficit running in excess of US$800 billion annually, and the corresponding surpluses and build-up of foreign reserves among oil exporters and emerging Asian economies. Oil plays a crucial role in these imbalances due to the US dollar's twin status as a denominator of oil prices (the petrodollar) and as the global reserve currency in which most economic transactions among countries take place. An abrupt fall in oil prices can have the effect of undermining global demand for the dollar and lead to its precipitous fall, provoking an upheaval in the global financial system, the so-called 'disorderly adjustment.' There are thus factors at play in favour of high oil prices to help prevent such a development.

A regional Compensatory Oil Finance Facility can assist least developed and low-income countries

Poorer countries of the region are besieged by these mega-trends outside of their control. Assisting them to cope with a high oil price future is a collective imperative for the international community since these countries are forced to bear the consequences of the actions of developed and fast developing countries. This invokes the notion of 'compensation', whereby those who benefit from high oil prices (oil exporters) or bear substantial responsibility for them (large importers with the ability to pay) help those who are disadvantaged by the phenomenon. The rationale for a financing mechanism to facilitate this consists of the following factors:

- The present oil price rise has lasted for an extraordinary length of time, with little indication of subsiding in the foreseeable future. It can well stabilize at an unsustainable level or rise even more.
- Even if oil prices come down in the short-term, there is no assurance that a new uptrend will not occur subsequently. The uncertainties and attendant financial risks for oil-importing LDCs and LICs are, therefore, high.
- Poorer countries of the region are already suffering from high oil prices. The financial impacts on them are acquiring a non-temporary characteristic, with potentially deeper structural implications, which is a matter of serious concern.
- Without focused external assistance, these countries will find their economic and social development prospects dimming further in an era of protracted high oil prices. Their progress toward the MDGs will be retarded as long-term development investment capacity shrinks in the face of current financial shortfalls.
- The economic, social and political repercussions of maldevelopment in poorer countries can spill over national boundaries in unpredictable ways. It is essential to minimize the chances of this happening.

Several financing facilities aimed at external shocks, such as an oil price shock, have been set up over the years by the IMF and the European Union (EU). The IMF's Compensatory Financing Facility (CFF) and the EU's grant funds (STABEX, SYSMIN and FLEX) have assisted developing countries in dealing with trade-related shocks, but their primary focus has been on abrupt falls in the prices of commodities exported by developing countries. The CFF, which was most relevant to an oil price shock, has fallen into disuse. Other international facilities belonging to IMF and the World Bank that can potentially offer relief against the present oil price shock include the Poverty Reduction and Growth Facility (PRGF), the Exogenous Shock Facility (ESF), the Heavily Indebted Poor Countries (HIPC) Initiative and the Multilateral Debt Relief Initiative (MDRI). None of these facilities, however, wholly or substantially matches the financing needs of Asia-Pacific LDCs and LICs under the present climate of protracted high oil prices. Their main drawbacks are:

- The lack of an explicit focus on oil price shocks, which limits the volume of financing available against an oil price shock.
- Unavailability of assistance, with both immediate liquidity problems and financing for longer-term structural changes essential against the present protracted oil price shock.
- Stringent eligibility criteria, preventing many LDCs and LICs from accessing available financing.
- Insufficient duration of assistance against the present oil price shock, of which impacts could spread over five years or more.

- Complex conditions that undermine timeliness of financing add to delays and uncertainties in disbursement, and can generate new social and political problems.

- Preference to loans, which could worsen the indebtedness of countries already heavily in debt.

- Insufficient funds against potential needs of affected countries – for instance, against the estimated US$60 billion required by oil-importing developing countries, the ESF plans to raise only US$2.9 billion in total funds until 2009 and a maximum of US$11.5 billion (PREM 2005).

It is, therefore proposed that an Asia-Pacific Compensatory Oil Finance Facility (AP-COIL) be developed to assist regional LDCs and LICs by way of (a) enhancing their liquidity to overcome balance of payments and fiscal deficits, and (b) financing essential structural changes in their energy economies to reduce their dependence on oil. The underlying intent is to guide them towards a low oil-intensive future through technological innovation and the expanded use of alternatives to oil, such that their long-term development prospects are built on a more sustainable energy base. The intent is not to advocate that they abstain from oil, but rather to help them limit consumption to those activities for which there are no viable alternatives at present. The guiding principles of the facility and ways to operationalize them may be the following:

Assistance provided to qualifying LDCs primarily in the form of grants and, for LICs, a blend of grants and highly concessional loans.

- All LDCs and LICs experiencing a significant worsening of balance of payments deficit in a climate of high oil prices and agreeing to implement measures to reduce oil intensity to be considered eligible for assistance

- Grants to heavily indebted LDCs with a foreign debt of more than 80 percent of their GNI or a debt service outflow of more than[1] 10 percent of their annual government revenue

- Blend of grants and zero-percent-interest loans to other LDCs

- Low-interest loans (0.25 to 0.50 percent[2]) to LICs, with grants to finance or lower costs of investments to reduce oil intensity

- Deferred loan repayments beginning five years after disbursement, with repayment volumes and durations set initially subject to annual reviews and adjustment

Adequate assistance to ensure financial liquidity of affected governments over the estimated duration of a shock's impacts, with provisions to assess the persistence of impacts without a prior ceiling on duration.

- Volume of assistance not less than the amount of increase in a country's balance of payments deficit from base year of a shock

- Assistance to include cost of servicing additional debt incurred to meet such deficits

- Assistance provided for structural changes to reduce oil intensity determined by a time-bound oil intensity reduction target

Funds for AP-COIL could be mobilized through bonds issued in regional and international capital markets

An automatic mechanism established to measure and determine the occurrence of a shock to minimize subjectivity, establishing eligibility to receive assistance.

- Occurrence of an oil price shock linked to price bands or percentage increases over a previous period of 12 months

- Countries experiencing a worsening of current account deficit by 15 percent a year for two successive years are automatically eligible

- Eligibility for continued financial assistance for more than three years depending on a country's progress with oil intensity-reducing measures

Oil intensity targets determined mutually between the facility and concerned governments based on clear criteria.

- Current per capita oil consumption

- Ratio of national oil consumption to GDP in base year (base year oil intensity)

- Country-specific trajectories of future per capita oil consumption and oil intensity of GDP, allowing for initial increases in oil consumption among poor and low-income populations with very low levels of such consumption

- Annual targets of per capita oil consumption and oil intensity of GDP, in conjunction with parallel targets for per capita energy

- consumption and overall energy intensity of GDP – to ensure oil intensity targets are met while allowing rise in aggregate energy consumption to sustain healthy economic growth, social infrastructure development and poverty reduction

A set of financial incentives and disincentives built into funding arrangements for a country's progress against the agreed targeted oil intensity.

- Additional grants and reduction/waiver of loan interest to countries exceeding oil intensity targets

- Reduced grants and increased loan interest to countries failing to achieve annual oil intensity targets by a margin of more than 25 percent for three successive years

Special considerations to minimize adverse impacts on poor and low-income populations.

US$100 per barrel of oil no longer seems out of the question

- Earmarked funds for measures to enhance the poor's energy access, including access to oil products

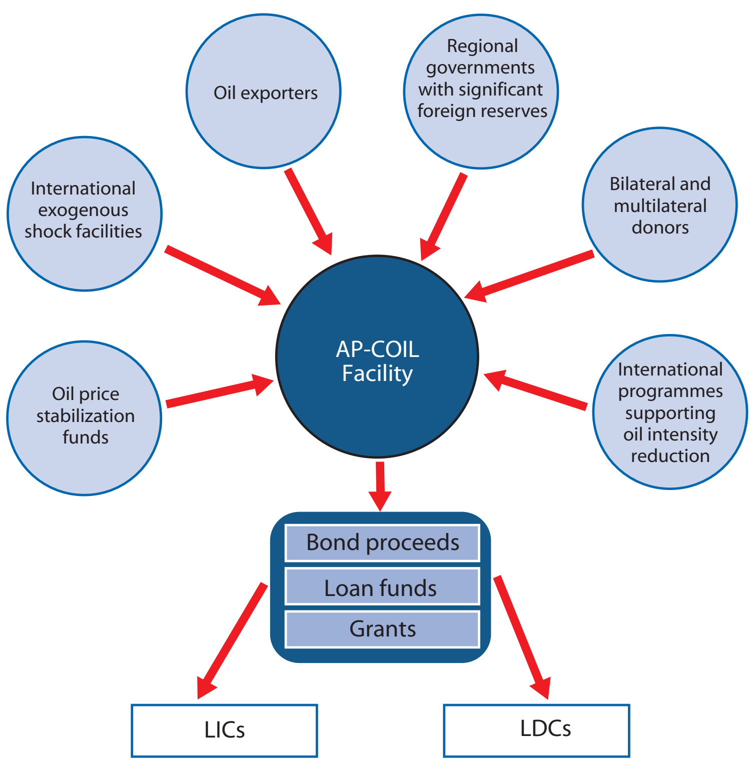
- Option to disburse earmarked funds to local authorities, NGOs and poor communities in specific situations

- Annual assessment of progress in programmes/projects supported by earmarked funds

Potential funding sources for the facility could include existing international financing mechanisms; the OPEC Fund for International Development; international bilateral and multilateral donors; regional countries with substantial foreign exchange reserves; international and regional funds/programmes for energy efficiency, renewable energy, climate change and poverty reduction; national oil price stabilization funds within the region; and regional and international capital markets.

