Energy sector reform: strategies for growth, equity and sustainability

PER LJUNG

Today some 1.6 billion people lack access to electricity and around 2.4 billion use traditional biomass such as wood or dung for cooking.

How should energy production and distribution in low income and lower-middle income countries be guided, owned and regulated in order to achieve development objectives on economic growth, environment, climate, equity and human rights? Per Ljung describes different models and structures. He highlights pitfalls as well as successful models and experiences from many parts of the world.

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Foreword by Sida

In spite of massive overseas development assistance to state-owned utilities in the energy sector in developing countries during the 1970s and 1980s, the quality of energy services steadily declined. Reasons include mismanagement of energy utilities, lack of competition and a highly politicised environment with unsustainably low tariffs and widespread corruption. The result was energy systems on the brink of collapse characterised by serious technical and financial losses, lack of investment and the inability to provide the required services to the population. By the 1990s the situation had deteriorated to a level where the sector had become an unacceptable hindrance to economic growth and social development in many countries. Radical changes had to be made.

An intensive period began with the introduction of reforms at various levels in the sector. Energy policies, legislation, regulations and institutions were reformed to break the monopoly of state-owned utilities and to provide space for a competitive market including private actors.

Reforms were designed and implemented differently in different countries. Some were successful, others did not live up to expectations. The reasons for shortcomings included a lack of real commitment to the reforms, poor design of reforms as well as unrealistic expectations on what the reforms could reasonably be expected to accomplish in a brief period of time. One disappointment was, for example, that private investments in the power sector in Sub-Saharan Africa did not materialise as expected. Conclusions from the first period of reforms have now been drawn and post reform adjustments and modifications introduced.

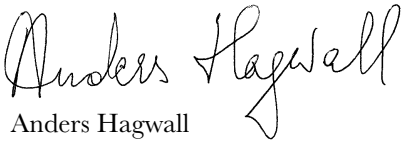
Energy is an important sector in Swedish development cooperation. Assistance to implementation of reforms in this sector has been a main focus area for a considerable period of time. In 2005, Sida made preparations for a new Sida Policy for Sustainable Energy Services for Poverty Reduction. As part of these preparations the former World Bank energy expert Per Ljung was commissioned to write a report on experience of energy sector reforms in developing countries and to draw conclusions for the future. He has subsequently expanded and deepened this analysis.

Although much has already been written on the subject, by the World Bank among others, Per Ljung's report is of particular interest as he, in a pedagogical and easy-to-understand manner, manages to synthesise an

extremely wide and complex subject. One special feature is the emphasis that has been given to poverty reduction aspects, environment, gender issues and energy security.

It is with great pleasure that Sida may now present Per Ljung's report to a wider audience.

August 2007



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Executive summary

Modern energy services play a critical role in promoting economic development and in achieving most of the Millennium Development Goals related to poverty alleviation, education and health. Thus, the fundamental objective of energy policies in developing countries should be to provide electricity and/or other modern energy sources to the 1.5–2 billion people who presently lack access. The problem of access is most serious in rural areas, especially in Sub-Saharan Africa.

However, energy policy cannot be one dimensional. It must be supportive of overall goals such as the promotion of economic growth, social development and poverty alleviation while ensuring sustainable use of natural resources, care for the environment – including concern for the climate, equality between women and men and security, as well as reflecting respect for human rights, democracy and good governance. A rights perspective should be integrated into planning and evaluation both of government measures and international development cooperation in the sector.

Energy sector restructuring is a global phenomenon, though the direction and rate of change is country – and sub-sector – specific and motivated by different factors. This report reviews the progress so far and assesses the forces that shape the process and determine the outcomes.

The emphasis of the discussion in the paper will be on the power sector because of its operational importance to Sida and its development cooperation partners, with only a brief review of reforms in the oil and gas sectors and district heating. The analysis will focus on energy delivery systems, i.e. it will follow traditional sector lines. However, this should not obscure the fact that various types of energy are substitutes. Wood, charcoal, kerosene, LPG and electricity can be used for cooking; wind, diesel or electricity – as well as animals or humans – can provide the power for groundwater pumping, etc. End users (households and enterprises) will choose whichever energy source that is most appropriate, taking into account not only the direct cost of the energy consumed but also connection charges, the cost of installation and appliances as well as the reliability of supply. This implies that the availability and price of one type of energy will influence the use of other types.

A differentiated strategy is often needed: grid electricity might be most appropriate for unserved urban and peri-urban areas (where population densities are high and the cost of building distribution networks is correspondingly low). Local mini-grids and non-grid electricity solutions (solar

PV systems, wind, mini hydro, etc.) or hydrocarbon (LPG, kerosene, diesel, etc.) might be more appropriate for light and motive power in remote rural areas. Access, affordability and financial viability of energy enterprises should be key objectives for various sub-programmes covered by the energy strategy. Where subsidies are required to meet these objectives, they should be explicit and transparent, well targeted, fully budgeted and aimed at reducing up-front, "first use" costs, especially for the poor.

The changing role of the state

Given the importance of energy in the development process, the state played a dominant role in the sector until the early 1990s. National oil corporations became the sole importer, refiner and distributor of petroleum products. Vertically integrated utilities generated, transmitted and distributed electricity. These vast monopolies operated with weak supervision and soft budget constraints. They became vehicles for political patronage and breeding grounds for corruption. Overstaffing, inefficiencies, political interference in tariff setting meant that financial losses mounted to such an extent that in the early 1990s, the average power utility covered only about 60% of its costs.

A major paradigm shift is underway, however, which is changing the way energy facilities are owned, operated and financed. Strapped for financial resources and realizing that infrastructure bottlenecks hampered economic growth, governments are increasingly building up their ability to regulate energy enterprises while divesting assets and/or encouraging the private sector to build and operate new facilities.