The bulk of the funds could be mobilized through bonds issued in regional and international capital markets. The bonds may be backed by the pledges of donor countries and regional governments with significant foreign reserves. They could also be guaranteed against their IMF Special Drawing Rights (SDRs). Given the volatility in currency markets, the possibility of denominating the bonds in the proposed Asian Currency Unit (ACU) of the Asian Development Bank may be examined. This can reduce exchange rate risk and take advantage of the growing strength of regional currencies. Figure 6-5 illustrates the structure of the proposed facility.

Figure 6-5 Structure of the proposed Asia-Pacific Compensatory Oil Finance (AP-COIL) Facility



Where do we go from here?

Along with the rest of the world, developing countries of the Asia-Pacific region face an uncertain oil future. While no one can predict with confidence how oil prices will move in the coming years, most signs seem to point upward. The situation is confounded by the extreme volatility in price movements. After surging to a record US$77 per barrel in July 2006, the price of crude plummeted close to US$50 per barrel in January 2007, only to take off again in the next eight months and enter uncharted territory, beyond US$80 per barrel in September 2007. A price of US$100 per barrel no longer seems out of the question. Even if prices subside, against the odds, toward their 2002 level of around US$22 per barrel, they might have a very short stay there.

Developing countries of the region need to come to terms with the possibility that oil prices may have entered an irreversible trend, as opposed to the short, cyclical spikes of the past. The reasons for this, as set out in this report, are varied. But in the final analysis, they converge on a single point, which is that the world's finite oil resources will one day or another be exhausted, and that day might arrive sooner rather than later. The real question is: Where do we go from here?

After five long years of high oil prices, developing countries of the region have reached a fork in their energy development road. On the one hand, most have been able to withstand the shock of the oil price rise without suffering permanent damage to their economies. GDP growth rates have not declined seriously, inflation remains manageable and other macroeconomic indicators are not yet flashing red. The main impact has been on their poor, but this may not be an insurmountable problem, because the amount of oil products consumed by them is a small part of the big picture. So long as countries have their own oil resources, or have other goods and services that they can trade in return for oil, there may be no need to panic. Economies may continue to expand and, as a part of the process, poverty may continue to decline and eventually be eradicated.

On the other hand, poorer countries of the region have not fared so well. High oil prices have translated into worsening trade deficits, declining liquidity and growing debt. The prices of alternatives to oil like gas, coal, electricity and even biomass, the fuel of last resort, have been pulled higher by rising oil prices, creating broader pressure on their economies. In a number of countries like Bangladesh, Myanmar and Nepal, people are finding the costs of food and essential commodities and services going up as well. What is happening to the economies of the poorer countries may well be a portent of what can happen to those of other developing countries, regardless of their current resilience. Not all countries in the bottom half of the OPVI rankings presented in this report are LDCs.

Which way, then, should developing countries turn? What is the way forward?

Poverty has no borders, not when it comes to oil which, in a globalized market, goes to the highest bidder. For the poor to rise above poverty, their consumption of electricity and modern fuels needs to increase, including the consumption of oil for those uses for which there are, as yet, no substitutes. Otherwise, the poor will remain poor, and they will be joined by those who live in a state of borderline poverty. Millions will slip back to relying on biomass fuels and human labour, back to eking out subsistence-level incomes while the rest of the population in their own societies moves farther ahead in social status and economic affluence.

This report has presented a range of scenarios for the world's future oil price outlook. These by no means exhaust the possibilities. The future could present a mixture of one or more of these scenarios, or an entirely different set of circumstances. The menu of potential responses is also necessarily incomplete, based partly on past experience, current thinking and a degree of speculation about likely trends or events.

While each country will doubtless weigh solutions in the light of its own circumstances, the broad direction should be clear: a dual track in energy policy. Policy and institutional response to rising oil prices is not only about 'national' energy security. This supply-side approach, so far rampant in developing country policy models, is usually based upon grid-based energy supplies through generation of electricity (nuclear, coal-based, oil-/gas-fired plants) or piped gas/LPG for cooking. Yet national energy security, the first track of a national energy policy, is a necessary condition for enabling the poor to move up the household energy ladder.

But to bridge the ever-increasing gap between those at the top of the ladder (urban consumers who are middle-class and above), who are the main beneficiaries of policies aimed at national energy security, and those at the bottom, a dual-track energy security strategy is essential. The second track would help generate the income for the poor that will feed the demand for non-traditional energy products (improved cooking stoves) and services (RETs such as micro-hydro, biogas, solar PV), thereby creating a virtuous cycle that can sharply reduce poverty through the use of modern energy.

Thus, all developing countries must alleviate the suffering of their poor in the immediate present while adopting strategies to secure the future of their economies. This means providing the poor with essential relief, by way of focused subsidies, compensation and direct cash transfers, against rising fuel prices. Simultaneously, a concerted effort is needed to shift the future trajectory of energy consumption, not only of the poor but also of whole economies, away from its reliance on oil. Reducing the oil intensity of development is no longer a matter of choice. It is the only course.

Other events unfolding on the global arena point in the same direction. Increasing physical evidence of climate change – the rise in natural disasters, changes in weather patterns, declining biodiversity – is also making it more and more difficult to ignore calls to reduce emissions from fossil fuel consumption. Financial markets around the world are convulsing as excesses of the past catch up with them, posing the spectre of a global economic slowdown that can sap the newfound economic strength of many developing countries and move oil supplies out of the reach of their poor citizens.

The time to act is now, before affordable oil becomes a distant memory.

Endnotes

1 Cutoffs are based on World Bank's classification of HIPCs and IMF's target for reducing unsustainable debt among HIPCs.

2 IMF's PRGF loans carry an interest rate of 0.5 percent.

Appendix A:

Socioeconomic and energy profiles

Appendix A.1: Country Profiles

Table A-1: Energy poverty profile of North-East Asia

Countries	Geophysical						Economic		
	Oil reserves (billion barrels)[a]			Forest area (percentage)[b]			Gross domestic product growth rate (percentage)[c]		
	1995	2000	2006	1990	2000	2005	1995	2000	2005
China	24.0	24.0	18.3	16.9	18	21.2	1.9	8.4	9.6
Cambodia	0	0	0	73.3	53	59.2	6.5	8.4	6.3
Mongolia	0	0	0	7.3	7	6.5	2.4*	1.1	6
Viet Nam	0.5	0.6	0.6	28.8	30	39.7	9.5	6.8	8.4
Lao PDR	0	0	0	75	54	69.9	7	5.7	7.2

Countries	Energy											Poverty and inequity			
	Oil consumption (thousand barrels per day)[a]			Oil imports as a percentage of oil consumption[a,d,#]			Traditional fuel usage, percentage of total energy usage[e]		Natural gas consumption (billion cubic feet)[a]			Percentage of population below US$1 (PPP) a day[f]		Gini index[g]	
	1995	2000	2004	1990	2002	2004	1997	2002	1995	2000	2004	1990	Latest	1990 - 2000	Latest year
China	3363.2	4795.7	6400.0			47**	5.7	5.3	581.5	902.4	1350.5	33.0	17 (2001)	35.7 (1990)	44.9 (2003)
Cambodia	3.4	3.5	3.8			100**	89.3	92.3	0	0	0	…	34 (1997)	46 (1994)	40 (1997)
Mongolia	11.5	8.5	11.0			100**	4.3	2.1	0	0	0	13.9	27 (1998)	33.2 (1995)	44 (1998)
Viet Nam	94.3	175.7	230.0	104.5	99.1	94.2	37.8	25.3	25.0	41.0	106.0	14.6	<2 (2002)	34.4 (1993)	37.3 (1998)
Lao PDR	2.3	2.7	3.0			100**	88.7	77.3	0	0	0	7.8	26 (1997)	29.9 (1992)	36.5 (1997)

* 1996 data
**2003 data
Computations based on data from IEA and EIA; figures may be incompatible with those derived from national data sources

Sources:
a: EIA 2006
b: World Bank 2005a, World Bank 2006
c: UNESCAP 2006
d: Oil Information (2006 edition), IEA
e: UNDP 2005
f: http://mdgs.un.org/unsd/mdg/News.aspx?ArticleId=13
g: http://www.wider.unu.edu/, last accessed on 15 December 2006

Table A-2: Energy poverty profiles in South and West Asia

Countries	Geophysical						Economic		
	Oil reserves (billion barrels)[a]			Forest area (percentage)[b]			Gross domestic product growth rate (percentage1)[c]		
	1995	2000	2006	1990	2000	2005	1995	2000	2005
Bangladesh	0.0	0.1	0.0	6.8	10.0	6.7	4.9	5.9	5.4
Bhutan	..	..	..	..	64.0	..	7.3	9.5	8.8
India	5.8	4.8	5.8	21.5	22.0	22.8	7.3	4.4	8.1
Iran	3363.3	89.7	132.5	6.8	6.8	6.8	3.2	5.1	5.0
Maldives	..	..	..	..	3.0	..	7.4	4.8	8.8
Nepal	..	..	..	33.7	27.0	25.4	3.3	6.1	2.6
Pakistan	0.2	0.2	0.3	3.3	3.0	2.5	5.2	3.9	8.4
Sri Lanka	..	..	..	36.4	30.0	29.9	5.5	6.0	5.5