One key element of these reforms involves changing the existing market structure to expand the scope for competition. This can take the form of classical "competition in the market" or "competition for the market." Under the latter approach monopoly franchises are awarded through competitive bidding, this process being repeated on a regular basis which provides incentives for firms to perform well in order to retain their franchises.

In short, the role of governments is shifting from energy service provider to that of policy maker, regulator and facilitator of private investments. The private sector, especially in the form of multinational corporations but also domestic firms, is gradually taking over service delivery. The role of civil society in this process is more muddled and still evolving.

Structure of the power industry

In electricity, the reform process involves three discrete, but interrelated, elements: modifying the *structure of the industry* to enhance the prospects for

competition, changing ownership patterns and/or creating various forms of *public-private partnerships* to provide stronger incentives for efficiency and growth, and establishing a transparent *regulatory framework* to balance private and public interests.

The various organizational arrangements and modes of interaction between the entities in the power sector can be classified according to six basic models, reflecting varying degrees of competition and government control. These models are independent of the source of electricity.

- *Vertically Integrated Monopoly*[1]. Until recently, this model was followed in most developing countries. With few exceptions, the utility was owned by the state. There were some variations on this vertically integrated structure; for example, distribution might have been handled by local distribution companies.
- *Vertically Integrated Single Buyer.* The most common form of introducing private investments into the power sector is that the state-owned, vertically integrated utility buys electricity from independent power producers (IPPs). It does this by entering into long-term (typically 20–30 year) power purchase agreements (PPAs).
- *Single Buyer in Unbundled System.* A key objective of power sector reform is to create an industrial structure that increases transparency and competition. This typically requires that the monolithic, state-owned utility be broken up into parts, a process commonly referred to as *"unbundling"*. This involves the establishment of a number of autonomous generating companies that are dispatched based on price/cost. Electricity distribution is split into a number of regional companies while the transmission network is usually kept intact as one entity. A central dispatch company (which may be the transmission company or a separate entity) purchases all wholesale power from the generating companies under long-term PPAs, and sells it at a standard price to the distribution companies.
- *Cost-based Wholesale Competition.* The creation of a competitive market requires that generation, transmission, and distribution have been unbundled and a regulatory authority has been established. Competition takes place at the

[1] I.e. they handled all generation, transmission and distribution.

wholesale power market level through bilateral contracts and a spot market. The competition, however, is limited: the system operator dispatches the power plants based on the marginal cost of the last unit needed to meet demand (rather than based on price bids).

- *Bid-based Wholesale Competition.* In a bid-based system, generators provide supply curves indicating the amount of power they are willing to provide at different price levels. Major consumers and distribution companies similarly provide bids indicating the amount of power they would like to purchase at different price levels. This is a pure competitive model where the price is determined based on market forces irrespective of the marginal cost of supply.
- *Retail Competition Model.* This involves transforming not only the transmission company but also the regional distribution companies into "common carriers" that transport the electricity (for a fee) from the generating plants to the consumers. In this case, marketing companies buy the power at the wholesale level and sell it to the consumers and provide various value-added services to their customers.

Main forms of public-private partnership in the power sector

Electricity like most other infrastructure services has both positive and negative externalities. The implication of this is that reliance on private profit motives alone will not ensure that the power sector develops in a desirable direction. Revenues and expenditures are only parts of the considerations in the investment decisions taken by private firms in the sector: risks of various kinds are often the determining factors. Thus, depending on the circumstances, different models have evolved that provide for sharing the risks and rewards between the government, the consumers and the private sector. The main forms of public-private partnership found in the power sector are:

- *Service Contracts.* The public enterprise employs a private contractor to undertake certain functions such as line repair or billing and collection.
- *Management Contracts.* A private contractor has full responsibility for day-to-day operations and routine maintenance but the public enterprise owns the assets and finances any new investments. The management contractor is typically responsible for billing and collection but the owner

controls the revenues. The extent to which contractors use their own staff tends to vary from case to case.

- *Affermage Contracts.* The state continues to own the assets and is responsible for capital investment but the system is operated by a private company. The operator's own staff operates and maintains the facility and undertakes all billing and collection. The revenues are shared – in accordance with a formula – between the owner (i.e. government utility) and the private operator.
- *Lease Contracts.* Similar to the affermage contracts but the private operator pays a predetermined lease fee. In general, a lease contract moves more of the revenue risk to the operator than an affermage contract.
- *Design-Build-Operate Contracts (DBO).* If private financing is not available, a design-build-operate contract can provide assurance that life-cycle costs are minimised and that private sector skills are also applied during the operational phase of the facility. The owner mobilises the financing and pays an annual fee to the contractor for a number of years.
- *Concessions.* The state continues to be the owner of the assets, but transfers responsibility – through a concession agreement – for both financing of new facilities and daily operations and maintenance to the private concessionaire. "Privatisation" of distribution networks is commonly carried out through concession arrangements.
- *Build-Own-Operate-Transfer Contracts (BOT).* Under this type of arrangement, the government entity enters into a long-term off-take contract with the private party who builds and operates the plant for a certain number of years (typically 20–30 years). There are various permutations of the BOT concept such as BOO (if the assets are not transferred to the government). The BOT model is best suited for large facilities such as power plants or refineries. Typically, the owner takes all commercial risks except that the public sector buyer assumes part or all of the market risk.
- *Divestitures.* Through the divestiture, full ownership of the assets is transferred to the private company that in turn takes full responsibility for capital investment, operations and maintenance. The assets are owned by the buyer in perpetuity. Following a divestiture, the investor takes on the maximum levels of market, legal/regulatory and operating risks.