Countries	Energy											Poverty and inequity			
	Oil consumption (thousand barrels per day)[a]			Oil imports as a percentage of oil consumption[a,d,#]			Traditional fuel usage, percentage of total energy usage[e]		Natural gas consumption (billion cubic feet)[a]			Percentage of population below US$1 (PPP) a day[f]		Gini index[g]	
	1995	2000	2004	1990	2002	2004	1997	2002	1995	2000	2004	1990	Latest	1990 - 2000	Latest year
Bangladesh	51.0	68.8	85.0	104.7	90.7	89.9	46	61.6	260.3	342.6	462.6	35.9	36.0 (2000)	28.2 (1992)	31.7 (1996)
Bhutan	0.9	1.0	1.2			100.0**	..	87.8	0	0	0	…	..		
India	1574.7	2127.4	2450.0	48.2	75.2	81.3	20.7	20.0	627.6	794.6	1088.8	42.0	35.0 (1999)	29.6 (1990)	36.0 (1999)
Iran	1140.2	1248.3	1510.0	13.2	4.3	8.2	0.7	0.1	1243.1	2221.0	3020.8	2.0	..	44.0 (1998)	
Maldives	2.4	3.1	7.2			124.0**	..	0	..	..	..	…	..		
Nepal	7.3	14.9	16.0	113.2	85.8	88.5	89.6	..	..	..	..	…	39.0 (1995)	38.4 (1996)	
Pakistan	298.1	365.0	324.0	76.7	84.1	82.8	29.5	..	645.9	855.7	967.6	47.8	13.0 (1998)	28.7 (1990)	29.6 (1998)
Sri Lanka	47.9	74.6	80.0	103.3	95.4	100.0	46.5	41.6	..	..	..	3.8	8.0 (2000)	34.3 (1996)	27.6 (2000)

* 2004 data
** 2003 data
# Computations based on data from IEA and EIA, therefore figures may be incompatible with those derived from national data sources

Sources:
a: EIA 2006
b: World Bank 2005a, World Bank 2006
c: UNESCAP 2006
d: Oil Information (2006 edition), IEA
e: UNDP 2005
f: http://mdgs.un.org/unsd/mdg/News.aspx?ArticleId=13
g: http://www.wider.unu.edu/, last accessed on 15 December 2006

Table A-3: Energy poverty profiles in South-East Asia

Countries	Geophysical						Economic		
	Oil reserves (billion barrels)[a]			Forest area (percentage)[b]			Gross domestic product growth rate (percentage)[c]		
	1995	2000	2006	1990	2000	2005	1995	2000	2005
Indonesia	5.8	5.0	4.3	64.4	58.0	48.9	8.2	4.9	5.6
Myanmar	0.1	0.1	0.1	59.6	52.0	49	6.9	13.7	4.5
Philippines	0.2	0.3	0.1	35.5	19.0	24	4.7	4.4	4.8
Malaysia	4.3	3.9	3.0	68.1	59.0	63.6	9.8	8.5	5.2
Thailand	0.2	0.3	0.3	31.3	29.0	28.4	9.2	4.8	4.5
Timor-Leste	..	..	..	..	..	..	..	..	..

Countries				Energy				
	Oil consumption (thousand barrels per day)[a]			Oil imports as a percentage of oil consumption[a,d,#]			Traditional fuel usage, percentage of total energy usage[e]	
	1995	2000	2004	1990	2002	2004	1997	2002
Indonesia	807.3	1036.7	1200	26.6	52.7	64.3	29.3	17.6
Myanmar	18.4	36.7	37			54*	60.5	74.1
Philippines	328.4	352.8	342.0	99.9	98.2	95.5	26.9	12.8
Malaysia	399.2	465.0	515.0	59.3	57.0	61.7	5.5	1.5
Thailand	678.7	724.9	900.0	85.5	90.1	92.6	24.6	13.6
Timor-Leste							..	..

*2003 data
Computations based on data from IEA and EIA, therefore figures may be incompatible with those derived from national data sources

Sources:
a: EIA 2006
b: World Bank 2005a, World Bank 2006
c: UNESCAP 2006
d: Oil Information (2006 edition), IEA
e: UNDP 2005
f: http://mdgs.un.org/unsd/mdg/News.aspx?ArticleId=13
g: http://www.wider.unu.edu/, last accessed on 15 December 2006

Table A-4: Energy poverty profiles in Pacific Island countries

Countries	Geophysical						Economic		
	Oil reserves (billion barrels)[a]			Forest area (percentage)[b]			Gross domestic product growth rate (percentage)[c]		
	1995	2000	2006	1990	2000	2005	1995	2000	2005
Fiji	..	..	..	..	45.0	..	2.5	-2.8	1.7
Federated States of Micronesia	..	..	..	..	..	..			
Papua New Guinea	0.2	0.3	0.2	69.6	68.0	65.0	-3.4	-1.2	3.0
Samoa	..	..	..	..	37.0	..	6.6	6.1	5.6
Solomon Islands	..	..	..	..	91.0	..		-14.3	2.9
Tonga	..	..	..	..	6.0	..	4.6	5.6	2.8
Vanuatu	..	..	..	..	37.0	..	-0.03	2.7	2.9

Countries	Energy									Poverty and inequity	
	Oil consumption (thousand barrels per day)[a]			Oil imports as a percentage of oil consumption[a,d,#]			Natural gas consumption (billion cubic feet)[a]			Percentage of population below US$1 (PPP) a day[f]	Gini index[g]
	1995	2000	2004	2003	1997	2002	1995	2000	2004	Latest year	Latest year
Fiji	5.7	5.4	10.0	122.0	..	..				25.5 (1990-91)	43.4 (1977)
Federated States of Micronesia	..	..	..	..	..	..				27.9 (1998)	
Papua New Guinea	15.2	14.9	28.0	100.0	62.5	61.9	4.0	4.0	5.0	37.5 (1996)	50.4 (1996)
Samoa	0.9	1.0	1.0	100.0	..	..				20.3 (2002)	
Solomon Islands	1.2	1.2	1.3	100.0	..	..				..	
Tonga	0.8	0.9	0.9	100.0	..	..				23.1 (2000-01)	
Vanuatu	0.4	0.6	0.6	100.0	..	..				..	

Computations based on data from IEA and EIA, therefore figures may be incompatible with those derived from national data sources

Sources:
a: EIA 2006;
b: World Bank 2005a, World Bank 2006
c: UNESCAP 2006
d: Oil Information (2006 edition), IEA
e: UNDP 2005
f: http://mdgs.un.org/unsd/mdg/News.aspx?ArticleId=13
g: http://www.wider.unu.edu/, last accessed on 15 December 2006

Table A-5: Sectoral oil consumption, percentage of total sectoral energy consumption, 2002

	Industry	Transport	Agriculture	Residential
North-East Asia and Mekong				
China*	17	92	51	5
Viet Nam	32	99	85	2
South and West Asia				
Bangladesh	5	100	92	7
India*	30	98	2	11
Iran	38	100	74	31
Nepal	12	100	96	4
Pakistan*	9	96	25	2
Sri Lanka	25	100	100	4
South-East Asia				
Indonesia*	31	100	100	20
Myanmar	19	100	100	1
Philippines	27	100	100	19
Malaysia	36	100	100	21
Thailand	34	100	99	20

Note: * China, India, Indonesia and Pakistan data points are for 2003

Source: IEA 2006

Appendix A.2: Socioeconomic profiles of households surveyed by the study

Table A-6: China

	Rural		Urban	
	Tanchang village	Jiuyan village	Beijing Xuanwu	Wuhan city
	%	%	%	%
Households below the poverty line	0.8	1.5	0	9.5/11.5
Adults literate in each household	85	75	98	97
Households owning a house	100	100	100	100
Households with daily wages as the primary source of income	-	-	-	-
Households owning motorized vehicles	43 motorcycle	32 motorcycle	6 motorcycle 13 household car	16 motorcycle 0.3 household car
Households using traditional biomass as primary cooking fuel	9	89	NA	0
Households electrified	100	100	100	100

Table A-7: India

	Rural		Urban	
	Hoglagare	Deepdi-Bangrasia	Kora-mangala	Kalyanpuri slum
	%	%	%	%
Households below the poverty line	28	44	56	80
Adults literate in each household	58	33	53	51
Households owning a house	-	-	-	94
Households with daily wages as primary source of income	28	69	44	19
Households owning motorized vehicles	14	10	8	None
Households using traditional biomass as primary cooking fuel	88	71	40	77 dung cake 69 fuelwood
Households electrified	100	100	96	100
Households using kerosene for lighting	100	73	8	25

Table A-8: Indonesia

	Rural		Urban	
	Sukamaju	Mekarjaya	Cikutra	Cisereuh
	%	%	%	%
Households with daily wages as primary source of income	65	24	48	4
Households owning motorized vehicles	0	12	8	0
Households using traditional biomass as primary cooking fuel	0	0	0	0
Households electrified	100	100	100	100
Households using kerosene for lighting	0	0	0	0%

Table A-9: Lao PDR

	Rural	Urban
	Ban Nammadao	Vientiane
	%	%
Households below the poverty line	67	75
Adults literate in each household	72	94
Households owning a house	100	95
Households with daily wages as primary source of income	2	4
Households owning motorized vehicles	0	92
Households using traditional biomass as primary cooking fuel	100	48
Households electrified	0	100
Households using kerosene for lighting	100	0

Appendix B:
Macroeconomic indices

Table B-1: Mean values of GDP, inflation and oil intensity, with elasticity

		Rural	Urban
		Before (1990-2002)	**After (2003 -2006 3rd Qtr)**
Normal variables	GDP growth for developing Asia (%)	7.1	8.50
	GDP growth for world (%)	3.55	4.78
	Inflation developing Asia	2.20	3.55
	Inflation world	4.17	3.73
	Oil intensity of GDP of developing Asia*	0.0038	0.0029
	Oil intensity of GDP of world*	0.00089	0.00079
Elasticity	Elasticity of GDP with reference to oil price for developing Asia	0.101	0.1357
	Elasticity of GDP with reference to oil price for world	1.12	1.19
	Inflation for developing Asia	-0.57	2.86
	Inflation for world	0.69	0.14

*Oil intensity is measured in barrels per US$ of GDP

Table B-2: Percentage changes in macroeconomic variables before and after oil price increases

	Change in GDP	Change in inflation growth (%)	Change in budget balance as percentage of GDP (%)	Current account balance as (deficit) as percentage of GDP (%)
Bangladesh	11	54	-24	-75
China	19	932	-36	127
India	60	5	-24	-230
Lao PDR	5	-74	7	13
Sri Lanka	76	-2	-12	-16
Malaysia	22	-2	-9	18
Papua New Guinea	63	-54	-101	-35
Samoa	3	100	-33	164
Indonesia	50	-35	-32	-58
Thailand	41	197	-106	-60

Note: The 'before' period is 2000 to 2002; the 'after' period is from 2003 to the first quarter of 2006.

Appendix C:

Methodology for Oil Price Vulnerability Index calculation

C-1: AN OIL PRICE VULNERABILITY INDEX

Is it possible to quantify the extent of this vulnerability? The degree of vulnerability will depend on many other factors such as the GDP growth rate, for example, and on the extent of foreign exchange reserves. And the extent to which poor people are vulnerable will vary accordingly, for example, to the types of energy they use. Factors and variables that influence a country's vulnerability to oil price changes, particularly in terms of impacts on poor households, are multiple and varied. These factors could be macroeconomic variables, such as GDP growth and foreign exchange reserves position, to more micro-level indicators, such as dominance of traditional fuels in the energy mix and incidence of poverty. This paper discusses such an attempt to develop a composite Oil Price Vulnerability Index (OPVI) for the 24 developing countries of the Asia-Pacific region.

As a first level of classification, it may be possible to say that three kinds of factors (albeit not comprehensive) that can influence oil price vulnerability are economy-related, energy-related and social-related. Broadly, however, most of these major factors can be subsumed under two categories: economy-related and energy-related. With this preliminary understanding, a set of 15 variables have been identified to be influencing the oil price vulnerability level of a country. The data required for measuring these variables have been obtained from various secondary sources (Table C-1). Among the 15 variables, the variables like real GDP growth rate, GDP per capita, balance of payments (current account), budget balance, import cover, share of net oil fuel subsidy/tax revenue in GDP, contribution of food and beverages to inflation, trade as % of GDP, the Gini index and Human Development Index could be broadly classified under economic variables and the variables like oil intensity of GDP, oil import dependence, share of oil in primary energy consumption, oil reserves to production ratio and share of transport in oil consumption could be classified under energy-related variables.

Among these variables (Table C-1), the first five economic variables (real GDP growth rate, GDP per capita, balance of payments – current account, budget balance and import cover) are expected to have positive influence in negating the vulnerability levels. The values of the variables determine the level of the influence (higher or lower) in negating the vulnerability levels. However, if these variables have negative values (e.g. negative balance of payments), even then they positively contribute to an increase in the vulnerability levels. On the other hand, the four energy-related variables (oil intensity of GDP, oil import dependence, share of oil in primary energy consumption and share of transport in oil consumption) are expected to have negative influence by contributing to the increase in vulnerability levels. As the values of the variables increase, there is a chance of experiencing higher vulnerability. Only the variable 'oil reserves to production ratio' has opposite influence compared to the other four variables.

Table C-1: Data used for construction of Oil Price Vulnerability Index

Countries	Real GDP growth rate (%)	GDP per capita (PPP USD)	Balance of payments: current account (% GDP)	Budget balance (% GDP)	Import cover (months)	Share of net oil fuel subsidy/ tax revenue in GDP (%)	Contribution of food and beverages to inflation (% of annual change in CPI)	Oil intensity of GDP (toe/'000 USD)	Oil reserves to production ratio (years)	Oil import dependence (%)	Share of oil in primary energy consumption (%)	Share of transport in oil consumption (%)	Trade as % of GDP 2005	Gini index 2004	HDI 2004
Afghanistan	12.0	1,440	-1.50	-1.5	6.23	0.24	7.68	0.06	0.0	100.00	59.04	91.16	68	35.50	0.346
Bangladesh	6.2	2,135	-0.30	-3.3	2.21	0.17	4.89	0.07	22.6	91.98	27.17	43.00	40	31.8	0.530
Bhutan	12.7	4,437	-3.10	-7.1	9.76	0.77	1.90	0.09	0.0	100.00	11.88	91.36	82	34.1	0.538
Cambodia	5.0	2,534	-5.60	-1.5	2.54	1.01	2.68	0.05	0.0	100.00	95.04	95.85	139	40.4	0.583
China	10.0	8,004	7.20	-0.4	13.26	0.40	0.66	0.23	12.1	44.43	22.00	39.00	69	44.7	0.768
Fiji	2.6	6,610	-0.13	-2.9	2.46	8.53	0.95	0.31	0.0	100.00	74.51	97.56	78.9	49	0.758
India	8.3	3,550	-2.10	-6.4	9.73	1.54	2.29	0.20	19.5	67.96	32.53	33.00	45	32.5	0.611
Indonesia	5.2	4,753	0.20	-1.0	5.13	-0.50	7.38	0.28	12.5	2.12	52.95	53.00	63	34.3	0.711
Iran	5.4	8,441	10.00	6.7	19.41	-7.63	6.73	0.40	91.2	-163.51	48.26	51.00	69	43.0	0.746
Lao PDR	7.3	2,260	-14.60	-5.7	3.77	1.46	5.53	0.07	0.0	100.00	11.77	65.74	58	34.6	0.553
Malaysia	5.5	11,914	15.60	-2.6	6.18	-1.15	1.11	0.23	11.0	-49.51	41.20	67.18	223	49.2	0.805
Maldives	13.0	8,284	-37.60	-18.1	2.41	0.70	1.06	0.69	0.0	100.00	100.00	36.28	172		0.739
Mongolia	6.5	2,322	4.30	3.9	2.43	8.81	11.41	0.37	49.5	95.11	23.88	49.62	160	30.3	0.691
Myanmar	7.0	1,753	4.10	-4.0	3.96	1.82	13.99	0.12	7.4	50.00	37.94	77.00	1.1		0.581
Nepal	1.9	1,761	3.30	-1.8	7.96	1.24	2.79	0.13	0.0	100.00	51.05	38.00	49	47.2	0.527
Pakistan	6.2	2,830	-3.90	-4.2	3.61	2.36	4.32	0.21	15.6	80.56	34.67	77.00	35	30.6	0.539
Papua New Guinea	3.7	2,460	6.80	0.0	3.31	2.48	0.99	0.25	9.3	-177.78	80.60	43.14	98	50.9	0.523
Philippines	5.0	5,160	2.40	-1.0	4.17	1.41	4.58	0.25	16.4	92.60	53.74	67.00	99	46.1	0.763
Samoa	4.0	1,225	-0.02	-0.4	4.29	3.54	4.83	0.17	0.0	100.00	83.54	86.12	78	44	0.778
Solomon Islands	5.3	1,974	-15.80	0.6	6.44	4.95	4.76	0.33	0.0	100.00	100.00	92.40	94		0.592
Sri Lanka	5.6	4,705	-4.90	-8.9	2.71	1.46	10.32	0.31	0.0	100.00	84.99	71.00	80	33.2	0.755
Thailand	4.5	8,877	-0.80	0.1	4.29	1.48	1.75	0.33	6.9	74.44	54.04	64.00	149	42.0	0.784
Vanuatu	3.0	3,424	-8.80	-0.5	3.74	5.79	0.65	0.14	0.0	100.00	100.00	88.49	47.3		0.670
Viet Nam	7.8	3,255	0.10	-5.0	2.49	0.58	4.75	0.69	17.1	-73.91	50.07	60.00	145	37.0	0.709

C-2: LOGICAL ASSESSMENT

For the present study, a set of 15 variables (related to economic, energy and social indicators) is given. It is possible that all of the 15 variables may not be necessary to develop an OPVI. Even when one observes the list of variables there are indications that some of them could be dependent on each other, and others could be contributing to double counting. Thus to identify the relevant variables and to justify their inclusion in the model in order to facilitate the development of OPVIs, a logical assessment of variables was carried out. This has been done through the assessment of variables for possible association, uniqueness, double counting and significance by using the correlation analysis and logical reasoning methods.

C-2.1: Correlation analysis

The results of the correlation analysis performed on the data are presented in Table C-2. It may be observed from Table C-2 that except for the variable "share of transport in oil consumption", all other variables are significantly correlated with one or more variables. Naturally, the next step would have been to select one of the correlated variables among different sets of correlated variables to be included in developing the OPVI. However, this is not the correct approach in creating a composite OPVI because of the following reasons.

1. Here the objective is not to model the variations in OPVI through a set of independent variables. OPVI is not expected to be a dependent variable, but is an estimate derived from many variables.

2. The aim is to develop a composite index capturing the collective influence of relevant variables. Relevance need not be equated to independence.

3. Statistically related variables need not relate logically.

Therefore, it is felt that the correct approach would be to combine the results of correlation analysis and logical reasoning to arrive at a decision to either include or eliminate a variable from the deriving of the composite OPVI.