Regulation in the power sector

A large number of ministries and government agencies influence the shape and magnitude of private and public investments in the power sector. An environmental protection agency might control where projects are built, the technology used and the cost and reliability of the service (for example by limiting the size of the reservoir in a hydropower project). Approval for new large-scale investments might be required by the Ministry of Planning. The central bank might need to approve debt service payments on foreign loans and expatriation of profits. The Ministry of Labour might impose requirements regarding health and safety. The judiciary provides the instruments for settlement of legal disputes, etc.

In addition to this broader regulatory framework, there is a need for special regulatory institutions and instruments governing the power sector. The nature of the institutions and the instruments used will depend on the legal and administrative traditions in the country, as well as on the market structure and the forms of private participation in the sector.

In principle, the regulatory regime depends on the structure of the market and not on the ownership of the assets. In practice, however, independent regulation of state-owned monopolies has rarely been successful in improving commercial performance.

If private participation is limited, regulation of the private companies can often be achieved through contracts rather than through elaborate regulatory machinery, which is commonly the case with independent power producers operating under BOT type of arrangements.

If the public utility has been "unbundled" and the private sector participates more widely in the electricity sector, there is a need for more elaborate arrangements. Transmission and distribution that constitute natural monopolies must be regulated to ensure that the public's interests in terms of service quality, access and tariffs are properly reflected and that generators are provided with equitable access to the grid and to consumers. Generation activities need to monitored and regulated to ensure that competition actually takes place and that the public benefits from lower production costs. The oligopolistic structure of the generation segment makes it possible for certain firms to exercise market power and manipulate prices. The use of cost-based rather than bid-based wholesale competition is part of efforts to limit market power.

Independent regulation can be a major challenge for many developing countries. The first problem concerns the availability of staff with appropriate training and experience to carry out the complex regulatory tasks. Tariff setting is often a sensitive political subject and even if the

regulatory authority has a de jure responsibility for tariffs, the Cabinet and the line ministry concerned sometimes retain the de facto power to approve tariff increases. A third problem relates to the relative power and influence of the regulator and the regulated enterprises. Finally, there is a risk that the regulator is "captured" by vested interests, possibly through outright corruption.

Factors shaping the scope for private participation in the power sector

Besides the legal and regulatory framework within which private electricity enterprises are expected to function, the scope for private participation is determined by a number of other factors, such as:

- *Limited availability and convertibility of foreign exchange* (i.e. the host country's weak balance of payment and its associated lack of creditworthiness) which makes servicing of loans and repatriation of profits uncertain; and
- *Shallow domestic financial markets and high costs of local debt* forcing developers to raise equity and debt internationally, even if a major share of project revenues and/or construction costs is in local currencies.
- *The willingness of lenders to take emerging market risk* tends to vary over time and between regions for a number of reasons, including "contamination" from isolated currency crises and changes in regulatory treatment of emerging market debt; and
- *The strategic focus of global power developers* has changed drastically over the last decade. They appear to have lost some of their appetite for emerging market risks and are consolidating and focusing more on closer markets (in OECD countries).

Since the Asian crisis, there has been a dramatic turn in investor sentiment. In the past few years, investments in power projects with private participation have been only about one third of the all-time high of US$ 44 billion in 1997.

There are a number of factors behind the dramatic decline in the interest of global power investors. The Asian crisis demonstrated that long-term power purchase agreements backed by government guarantees provided only limited protection against the impact of steep currency devaluations. The competitive wholesale markets in Latin America did not provide the

expected returns to investors in distribution companies, who suffered from poorly implemented regulatory frameworks and external shocks such as the devaluation in Argentina, or outright non-performance of the government as in the Dominican Republic. At the same time, project developers learned that country governance problems could have a major impact on their investments in countries such as Pakistan and Georgia.

Internal problems and strategic shifts in business strategies have also led to a retrenchment of major global developers. Some international firms have taken advantage of this retrenchment and created significant portfolios of power assets. Similarly, some local companies have been buying distressed assets. Indeed, developing country firms have become more active – not only in their domestic markets but also in other developing countries especially within the same region.

Foreign lenders remain especially reluctant to invest in low-income countries and typically require credit enhancements from export credit agencies and support from the multilateral development banks and their affiliated private sector entities. Indeed, the multilateral organizations supported nearly one third of all power projects with private participation in low income countries. In spite of this support, private power schemes remain a small fraction of the investment needed in the sector, which implies that public sector financing will have to continue to play a major role within the foreseeable future.

The impact of private participation on the power sector

A number of studies of varying scope and quality have been undertaken to assess the impact of private participation on the power sector. They have generally found significant improvements in utility performance in terms of financial viability, system losses and quality of service. However, given the monopolistic characteristics of the power sector, efficiency improvements represent only one part of the picture. Such efficiency improvements might only benefit the private owners/operator and not the consumers, the government and society at large. Thus what is needed, from a public policy point of view, is an assessment of the overall impact on public welfare. Such assessments are, unfortunately, very hard to undertake and require an extensive data collection effort. More importantly, the analysts need to make reasonable assumptions about the "counterfactual," i.e. what would have happened without sector restructuring and private participation. The problem becomes even more complicated if the objective of the analysis is to estimate the impact on different stakeholders (for example, the impact on the poor). In short, the various studies

show that efficiency improvements resulting from private management of power systems do not necessarily lead to benefits for consumers. However, if private participation results in a more rapid expansion of service and improved access for the poor, welfare increases can be very significant.