Table C-2: Results of correlation analysis

	Significantly Correlated Variables		
Real GDP growth rate	Budget balance**(-ve)	Gini index 2004(-ve)	
GDP per capita	Share of net oil fuel subsidy /tax revenue in GDP(-ve)	Trade as percent of GDP 2005**	HDI 2004**
Balance of payments: current account	Budget balance**	Oil import dependence (-ve)	Share of oil in primary energy consumption*
Budget balance	Real GDP growth rate (-ve)	Balance of payments: current account**	Oil reserves to production ratio**
Import cover	Share of net oil fuel subsidy/ tax revenue in GDP(-ve)	Oil reserves to production ratio**	
Share of net oil fuel subsidy/ tax revenue in GDP	GDP per capita(-ve)	Import cover(-ve)	Oil import dependence**
Contribution of food and beverages to inflation	Gini index 2004**(-ve)		
Oil intensity of GDP	Trade as per cent of GDP 2005*	HDI 2004**	
Oil reserves to production ratio	Budget balance	Import cover	Oil import dependence(-ve)
Oil import dependence	Balance of payments: current account*(-ve)	Share of net oil fuel subsidy /tax revenue in GDP**	Oil reserves to production ratio(-ve)
Share of oil in primary energy consumption	Balance of payments: current account*(-ve)		
Share of transport in oil consumption			
Trade as percent of GDP 2005	GDP per capita**	Oil intensity of GDP*	HDI 2004*
Gini index 2004	Real GDP growth rate* (-ve)	Balance of payments: current account**	Contribution of food and beverages to inflation**(-ve)
HDI 2004	GDP per capita**	Oil intensity of GDP** 2005*	Trade as percent of GDP

**Correlation is significant at the 0.00 level (2-tailed)

*Correlation is significant at the 0.05 level (2-tailed)

C-2.2: Logical reasoning

An attempt is made here to logically reason out the justification for the inclusion or elimination of a variable to develop a composite OPVI by taking the following aspects in to consideration.

1. The variables are independent, as far as possible, in the sense that each one measures a unique aspect of a system performance (economic or social).
2. Double counting or two or more variables measuring the same aspect should be avoided.
3. The variables significantly influence the levels of vulnerability.

It is possible to argue that the variables can influence the vulnerability levels in two ways:

1. Positive influence: Higher observed values will reduce the vulnerability levels (economic variables).
2. Negative influence: Higher observed values will enhance the vulnerability levels (energy variables).

As explained earlier, among the 15 variables, the first five are economic variables that are expected to have positive influence in negating the vulnerability levels. The values of the variables determine the level of the influence (higher or lower) in negating the vulnerability levels. However, even if these variables have negative values (e.g., negative balance of payments), they positively contribute to an increase in the vulnerability levels. On the other hand, the four energy-related variables are expected to have negatives influences by contributing to an increase in vulnerability levels. The higher the values of the variables, the greater the chance of experiencing a higher vulnerability. Only one variable, oil reserves to production ratio, has opposite influence compared to the other four variables.

1. **Real GDP growth rate:** This represents a country's "dynamic ability to cope" with price increase. If we can assume that the current rate of growth is a reasonable indicator of immediate past and expected future growth rates of real GDP, this variable can have a positive influence in determining the vulnerability levels. Countries experiencing higher growth rates can be expected to be less vulnerable than those experiencing lower growth rates. For example, a country like China will be significantly less vulnerable than Nepal. Afghanistan is an exception because of past poor performance.

2. **GDP per capita:** This represents a country's "inherent capability to cope" with oil price increase. This basically represents the economic strength of a country. In other words, it determines a country's affordability levels with the price increase. The higher the GDP per capita, the greater is its ability to be less vulnerable. For example, Malaysia is far less vulnerable than Samoa.

3. **Balance of payments - current account:** The current account is the sum of net sales from international trade in goods and services, net factor income (such as interest payments from abroad), and net unilateral transfers from abroad. This can be termed to represent a country's "capability to pay in FOREX". A positive and higher (as a share of GDP) balance of payments on current account represents a comfortable position in terms of paying for the imported oil (especially to take care of an oil price rise). Most importantly, this will be the surplus generated in terms of foreign exchange. Countries with negative balance of payments will be more vulnerable to an oil price rise. Oil-importing counties like China will be less vulnerable compared to Maldives.

4. **Budget balance:** This represents a country's "capability to pay from internal sources" to tackle the problem of oil price rises. Any budget surplus can act as a cushion at the time of crisis, especially in regulating the oil prices to reduce the burden on consumers. Among the oil-importing countries, Mongolia is best placed with respect to this aspect, whereas Maldives appears most vulnerable.

5. **Import cover:** This basically suggests the amount of time a country can manage its monthly imports bills through accumulated foreign exchange reserves. For an oil- importing country, the major portion of the import bill will be on account of oil imports. A higher import cover means the country will be more comfortable in tackling the price rise. This variable can be equated to a country's "capability to sustain" the impact of oil price rise in terms of duration. In other words, how long can a country sustain the oil price rise? China is less vulnerable compared to Bangladesh.

6. **Share of net oil fuel subsidy/tax revenue in GDP:** This ratio gives the degree of oil subsidy burden on the economy. Because tax revenue is the most important component of government income, it is relevant to establish how much of it goes for subsidizing oil prices. If it accounts

for a small or negligible share, then there is scope for increasing it to tackle the impact of oil price rise. Countries with smaller shares will be less vulnerable than those with higher shares. At the outset, this variable appears not to be relevant, because both the components of oil fuel subsidy and tax revenue are part of budget estimates. Already, there is a variable "budget balance" that captures the position of a country in terms of vulnerability levels. Logically, we may state that this particular variable is redundant; however, this is not corroborated by the correlation analysis results, indicating no significant correlation between the two variables. The reason could be a negligible share of net oil subsidy in tax revenue, resulting in negligible contributions to overall variations. Again logically, this variable can be eliminated from the index determination model.

7. **Contribution of food and beverages to inflation:** This basically indicates how developed a country is. A country with higher contributions from agricultural commodities in the overall inflation is stated to be at the initial stages of development. Thus, one could conclude that a country having higher contributions of food and beverages to inflation would be more vulnerable to an oil price rise. However, this type of influence has already been captured through two variables, "real GDP growth rate" and "GDP per capita," making this variable redundant. Even so, this is an indirect measure of influence on vulnerability levels. Instead of this variable, a better variable could have been "contribution of oil price changes to inflation." This can be expected to capture both the direct and indirect impact of oil price changes on the economy, and would have enabled obtaining a better indicator for arriving at a vulnerability index.

8. **Oil intensity of GDP:** This determines the oil dependency levels of a country. The higher the intensity, the greater is the vulnerability of a country to the oil price increase. Cambodia is less vulnerable compared to Maldives.

9. **Oil reserves to production ratio:** This basically indicates a country's level of ownership of oil reserves and rate of exploitation. The higher the ratio, the greater is the comfort level of a country. Indigenous production of oil can act as an insurance cover for the international oil price rise. This indicator is more relevant for long-term vulnerability index. Countries that do not have any reserves are more vulnerable.

10. **Oil import dependence:** This is the most critical variable determining a country's vulnerability level. Those countries that depend 100 percent on imported oil are the most vulnerable to the oil price rise. Logically, those who do not have any oil reserves will be forced to import 100 percent of oil requirement. This may indicate that one of the two variables "oil reserves to production ratio" and "oil import dependence" is redundant in deriving the OPVI. That does not mean that a country that has oil reserves cannot have high import dependence. This is a possible situation for countries keeping their oil stock as strategic reserves and relying on imports for current requirements. In other words, it is possible to have countries with high oil import dependence as well as a high reserves to production ratio that exhibit less vulnerability to oil price shocks. Logically, both the variables are necessary for determining the OPVI; however, the data state the opposite. The correlation analysis shows that both the variables are highly correlated, and it is significant. Thus, it may be advisable to retain "oil import dependence" and eliminate "oil reserves to production ratio," at least in the present context.

11. **Share of oil in primary energy consumption:** This variable indicates how important oil is in relation to other energy sources. The countries with a higher share will be more vulnerable than those with a lower share.

12. **Share of transport in oil consumption:** Just this variable alone would be inadequate to assess the linkage to vulnerability levels. It also is important to know how much the transport sector is important to the economy. It may be possible that most of the oil is consumed by the transport sector (this typically happens in less industrialized countries), but it need not be critical. With this variable alone, it may not be possible to state the relationship to vulnerability level. It cannot be true if one states that the countries with a higher share of transport in oil consumption will be more vulnerable to oil price shocks. It is necessary to include variable/s assessing the importance of transport. A derived variable capturing the essence of the two would be an ideal replacement.

13. **GDP as % of trade:** Much cannot be interpreted from this. Typically, smaller countries with relatively small domestic markets will have significantly higher international trade

compared to the country's GDP. It is logically difficult to assess the influence of this variable on vulnerability. Even the observed trend based on the data provided does not appear to provide much insight on vulnerability levels. Thus, it may be eliminated from the basket of variables included for estimating OPVI.

14. **Gini index:** This is a measure of income inequality ranging from 0 (perfect equality) to 100 (perfect inequality). Higher values exhibit higher inequality. This may not be an appropriate variable for assessing the vulnerability levels. Income equality or inequality can happen at both extremes. A poor country can exhibit high equality, and the same might be the case for a rich country. Even the opposite can be true. For example, Afghanistan (35.5) exhibits higher equality compared to Malaysia (49.2), whereas Nepal, with a Gini index of 47.2, shows high inequality in comparison to Indonesia (34.3). We cannot state that countries with a higher Gini index are more vulnerable or vice versa. Mere observation of the data related to the Gini index of different Asian countries indicate that countries with higher Gini index values (higher inequality) are less vulnerable to an oil price rise. This variable may be eliminated because it may not have much influence in determining the vulnerability index.

    That countries with a higher Gini index are less vulnerable to an oil price rise can be logically argued in the case of India. On the basis of a composite index derived from the macro indicators, countries like India at the outset might look more vulnerable to the oil price rise. However, the reality may be different. This is due to the fact that a large majority of the population is not part of the energy mainstream (depending on modern energy carriers) and their role in oil economy is negligible. They hardly get impacted directly by the oil price rise. Even the indirect effects may be marginal because they are not a part of the mainstream market system. However, the macro indicators that are being used to arrive at the composite vulnerability index are derived, taking into consideration even this section of the population (e.g., per capita GDP with and without this section of the population).

15. **Human Development Index:** This is a socioeconomic indicator of well-being of a country that represents the overall social capacity of the population to respond to adversities. The countries with higher HDI values tend to be less vulnerable to the oil price rise. It may be possible that HDI can be significantly correlated with "GDP per capita" and "oil intensity of GDP," because both of these variables are part of the indicators that are used to determine HDI. However, logical considerations necessitate inclusion of all three variables in the model determining the composite index because the three variables measure different aspects of economic system. Though HDI includes economic indicators, the advantage is that it also captures the influence of social indicators. However, in the present analysis, the HDI has been excluded because of the following reasons:

    - It is a relative index (across countries) unlike other variables included in the analysis. Other variables either indicate exact measurements or are relative to sectors/ segments within the country.
    - The main objective here is to develop a country's vulnerability index. All the variables facilitate this except the HDI. The HDI goes beyond this and attempts to capture the "social empowerment" levels, which are people-driven.

C-2.3: Conclusion

Based on the logical reasoning and statistical analysis, the following are the possible final status of the variables:

Included Variables:

1. Real GDP growth rate
2. GDP per capita
3. Balance of payments-current account
4. Budget balance
5. Import cover
6. Oil intensity of GDP
7. Oil import dependence
8. Share of oil in primary energy consumption

Excluded Variables:

1. Share of net oil fuel subsidy/tax revenue in GDP
2. Contribution of food and beverages to inflation
3. Oil reserves to production ratio
4. Share of transport in oil consumption
5. GDP as % of trade
6. Gini index
7. Human Development Index

C-3: DEVELOPING AN OIL PRICE VULNERABILITY INDEX USING PRINCIPAL COMPONENT ANALYSIS

Principal Component Analysis (PCA) is a popular dimensionality reduction technique used for reducing the number variables in a model (e.g., econometric models). It uses the correlation structure of the variables to perform this task. Basically, the PCA forms linear combinations of variables to arrive at a principal component, and this principal component can be logically related to a dimension representing a set of variables. Taking the example of developing OPVI for 24 countries of the Asia-Pacific region itself, the attempt here is to quantify the degree of vulnerability by using a set of eight included variables which remain after the logical assessment. However, deriving an index with eight variables and then attempting to interpret it would be quite complex. Therefore, the purpose of using PCA is to reduce these eight variables into a manageable number of dimensions (or principal components) to facilitate development of a composite OPVI. Ideally speaking, if we can get one principal component (or single dimension), which accounts for maximum variation, then with few more simple steps, we could obtain the composite OPVI. The values obtained for this principal component for each of the 24 countries can be used for developing the OPVI. However, in reality, that too with eight variables, this cannot be expected. Arriving at a composite OPVI with more than one principal component is always complex (but easier than having eight variables). But the decision to use how many principal components is ours. The number of principal components depends on how much variance we want to account for.

C-4: PRINCIPAL COMPONENT ANALYSIS – REDUCED MODEL WITH EIGHT VARIABLES

The principal component analysis resulted in extracting three principal components from the eight variables considered for arriving at OPVI. The principal components having Eigenvalues of above 1 have been included in the model, explaining the total variation resulting in three principal components. The individual Eigenvalues and the explained variance are given in Table C-3. principal component 1 accounts for 32.74% variance, principal component 2 and 3 account for 23.1% and 19% variance and, cumulatively, all three account for 74.8% variance. Theoretically, we can account for 100% variance by including all the eight principal components (equal to eight variables).

Table C-3: Principal components and explained variance (with eight variables)

Principal components	Eigenvalues	Percentage variance	Cumulative variance
Principal component 1	2.619	32.739	32.739
Principal component 2	1.846	23.080	55.818
Principal component 3	1.519	18.993	74.811

The factor (or component) loadings of each of the 8 variables on the principal components are given in Table C-4. The numbers are called factor loadings and these are equivalent of correlation coefficients. In other words, these numbers tell us how much the variable/s is/are correlated with the principal components. Principal component 1 has four significant variables loaded (are grouped under principal component 1), whereas PC 2 has two variables and PC 3 two variables (Table C-5).

Table C-4: Factor loadings on the principal components (with eight variables)

	Principal Component 1	Principal Component 2	Principal Component 3
Real GDP growth rate	-0.392	0.516	-0.650
GDP per capita	0.199	0.748	0.135
Balance of payments: current account	0.902	-0.114	-0.049
Budget balance	0.820	-0.316	0.182
Import cover	0.600	0.430	-0.307
Oil intensity of GDP	-0.233	0.706	0.480
Oil import dependence	-0.613	-0.462	-0.340
Share of oil in primary energy consumption	-0.386	-0.101	0.777

From the above data, the significant factor loadings have been extracted to know which variables have been grouped into a single given principal component. Table C-5 contains these details. Principal component 1 has four variables loaded (or four variables are grouped under principal component 1), whereas 2 and 3 have two variables each. The principal component analysis is used for variable reduction. In this case, the linear combinations of four variables formed the first principal component (PC1). Linear combination of the next two variables formed principal component 2 (PC2), and similarly, the remaining two variables formed principal component 3 (PC3).

Table C-5: Significant and dominant factor loadings on the principal components (with eight variables)

	Principal Component 1	Principal Component 2	Principal Component 3
Real GDP growth rate			-0.650
GDP per capita		0.748	
Balance of payments: current account	0.902		
Budget balance	0.820		
Import cover	0.600		
Oil intensity of GDP		0.706	
Oil import dependence	-0.613		
Share of oil in primary energy consumption			0.777

Please note that in Table C-5, the variable "real GDP growth rate" has a negative sign for the factor loading and "share of oil in primary energy consumption" has a positive sign, where logically the signs should have been opposite. Therefore, for the subsequent analysis the signs have been reversed for the factor loadings of principal component 3 (third column in Table C-4).

From Table C-5, the groupings of the variables under each of the principal components are as follows:

Principal Component 1:
Economic Strength (Strength)

- Balance of payments: current account
- Budget balance
- Import cover
- Oil import dependence

Strength represents the economic capacity to afford oil imports. A country will be less vulnerable if it has high and positive scores for balance of payments, budget balance and import cover, and a lower score for oil import dependence.

Principal Component 2:
Economic Performance (Performance)

- GDP per capita
- Oil intensity of GDP

Better economic performance results in higher levels of GDP per capita, which should make a country less vulnerable. In developing countries that are shifting from low-quality traditional fuels to high-quality modern fuels such as petroleum products, this will lead to an increase in oil intensity. This may not be an attractive indicator from an environmental standpoint, but its is relevant at initial stages of economic development.

Principal Component 3:
Economic Growth with low share of oil in primary energy (Low-oil-growth)

- Real GDP growth rate
- Share of oil in primary energy consumption (Reducing share)

Many countries initially base their development on primary energy sources other than oil, including traditional fuels or, as in the cases of China and India, coal and hydro. But they are likely to become increasingly oil-dependent. A country will be less vulnerable if it can combine a high GDP growth rate with a low share of oil in primary energy consumption.

The values of these three principal components are called factor scores. As mentioned earlier, the principal components are derived based on the linear combination of the variables. In other words, the values of the principal components can be derived from these linear combinations. The equation for this is as follows:

$$PC_n = \sum_{j=1}^{m} a_{jn} n_j, \quad \text{for all 'n'}$$

Where,

PC_n = The factor score for principal component "n" (here, n = 1, 2, …, 5)

a_j = Factor loading of variable 'j' on principal component "n" (here j = 1, 2, …, 15)

X_j = Standardized variable 'j' (here j = 1, 2, …, 15)

In expanded form for principal component 1, the equation will be

$$PC_1 = a_{11}X_1 + a_{21}X_2 + a_{31}X_3 + \ldots + a_{151}X_{15}$$

The factor scores for different countries are estimated using the factor loadings (Table C-4) and standardized values[1] of the original data (given in Table C-1). Table C-6 contains the factor scores for the 24 countries of the Asia-Pacific region.

[1] Standardized Value = $\frac{\text{(Original Value - Mean Value)}}{\text{Standard Deviation}}$

Table C-6: Factor scores (with eight variables)

	Strength	Performance	Low-oil-growth
Afghanistan	-0.73	-0.85	1.98
Bangladesh	-0.25	-1.79	1.28
Bhutan	-0.61	1.08	3.69
Cambodia	-1.11	-2.31	-0.83
China	2.65	2.19	2.10
Fiji	-0.38	-0.47	-1.65
India	-0.08	0.59	1.75
Indonesia	0.97	0.11	-0.57
Iran	6.61	3.42	-0.77
Lao PDR	-1.67	-1.07	2.11
Malaysia	3.24	2.22	-0.40
Maldives	-8.42	4.68	-0.84
Mongolia	1.04	-0.99	0.37
Myanmar	0.23	-1.16	1.04
Nepal	1.25	-2.05	-0.03
Pakistan	-0.67	-0.75	0.72
Papua New Guinea	2.48	-0.29	-2.35
Philippines	0.43	-0.55	-0.28
Samoa	-0.15	-2.22	-0.90
Solomon Islands	-1.60	-0.86	-1.51
Sri Lanka	-2.46	-0.02	-0.96
Thailand	0.70	0.74	-0.92
Vanuatu	-0.92	-1.95	-1.67
Viet Nam	0.17	2.78	0.05

Table C-7: Ranking of countries based on factor scores for different principal components (with eight variables)