General strategy for the development of the power sector in developing countries

In conclusion, private participation has not been a panacea for development of the power sector in developing countries. Still, experience has shown that private enterprises can bring essential management skills and financing to the sector. The general strategy for low income countries and most lower-middle income countries can be summarised as follows:

- Introduce simplified solicitation procedures and contracting models for smaller, locally owned and financed generating projects;
- Unbundle the utility only if it is sufficiently large (annual sales exceeding, say 5,000 GWh);
- Use management and lease contracts to help improve operating performance of state-owned assets;
- Encourage local entrepreneurs to set up smaller (village/neighbourhood) systems in unserved areas and simplify concession arrangements (including permitting lower technical standards) for such schemes;
- Adopt a single buyer model for new generating capacity and enter into new contracts (based on two part tariffs rather than take-or-pay arrangements) only after competitive bidding;
- Allocate public sector subsidies to grid extension and connection of rural and peri-urban, low-income consumers.

Market models in the oil and natural gas sector

The activities in the oil and gas sector comprise segments with varying scope for competition: (i) upstream activities i.e. exploration, field development and production of oil and/or gas; (ii) oil refining; (iii) wholesale and retail distribution of petroleum products; and (iv) transmission and distribution of natural gas.

The market model that has evolved in upstream activities is that countries auction off exploration-production rights in certain areas (normally

referred to as "blocks") to joint ventures (JVs) of foreign firms. The JV is typically required to pay a certain amount up front for the concession but the most important criterion for selection is the share of profits and/or the production that they are prepared to give to the state. The state-owned oil company is often a mandatory partner in the JV. Thus, the government receives revenues from the JV in the form of: (i) up-front payment for the concession; (ii) royalties on the amount of oil or gas pumped; (iii) a share of the profit and a share of the oil/gas produced; and (iv) taxes on the profits of the JV. Through the competition for the exploration and development rights, the state maximises its revenues from the concession and through the profit or production sharing formula it will benefit from any "upside" due to rising oil/gas prices. This model has so far proven to be successful in attracting capital for oil and gas development in even such remote places as Chad. However, it has come under stress in many countries over the last few years when petroleum prices have boomed and some host governments have felt that the international JV partners have made excessive profits.

Refining is a highly capital intensive activity that has generally been a state monopoly, but the market has gradually been opened up through divestitures, especially in Eastern Europe and Central Asia. In many other cases, there has been strong resistance against divestiture (such as in Mexico where the constitution requires that refinery assets are owned by the state). In other countries, the refineries are of little interest to potential buyers since they are small, old, inefficient and environmentally unsound and produce an outdated product mix. Thus, the most important reform typically is to allow free import of petroleum products.

Within the oil and gas sector, the import and distribution of petroleum products is the market segment that potentially can be most competitive. While there obviously are some economies of scale in import and storage and some economies of scope in having vertically integrated companies, the merit of state monopolies controlling both the wholesale and retail market is doubtful.

Provided that safety aspects can be adequately handled, it appears that significant efficiency gains can be achieved by breaking down the old vertically integrated monopolies, privatizing the individual gas stations and allowing new entrants into the whole distribution chain. Especially in the case of products such as LPG and kerosene, market liberalization is likely to significantly improve access in peri-urban and rural areas. The challenge from a policy and implementation point of view is to replace the system of implicit taxes and cross-subsidies that prevail in many state-owned oil companies with a transparent, explicit system of taxes and subsidies.

Until some 15 years ago, international oil companies had little interest in finding and producing natural gas in developing countries, largely because they saw little demand in the local market and the export potential was too limited to justify the heavy investment in both gas fields and gas pipelines or complex and capital intensive LNG transportation infrastructure comprising liquefaction facilities, ships, storage and regasification terminals. Advances in combined cycle gas turbines have made the use of natural gas more attractive and a handful of developing countries have entered the export market while others, such as Nigeria and Angola, are planning to do so. The development of gas fields follows a contractual regime similar to that of oil fields. Export sales are usually through long-term contracts negotiated between the parties. Little government regulation is generally needed.

Since they tend to be natural monopolies, the issues related to gas distribution companies serving a broad range of customers are virtually identical to those related to electricity distribution and transmission. Thus, outright divestitures have taken place predominantly in Eastern Europe, Central Asia and Latin America. The regulatory regime and the key considerations are similar to those in electricity transmission and distribution.

Reform of district heating systems

District heating is a system for central generation and distribution of heat to residential and commercial areas. In the simplest systems, a boiler fueled by gas, oil, coal or biomass produces hot water (or steam) that is distributed in insulated pipes to the customers. A more efficient approach is usually to combine the generation of heat with the generation of electricity (usually referred to as "cogeneration").

District heating systems – if properly designed and well managed – offer certain advantages: lower overall investment costs, higher efficiencies and greater potential for the economic installation of exhaust cleaning technologies. They are widely used in Eastern Europe and Central Asia. Indeed, heating is critical to the welfare of the people in these countries. However, the difficult transition to market economies (often associated with drastic falls in incomes) and the legacy of inefficient, wasteful energy systems have created special problems.

Reform of district heating systems has tended to focus on technical and management improvements for the basic infrastructure while actions at the building and apartment level have been neglected. Better systems for charging for heat are required (taking into account potential free-rider problems and the transition underway on the housing market). There also

appears to be a need to develop energy service companies that can support individual households and building owners (private and cooperative) in addressing the need for improved energy efficiency at these levels. Furthermore, regulation and governance need to be strengthened, given the monopoly characteristics of individual systems.

The challenge of rural energy

The problem of access to modern energy is most severe in rural areas. Most countries in Eastern Europe and the former Soviet Union have basically achieved universal access to electricity. China and other countries in East Asia have made major progress in providing electricity to rural areas over the last couple of decades. In other regions, rural areas lag far behind cities and towns. Indeed, in many countries in Sub-Saharan Africa such as Mali, Tanzania and Uganda, only a few percent of the rural population are connected to the power grid. Responding to this problem, many governments have initiated ambitious programs for rural electrification. However, low population densities and low levels of household demand makes the extension of national power grids into remote rural areas very costly. This means that the focus of government policies and programs should be on improving access to energy services in the most cost-effective manner possible.