	Strength	Performance	Low-oil-growth
Afghanistan	18	15	4
Bangladesh	13	20	6
Bhutan	16	6	1
Cambodia	20	24	15
China	3	5	3
Fiji	14	12	22
India	11	8	5
Indonesia	7	9	13
Iran	1	2	14
Lao PDR	22	18	2
Malaysia	2	4	12
Maldives	24	1	16
Mongolia	6	17	9
Myanmar	10	19	7
Nepal	5	22	10
Pakistan	17	14	8
Papua New Guinea	4	11	24
Philippines	9	13	11
Samoa	12	23	17
Solomon Islands	21	16	21
Sri Lanka	23	10	19
Thailand	8	7	18
Vanuatu	19	21	23
Viet Nam	15	3	20

Now, the next step is to combine these principal components to derive an integrated factor score. If the weights are the same (or uniform), then one easily could have estimated the integrated factor score by taking the average. However, in the present case we are aware of the fact that the weights of the three principal components are different. We know that principal component 1 accounts for highest variance (33 percent), principal component 2 accounts for 23 percent and principal component 3 for 19 percent. Here we have assumed that the percentage variance accounted by a principal component is equal to the weight (last row of Table C-8). Using these weights, the weighted total factor score was estimated (Table C-8). The OPVI for each of the countries was developed using the following formula on the weighted total scores.

$$\text{Dimension Index} = \frac{\text{Actual value - minimum value}}{\text{Maximum value - minimum value}}$$

Table C-8: Weighted factor scores, OPVI and ranking based on OPVI (with eight variables)

	Strength	Performance	Low-oil-growth	Weighted total score	OPVI	Rank
Afghanistan	-0.24	-0.20	0.38	-0.06	**0.38**	**13**
Bangladesh	-0.08	-0.41	0.24	-0.25	**0.34**	**15**
Bhutan	-0.20	0.25	0.70	0.75	**0.56**	**4**
Cambodia	-0.36	-0.53	-0.16	-1.05	**0.17**	**22**
China	0.87	0.50	0.40	1.77	**0.78**	**2**
Fiji	-0.12	-0.11	-0.31	-0.55	**0.28**	**18**
India	-0.03	0.14	0.33	0.44	**0.49**	**5**
Indonesia	0.32	0.03	-0.11	0.23	**0.45**	**7**
Iran	2.16	0.79	-0.15	2.81	**1.00**	**1**
Lao PDR	-0.55	-0.25	0.40	-0.39	**0.31**	**17**
Malaysia	1.06	0.51	-0.08	1.50	**0.72**	**3**
Maldives	-2.76	1.08	-0.16	-1.84	**0.00**	**24**
Mongolia	0.34	-0.23	0.07	0.18	**0.43**	**9**
Myanmar	0.08	-0.27	0.20	0.01	**0.40**	**11**
Nepal	0.41	-0.47	-0.01	-0.07	**0.38**	**14**
Pakistan	-0.22	-0.17	0.14	-0.25	**0.34**	**16**
Papua New Guinea	0.81	-0.07	-0.45	0.30	**0.46**	**6**
Philippines	0.14	-0.13	-0.05	-0.04	**0.39**	**12**
Samoa	-0.05	-0.51	-0.17	-0.73	**0.24**	**19**
Solomon Islands	-0.52	-0.20	-0.29	-1.01	**0.18**	**21**
Sri Lanka	-0.81	0.00	-0.18	-0.99	**0.18**	**20**
Thailand	0.23	0.17	-0.18	0.22	**0.44**	**8**
Vanuatu	-0.30	-0.45	-0.32	-1.07	**0.17**	**23**
Viet Nam	-0.18	0.53	-0.26	0.10	**0.42**	**10**
Weights based on variance accounted (%)	**32.739**	**23.08**	**18.993**			

Table C-9: Indicators, formulas and sources in data compilation for the OPVI

	Indicator	Formula	Principal source chosen and year of data	Justification for source	Missing data compiled from additional sources	Additional sources searched	Additional sources searched – country-specific
1	Real GDP growth rate	Direct Data	IMF 2006a	Good coverage, other databases/ publications often use/cite data from IMF		ADB, WB, UNESCAP, UNSD, UN HDR	
2	GDP per capita	Direct Data	IMF 2006a	Good coverage, other databases/ publications often use/cite data from IMF			
3	Balance of payments	Direct Data	IMF 2006a	Good coverage, other databases/ publications often use/cite data from IMF			
4	Budget balance	Direct Data	ADB 2006	ADB most complete coverage for recent years	For Afghanistan from CIA	IMF ASEAN WB, OECD	
5	Import cover	International Foreign exchange reserves = A (import bill for good + import bill for services) / 12 = B = average monthly import bill A/B = months of import cover sustained by forex reserves	ADB 2007 (international reserves) WTO 2007 (trade figures)	Good coverage of the countries, these data sets were recently updated/released		UNCTAD	
6	Share of net oil fuel subsidy/ tax revenue in GDP	Local price of petroleum - International Price of petroleum = Average net subsidy/tax on transport fuels = US$/liter * 1160.07/100 = US$/toe = A Annual consumption of transport fuels ktoe = B A*B*1,000/ 1,000,000,000 = Annual net government expenditure on transport fuel subsidy or revenue from fuel tax in billion US$ = C GDP at current prices billion US$ = D C/D*100 = Net Government transport fuel subsidy/revenue as share of GDP (%)	EA (transport fuel consumption data for 13/24 countries), and EIA calculations for other remaining countries (see variable 12 calculations) GTZ 2007 and GTZ, 2005 (transport fuel prices) IMF 2006 (GDP) Country level agencies/ websites/ publications	IEA has a sectoral breakdown of the data, but the countries covered are smaller. IEA countries are: Bangladesh, China, India, Indonesia, Iran, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand and Viet Nam. EIA has a total oil consumption data. The countries covered by this calculation are: Afghanistan, Bhutan, Cambodia, Fiji, Lao PDR Maldives, Mongolia, Papua New Guinea, Samoa, Solomon Islands, and Vanuatu.	Country level agencies/ websites/ publications/ UNDP COs/ other country level contacts for: Afghanistan Bhutan Cambodia Fiji Maldives Mongolia Samoa Vanuatu	CEIC, UNSD, EIA, UNIDO, ADB, UNESCAP, WRI, OECD, ASEAN	UNDP COs/ other country level contacts etc. for: Afghanistan Bhutan Cambodia Fiji Lao PDR Mongolia Papua New Guinea Samoa Solomon Islands Vanuatu

	Indicator	Formula	Principal source chosen and year of data	Justification for source	Missing data compiled from additional sources	Additional sources searched	Additional sources searched – country-specific
7	Contribution of food and beverages to inflation	(Weight of food in CPI basket)*(CPI2005-CPI2004)	IMF 2007 (WEO 2007 April (CPI inflation)) (Country level contacts/ publications/ websites for all weights)	IMF data most complete for annual CPI. Even though UNSD (UN Common Database) had all countries, after 2004 the figures were given monthly or quarterly and it was not consistent data. Therefore, the IMF data was used, since it provided the data annually. None of the global/ regional databases have CPI weights, therefore a considerable amount of time was spent in going through each national database. Other issues: • the weightages of food in the CPI basket was searched through all the national databases both online and print. It was found that not all countries publish their weightages and it required a considerable amount of time to contact the national statistics offices to retrieve data from them. • The weightages years vary from country to county, as the percentage is based on the national household survey a country conducts.	Ministries, statistics offices, country level contacts Pacific Countries: http://www.spc.int/prism Central Banks http://en.wikipedia.org/wiki/List_of_central_banks Country specific national statistics offices: Afghanistan http://www.cso.gov.af Mongolia http://www.nso.mn Myanmar http://www.csostat.gov.mm	CEIC, ASEAN UNSD, ADB, Ministries, statistics offices, country level contacts	Indonesia http://www.bps.go.id Lao PDR http://www.nsc.gov.la
8	Oil intensity of GDP	Petroleum consumption (quadrillion BTU) * 1055056000 (GJ)/ 42 = toe = A Real GDP billion US$ *1,000, 000 = Real GDP 1,000 US$ = B A/B = Oil intensity (toe/000 US$)	IMF 2006b (Real GDP) EIA 2006 (Petroleum consumption)	EIA covered all the countries in their database. Good coverage, other databases/ publications use often quoted IMF database.			