Off-grid and mini-grid solutions are often appropriate for meeting rural electricity needs. However, experience has shown that past "top-down" government and donor sponsored schemes often failed when maintenance needs increase after a couple of years. Thus, successful small scale schemes need to be demand driven. The basic strategy involves the removal of regulatory constraints (such as forbidding private mini-grids within the concession area of a distribution company) as well as price distortions (such as high import duties or taxes and "biased" or selective subsidies). Various approaches have evolved to both provide incentives to private entrepreneurs or NGOs to assist in the spread of off-grid electricity and, in some cases, provide subsidies to end users.

Energy efficiency

In many developing countries, numerous opportunities exist to improve energy efficiency through cost-effective commercial technologies with short payback periods on investment. Energy efficiency offers significant opportunities to reduce both urban air pollution and greenhouse gas emissions, enhancing the positive environmental impact of these investments.

Energy efficiency technologies can bring sustainable development and financial benefits, such as reduced need for new power plants. With some notable exceptions such as EGAT in Thailand, most public monopolies have tended to neglect energy efficiency measures. There were no incentives for public utilities to carry out efficiency measures and without any incentives, delivery of services tended to be of substandard quality and operational inefficiencies (measured by high technical and non-technical losses) were commonplace.

As economic and sector reforms became more widespread, the traditional energy efficiency project characteristics (government-financed, state agency implemented and supply driven) are becoming unsustainable. The private sector is taking on an increasingly central role as counterparts that intermediate and deliver energy efficiency projects. Energy efficiency requires a policy framework that fosters competition, rational pricing and appropriate standards and that provides a stable legal system, adequate procurement rules and cost-effective subsidies. Finally, incentives for energy service companies to implement more energy efficiency projects should be developed to broaden the application of technologies and expand the reach of these projects to as many countries as possible.

Renewable energy

Given growing concerns about global warming, industrialised countries have, over the last decade, placed increased emphasis on the use of renewable energy. However, the costs of many of these sources have long remained well above the cost of fossil fuel-based alternatives. Although some developing countries (such as Brazil, China, India and Thailand) have long promoted the use of various renewable technologies, the recent rise in oil prices has rekindled interest in biofuels in many other developing countries. The cost of producing ethanol and biodiesel depends on the cost of the agricultural raw material and, unfortunately, few developing countries can produce sugarcane, corn or vegetable oils at a cost that makes biofuels competitive with fossil-based alternatives if crude oil prices are below US$ 50 per barrel. The most recent projections by the World Bank and the US Energy Information Administration indicate that crude oil prices are likely to decline from their high in 2006 and be in the range of US$ 30–50 per barrel during the 2010–2015 period.

Technological advances and economies of scale in manufacturing have significantly reduced the cost of electricity generation using solar and wind power, but it still remains higher than the cost of efficient thermal generation. However, solar and wind power as well as other small-

scale renewable energy sources are often economical in rural areas where the cost of building power grids is high.

Hydropower offers the greatest potential for cost-efficient renewable generation in developing countries with adequate water resources. However, large scale hydropower schemes often have far reaching environmental, social, cultural, technical, financial and economic impacts. Without mitigating measures, these impacts are unevenly distributed, potentially creating both winners and losers. Hydropower projects not only offer the prospects of high rewards but also carry high risks with them.

The growing awareness of the impact of dams on natural habitats and the livelihoods of the people affected led governments and donors to gradually curtail funding for hydropower. The World Commission on Dams (an independent body comprising 12 members from governments, the private sector and civil society) developed a set of guidelines that addressed the social and environmental aspects of dams. These guidelines have subsequently been developed further and refined by UNEP, the World Bank and others. If dams are planned, built, operated and, ultimately, decommissioned following the emerging global "best practices," hydropower can provide a cost-effective, environmentally sustainable and socially acceptable source of renewable energy.

Governments should aim at creating an institutional infrastructure that makes energy conservation a profitable commercial undertaking rather than investing directly in energy efficiency projects. As such, energy service providers or energy service companies (ESCOS) should be supported to offer a broad range of options not only to satisfy customers' needs but to take advantage of alternative energy sources, renewable resources and energy-efficient services already in use.

Quite naturally the interest in, and orientation of, policies and programmes promoting the use of renewable energy sources depend on the local resource base. The instruments used to achieve these targets depend on a number of factors such as budgetary resources, as well as the structure of the power sector and the market model adopted. In some cases, the energy ministry can simply issue instructions to the state-owned power utility. Generally, however, the government needs to provide financial incentives and/or change the principles for risk sharing for private owners of power plants. Thus, there is a whole menu of policy options that developing countries have or can put in place to encourage the development of wind, solar, hydro and waste generating plants

Reduction of greenhouse gases

The Kyoto Protocol has created various instruments that encourage developing countries to reduce greenhouse gases. The main mechanisms are the Joint Implementation (JI) procedure and, especially, the Clean Development Mechanism (CDM) that can help mobilise additional funding for projects that reduce greenhouse emissions. In principle, these mechanisms are open to both private and public sector energy companies. However, both mechanisms are subject to complex international and national negotiation and verification regimes, which explain why project-based emissions transactions have been concentrated in a small number of countries with high institutional capacity. The bureaucratic nature of the process might limit the ability of small private companies in low-income countries to take advantage of the Kyoto mechanisms.

Gender aspects

When gender has been taken into account in energy planning, the concern has typically been narrowly focused on women's role in cooking, collecting firewood and fetching water. However, there is a need to take a much broader approach and consider all economic activities undertaken by women..

Men and women not only have different energy needs but also different access to resources and input into the decision making process – be it at the household, community or society level. Some of this can be studied and analysed, but studies are no substitute for active involvement and consultation with stakeholders. Indeed, this is true for all energy services targeted at the rural and urban poor. The present supply-oriented planning paradigm for the energy sector needs to incorporate a comprehensive demand-side analysis of all the energy needs of poor people in order to support all their livelihood functions, taking into account their particular constraints and opportunities.

As countries have moved to mainstream gender issues into their development planning, it has become clear that women must not only be regarded as consumers of energy services, they must also play a role as energy suppliers, i.e. decision makers, entrepreneurs and workers. Addressing gender imbalances generally begins with a "gender audit." Unlike financial audits that are external, gender audits are generally internal exercises undertaken jointly by managers and staff. These audits are forward-looking instruments that form the basis of concrete action

programmes for mainstreaming of gender issues into all aspects of the organization's operations.

Indoor air pollution from use of biomass in traditional stoves forms a serious health hazard to women and children. Significant health benefits and other social benefits can be achieved through improved stoves and a switch from wood and dung to modern fuels. For example, it has been estimated that switching from cooking with wood to coal will reduce health risks by a factor of four. A shift to kerosene results in a reduction by a factor of six. Using LPG reduces the overall health risk by a factor of more than 100. Kerosene and LPG are also suitable sources of light when electricity is not available. The use of fuel wood also contributes to deforestation in many drier climates.

Programmes to introduce improved stoves and modern fuels for cooking have had mixed success, often due to a failure to take into account the concerns of women and to consider the utensils that the family owns. In other cases, programmes have had unintended negative effects. This has been the case in Bangladesh and some parts of India where poor women and girls collect cow dung, form it into cakes and let the dry. The dung cakes are subsequently sold, providing an important supplemental income for the household. Obviously, programmes resulting in reduced demand for dung cakes may result in an income reduction for poor women.

Energy security

The issue of global energy security came about as a result of the 1970s oil shock which altered the economic thinking of many oil importing countries. Few of these countries had the necessary foreign exchange reserves to absorb the enormous price increases, which significantly impacted their macro-economic position and fiscal balance. While energy security was enhanced in some countries in response to this phenomenon through greater reliance on domestic resources, bilateral energy trading and access to regional markets, a great number of countries exposed their vulnerability to significant price fluctuations. Thus so far, energy security has been more a question of price volatility which, in turn, is highly dependent on geopolitical developments in oil- producing countries, rather than the physical availability of energy.

Temporary shortages are more likely to occur for refined products than for crude oil. Domestic refinery capacity can help mitigate against such events. Longer term supply contracts – although typically somewhat more expensive that spot market purchases – is a common approach to protection from price volatility.

There is also a risk of supply interruptions, especially in the power sector. Centralised energy infrastructure, while efficiently exploiting economies of scale in construction and operation, is also vulnerable to large-scale disaster and loss. Reducing infrastructure vulnerability through distributed generation is a potential element of enhancing energy security.

Another strategy aimed at enhancing energy security is to diversify sources of supply and promote regional cooperation in energy supply. Market forces have led to the construction of regional oil and gas pipelines as well as development of international trade in LNG. Gradually, regional transmission networks for electricity are being created in Central America, Southern and Western Africa. However, regional power grids are difficult to put in place. The private sector has shown little interest in such schemes. Rather, they involve the participation of several governments in planning, development, financing and implementation of policies and projects that benefit all participants.

Tariffs and subsidies

Given the social and economic importance of energy services, many governments have subsidised certain forms energy and/or certain consumer groups. Unfortunately, many of these subsidies have been poorly targeted and have distorted incentives. Furthermore, the subsidies – especially for electricity – have undermined the financial viability of power utilities and curtailed investments as well as maintenance expenditures. The end result has often been unreliable – but subsidised – services for a privileged few connected to the power grid while the great majority of the population has no access. Energy subsidies can have major macroeconomic impacts. It has been estimated, for example, that explicit and implicit subsidies to electricity consumers in the Kyrgyz Republic amounted to 16% of GDP in 1999.

Many studies show that the poor are often willing to pay for higher-quality energy services (such as electricity, LPG and kerosene) but are deterred from obtaining these services by high access costs (high connection fees, deposits for LPG bottles, etc.) or the unavailability of services. As such, the benefits of access may justify some form of subsidy for the front-end costs, such as lower connection fees or credits for new connections for electricity, and smaller initial service fees and smaller bottles for LPG users. Especially when it is desirable to extend service to previously unserved groups, the subsidy can be structure along the principles of output-based aid.

Governance in the energy sector

The high cost of energy services in developing countries – and thus the "need" for subsidies – is largely a result of poor governance of state-owned utilities. These enterprises are used as instruments of the government's political, social, and economic objectives, which obfuscates the commercial objectives of the enterprises and dilutes management controls, the transparency of their operations and the accountability of enterprise managers. Gradually this can lead to corruption, inefficiency, overstaffing, poor standards of supply and service, poor financial performance of enterprises and a fiscal burden on the state. Indeed, surveys by Transparency International consistently rank petroleum and electricity among the sectors where corruption is most prevalent.

The energy sector suffers from both "petty" and "grand" corruption. The so called "petty" corruption involves such items as illegal connections carried out with the connivance of the line men, bribes to meter readers to under-record the amount of power used, facilitating payments to obtain a new connection. "Grand" corruption is what tends to grab the headlines: kickbacks on major contracts to sell or buy oil, construction of power plants, etc. It appears, however, that the aggregate amounts involved in "petty" corruption are significantly larger than those collected through "grand" corruption. Because of its nature, petty corruption is even harder to combat than grand corruption. Traditional management techniques (better accounting and auditing, supervision, "zero tolerance" policies, regular rotation of staff, etc.) need to be complemented by tools such as Citizen Report Cards and Community Score Cards for monitoring and reporting on the quality and reliability of service delivery at ground level.