	Indicator	Formula	Principal source chosen and year of data	Justification for source	Missing data compiled from additional sources	Additional sources searched	Additional sources searched – country-specific
9	Oil reserves to production ratio	Proved Crude Oil Reserves billion barrels*1,000 = million barrels = A (Production of Crude Oil, NGPL and other liquids and refinery pressing gain thousand barrels/day)*365)/ 1000 = million barrels/ year = B A/B = oil reserves to production ration in years	CIA 2007	CIA coverage good, most recent data, reliable when confirmed from other sources		CEIC, ASEAN UNSD, ADB Ministries, statistics offices, country level contacts	Nicolau & Scheiner, 2005, Oil in Timor-Leste, Guteriano Nicolau and Charles Scheiner, La'o Hamutuk, September 2005, at http://www.lao-hamutuk.org/Oil/curse/OilInTLOilwatch.htm
10	Oil import dependence	Oil consumption barrels/day = A Oil Production barrels/day = B (A-B)/ A * 100 = Oil Import dependence	CIA 2007	CIA coverage good, most recent data, reliable when confirmed from other sources	For Bangladesh from EIA		BP, 2006, BP Statistical Review of World Energy 2006, July 2006, British Petroleum, London
11	Share of oil in primary energy consumption	Petroleum Consumption (quadrillion BTU/quad) * 1055056000/ 42/1,000 = A Primary Energy Consumption (quadrillion BTU/quad)* 1055056000/ 42/1,000 = B A/B*100 = Calculated Share of oil in total energy consumption (%)	EIA 2004 IEA 2006; EIA 2004	EIA coverage best			
12	Share of transport in oil consumption	Direct Data from IEA ((Total oil consumption Thousand Barrels/Day)* 365*159)= (litres/day)/ 1160.70)/1000 = Total oil consumption ktoe = A (((Total Electricity Thermal Generation Billion kwh*1,000,000,000)*3.6) /1,000 =kilojoules/42 = Oil consumption for power generation in ktoe = B A-B = Share of transport in oil consumption		IEA has a sectoral breakdown of the data, but the countries covered are smaller. IEA countries are: Bangladesh, China, India, Indonesia, Iran, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand and Viet Nam. EIA has a total oil consumption data. The countries covered by this calculation are: Afghanistan, Bhutan, Cambodia, Fiji, Lao PDR Maldives, Mongolia, Papua New Guinea, Samoa, Solomon Islands, and Vanuatu.	For Cambodia, PNG from APEC; Country level agencies/ websites/ publications/ UNDP COs/ other country level contacts for: Afghanistan Bhutan Fiji Maldives Mongolia Samoa Vanuatu	EIA, ADB, OECD, WEC, Petrol journal Country level publications/ websites IEA, ADB, CEIC www.ceicdata.com ISI Emerging Markets CEIC, UNSD, EIA, ADB, UNIDO, UNESCAP, WRI, OECD, ASEAN, WEC	UNDP COs/ other country level contacts for: Afghanistan Bhutan Cambodia Fiji Lao PDR Maldives Mongolia Papua New Guinea Samoa Solomon Islands Vanuatu

Appendix D:

Oil Price Vulnerability Index: country grouping

Following the ranking of countries on the basis of overall oil price vulnerability, they have been categorized as shown in Table 3-3. The categorization of countries into low, medium and high OPVI groups has been done using the mean (0.396) and standard deviation (0.215) combination on the estimated OPVI:

Low OPVI countries	→	OPVI value ≥ Mean + Standard deviation
High OPVI countries	→	OPVI value ≤ Mean
Medium OPVI countries	→	All the countries between the two limits

1. *Low OPVI countries*: High economic capacity (or strength) to absorb oil price shocks, perform better with high per capita GDP and economic growth rate, and have either low reliance on oil or are net exporters of oil
2. *Medium OPVI countries*: Medium economic capacity (or strength) to absorb oil price shocks, perform better with high or medium per-capita GDP and economic growth rate, and have either low reliance on oil or are net exporters of oil
3. *High OPVI countries*: Low economic strength, lower economic performance and high oil dependency

Appendix E:

Assumptions used in the comparative analysis of the generation costs of renewable energy technologies vs oil-based power generation

The assumptions used in the comparative analysis of generation costs were based on the results and assumptions of a 2005 study undertaken jointly by energy research institutions and power generating companies under the direction of the World Bank.[2] The study covered whether renewable energy technologies for off-grid and mini-grid applications are competitive with gasoline and diesel generation sets. The study shows:

- Renewable energy is more economical than conventional generation for off-grid (less than 5 kW) applications. Renewable energy technologies – wind, mini-hydro and biomass-electric – are the least-cost option (on a levelized basis) for off-grid electrification applications, assuming availability of the renewable resource. Pico-hydro, small wind, and PV-wind hybrid technologies, in particular, are projected to be in the range of 15-25 cents/kWh, less than half the 30-40 cents/kWh for gasoline and diesel engine generators. The most expensive renewable energy technology (solar PV) is comparable in levelized electricity costs to the projected costs for gasoline or diesel engine generators, especially for small power applications (50-300W).

- Several renewable energy technologies are potentially the least-cost option for mini-grid applications. Mini-grid applications are village- and district-level networks with loads between 5 kW and 500 kW that are not connected to a national grid. The assessment indicates that numerous renewable energy technologies (biomass, biogas, geothermal, wind and micro-hydro) are the potential least-cost generating option for mini-grids, assuming a sufficient renewable energy resource is available. Two biomass technologies – biogas digesters and biomass gasifiers – seem particularly promising, due to their high capacity factors and availability in size ranges matched to mini-grid loads. Geothermal also appears economical, recognizing that it is restricted to only those developing economies with easy-to-tap hydrothermal resources and no large field development costs. Because so many renewable energy sources are viable in this size range, mini-grid planners should thoroughly review their options to make the best selection.

The levelized cost of energy was used to examine the relative costs of individual technologies compared to oil-based technologies.[3] The economic assessment was performed for different operating conditions (full-time and limited operating hours in mini-grid and off-grid configurations) and different time periods (2004, 2010 and 2015) in order to incorporate projected cost reductions from the scaling up of emerging technologies. The study results make it possible to compare the levelized economic costs of electricity technologies over a broad range of deployment modes and demand levels, both at present and in the future. The forecast value of the future price in 2010 and 2015 is calculated by considering the decrease of the future price as a result of both technological innovation and mass production. A forecast decrease in capital cost is done for each generation technology group, as shown in Table E-1, reflecting the relative maturity of each technology. Thus, a "lower-range cost," a "most probable cost" and a "higher-range cost" were estimated for each technology.[4]

[2]Techno-Economic Assessment of Off-Grid, Mini-Grid and Grid Power Generation Technologies, World Bank , 2005 (WB Toolkit Website - http://web.worldbank.org/

[3]Ibid. "Levelization" involves calculating a stream of equal cash flows whose "Net Present Value," or NPV, is equal to a given stream of variable cash flows. Levelized cost is usually calculated in constant dollars. If a project's levelized annual cash flow is divided by the annual amount of energy produced, the result is called the levelized cost of energy. The result can be used to compare the given project with other projects or energy sources for which the costs also have been levelized.

[4]Ibid.

Table E-1: Forecast rate of decrease in power generation technologies, 2004 to 2015

Decrease in capital cost	Generating technology type
0% to 5%	Geothermal, Biogas, Pico/Micro-Hydro, Diesel/Gasoline Genset
6% to 10%	Biomass Gasifier
11% to 20%	Solar PV, Wind, PV-Wind Hybrids

Other cost analysis considerations include:

- Following World Bank guidance, the study used a discount rate set at 10 percent/year and performed and expressed all economic analysis in constant June 2004 US dollars. Economic cost equivalent to international competitive price of machines, materials and fuel were used. Transport costs were included and shown separately, and only labour expenses were assumed to differ between regions.

- The local and regional emissions (e.g., particulate, SO_2 and NOx) were assumed to meet World Bank environmental safeguard requirements. The cost of land was not included in the analysis due to its site-specific nature.

- Key uncertainties including fossil fuel costs, future technology cost and performance, and resource risks were systematically addressed using a probabilistic approach based on the "Crystal Ball" software package.

- Accommodating the Intermittency of RETs. When solar PV, wind PV and wind hybrids were in a mini-grid area or off-grid configuration, battery costs or backup generator costs were included in the costs of the power system as a way to smooth stochastic variations in the available resource and provide for a reliable power output.

- Regional Adjustment. Location factors for the Asian region were determined, and analysis indicated that the variation in costs of engineering, equipment and materials was quite small when procurement was done under ICB (International Competitive Bidding) or comparable guidelines. The labour costs, however, varied from region to region, depending on GDP and per capita incomes.

Appendix F:

Methodology of sub-strategy priorities

The methodology adopted for obtaining the ranking was two-pronged:

1. Capturing the perceptions of the group of energy experts in a brainstorming session on the classification of strategies from the perspective of various objectives. The three objectives considered are overall effectiveness (combining all the objectives listed above), cost of implementation and time required for implementation. Three classification levels – high, medium and low – were used. Through a consensus, each of the strategies were classified as high, medium or low.

2. Again through a consultative process and with a consensus, the weights for the three objectives were obtained. The weights assigned were 0.50 for overall effectiveness, 0.30 for cost of implementation (since all the countries are developing countries and cost is an important consideration), and 0.20 for time required for implementation.

Appendix G:

Energy units, conversion factors and abbreviations

Table G-1: Energy conversions

To:	Terajoule (TJ)	Gigacalorie (Gcal)	Megatonne oil (equiv) (Mtoe)	Million British thermal units (Mbtu)	Gigawatt-hour (GWh)
From:			**Multiply by:**		
Terajoule (TJ)	1	238.8	2.388×10^{-5}	947.8	0.2778
Megatonne oil (equiv) (Mtoe)	4.1868×10^{4}	107	1	3.968×10^{7}	11,630
Million British thermal units (Mbtu)	1.0551×10^{-3}	0.252	2.52×10^{-8}	1	2.931×10^{-4}
Gigawatt-hour (GWh)	3.6	860	10^{-5}	3,412	1

Figures from IEA. Additional conversion figures available at http://www.iea.org/Textbase/stats/unit.asp

Table G-2: Unit abbreviation

b	Billion
bbl	Barrel
Btu	British Thermal Units
m/s	Metre/second
M^2	square metre
m^3	cubic metre
km^2	square kilometre
A	Ampere
kVA	Kilo Volt-Ampere
Wp	Watt peak
kW	Kilowatt
kWh	Kilowatt-hour
kWh/m^2	Kilowatt-hour/square metre
kgoe	Kilogrammes oil equivalent
MW	Megawatt
MWh	Megawatt-hour
GW	Gigawatt
t	Tonne

Table G-3: Unit prefix

k	kilo (10^3)
M	mega (10^6)
G	giga (10^9)
T	Tera (10^{12})
P	Peta (10^{15})

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