However, poor governance in the energy sector involves much more than corruption. In simple terms, "governance" comprises a myriad of factors that influence access to and price, quality and reliability of service. Indeed, unreliable power supply and associated black-outs and brown-outs can impose a heavy burden on the economy. The cost of power outages in Bangladesh, for example, has been estimated at 1.7% of GDP.

The reforms described in this report – involving elements of (i) private participation and introduction of competition; (ii) strengthened regulation; (iii) removal of price distortions; and (iv) participation of civil society at both sector and project levels – are largely aimed at improving governance and resource mobilization in the energy sector.

Introduction

CHAPTER 1

1.1. Energy is essential for development

Energy provides heat, light and motive power. Indeed, access to modern energy services is essential for sustainable development, as described in a key background document for the World Summit on Sustainable Development[2]:

> *"…The way in which these services are produced, distributed and used affects the social, economic and environmental dimensions of any development achieved. Although energy itself is not a basic human need, it is critical for the fulfillment of all needs. Lack of access to diverse and affordable energy services means that the basic needs of many people are not being met."*

Still, modern energy services are scarce in many developing countries and the main energy sources are traditional biomass fuels (see Figure 1 below). The International Energy Agency (2002) estimates that some 2.4 billion people use biomass for cooking, often threatening both the local environment and the health of the users. It also estimates that some 1.6 billion people are without electricity.

There is a strong relationship between energy and economic development, which is clearly shown in Figure 2 below. This relationship is complex and varies from case to case. In some cases, the availability of modern energy services can act as a powerful catalyst for development. For example, the spread of diesel, gasoline and electrical irrigation pumps provided a strong impetus for groundwater exploitation in India and was a major force behind the green revolution. But, as noted in a recent assessment of microhydro installations in Nepal and Kenya (ITC 2002), the provision of energy infrastructure and services will not automatically lead to the creation of

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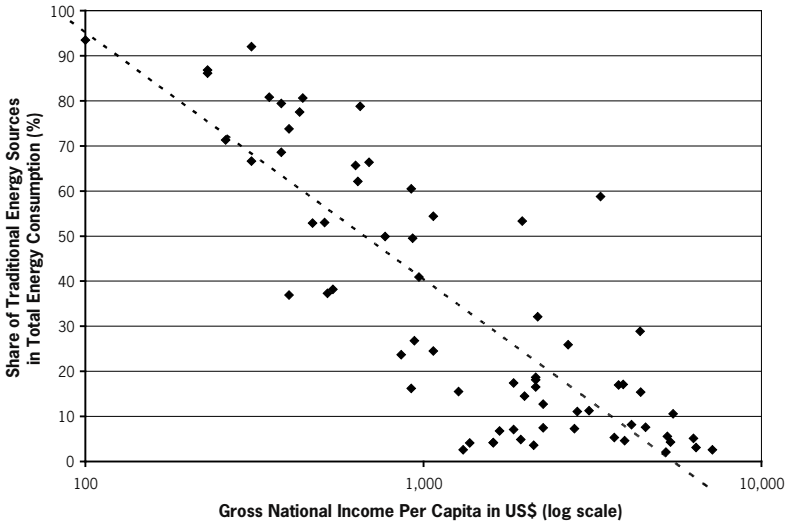
2 WEHAB Working Group (2002, p. 7)

enterprises and income generation. Consequently, access to modern energy should be viewed as one of a suite of critical enabling factors that act individually and/or in concert to create a suitable environment in which farmers, small and large enterprises can operate. In short, access to modern energy is a necessary, but insufficient, condition for economic development.

Figure 1: The importance of traditional biomass fuels[3]



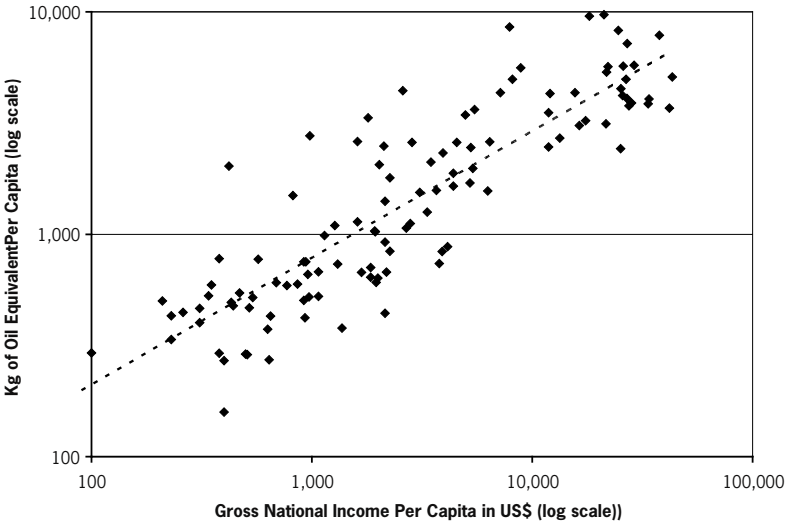
Data for 2003
Source: WDI 2006

An idea of the economic benefits of access to modern energy can be obtained from an examination of what happens if the energy supply is interrupted. In Bangladesh, for example, the average industrial enterprise experiences power blackouts lasting about two hours per day. The resulting financial loss due to these interruptions is estimated at around US$ 780 million or 11–12% of industrial value added (Nexant, 2003a). The economy-wide cost of blackouts and load-shedding in Pakistan in the mid-1990s was estimated by the World Bank (1995) at US$ 950 million.

Access to modern energy sources also brings major social benefits. Using Liquefied Petroleum Gas (LPG) or kerosene rather than traditional stoves fuelled by biomass reduces indoor air pollution and the associated health hazards. Electricity enables students to study at night, provides re-

[3] See *Note on Data Sources* in this report for a discussion of data sources.

Figure 2: Energy use and per capita income



Data for 2003
Source: WDI 2006

frigeration for vaccines in health clinics, powers pumps that supply safe drinking water, lights streets and improves safety... The list is virtually endless. Indeed, a recent UN (2005) publication describes how better energy services can help achieve the Millennium Development Goals (Box 1).

Box 1: Energy and the Millennium Development Goals

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 in order 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 illnesses 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, 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. Health care 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: Energy production, distribution and consumption has 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.

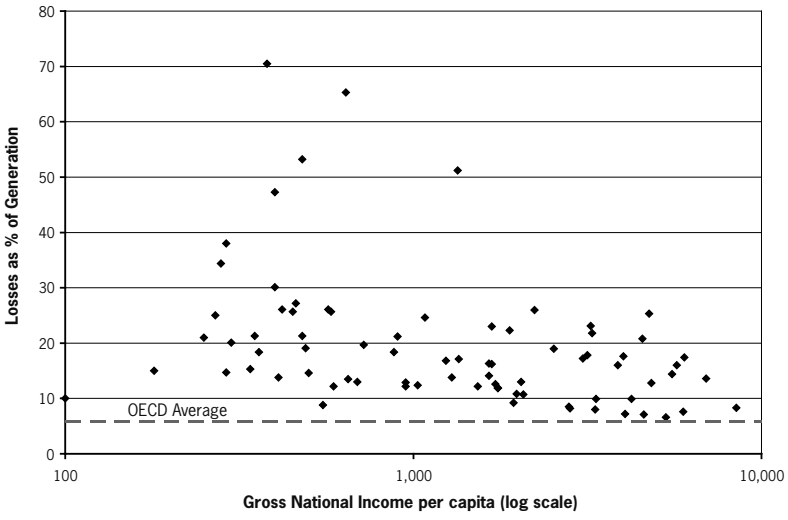
Quoted from United Nations (2005)

1.2 The changing roles of the state

Given the importance of energy in the development process, the state played an increasingly dominant role in this sector until about a decade ago. National oil corporations became the sole importers, refiners and distributors of petroleum products. Vertically integrated utilities (see ch. 2.1) generated, transmitted and distributed electricity. These vast monopolies operated with weak supervision and soft budget constraints. They became vehicles for political patronage and breeding grounds for corruption (see, for example, Lovei & McKechnie, 2000, and Transparency International, 2002). Overstaffing, inefficiencies and political interference in tariff setting meant that financial losses mounted to such an extent that in the early 1990s, the average power utility covered only about 60% of its costs (World Bank, 1994). One

– of many – indicators of the inefficiencies found in the power sector is the high losses in transmission and distribution including theft, as shown in Figure 3.

Figure 3: Power system losses in developing countries



Data for 2003
Source: WDI 2006

During the 1960s and the early 1970s, development policy focused on investments in basic infrastructure and industrial facilities. The state was a leading actor, seeking to control "strategic" sectors (such as energy and mining) and moving into areas where it perceived that the private sector was slow to act (for example, agricultural marketing). Capital formation was supported through control of the banking system, either through outright ownership or through heavy-handed regulation keeping interest rates low and directing loans to "priority" sectors. The desire to protect "infant industries" and the need to raise public sector resources led to high tariffs on imports (as well as quantitative restrictions) and sustained inefficient manufacturing enterprises.

Rising oil prices following the Yom Kippur War[4] and culminating in 1981 during the early phase of the Iran-Iraq War, combined with declining non-petroleum commodity prices created widespread balance of pay-

[4] The Yom Kippur War was fought in October 1973, between Israel and a coalition of Arab states led by Egypt and Syria.

ment problems. At the same time, many developing countries experienced mushrooming budget deficits and rising inflation. The initial response was IMF supported stabilization programs aimed at restoring internal and, especially, external balances. However, it was soon clear that these programs led to a contraction of economic activity and that restoration of growth required changing the way most developing economies worked. These structural adjustment policies sought to enhance the efficiency and competitiveness of local economies by lowering tariffs, removing import tariffs and liberalizing domestic markets, especially financial markets.

1.2.1 Bureaucrats in business

It also became obvious that the large, state-owned enterprise (SOE) sector represented a major obstacle to growth in many – if not most – developing countries. SOEs tended to be less efficient than private firms and aggregate SOE deficits were typically financed in ways that undermined macroeconomic stability. Subsidies to SOEs often diverted scarce funds from growth-enhancing public spending such as education and health. In addition, SOEs usually received preferential treatment from (state-owned) banks and crowded out private enterprises. As noted by Shirley (1995, p. 3), the problem was to a large extent rooted in the nature of state ownership:

> *"Bureaucrats typically perform poorly in business not because they are incompetent (they aren't) but because they face contradictory goals and perverse incentives that can distract and discourage even very able and dedicated public servants. The problem is not the people but the system, not bureaucrats per se but the situations they find themselves in as bureaucrats in business."*

Straightforward divestitures (i.e. outright sales of public enterprises) were relatively easy and worked well in some manufacturing and service industries (like bakeries and hotels) that operated in competitive markets. In the energy sectors, where most enterprises were either "natural" monopolies or de facto monopolies, the process was more complicated and controversial.

1.2.2 Major paradigm shift

A major paradigm shift is, however, underway which is changing the way energy facilities are owned, operated and financed. Strapped for financial resources and realizing that infrastructure bottlenecks hampered economic growth, governments are increasingly building up their ability to regulate energy enterprises while divesting assets and/or encouraging the private sector to build and operate new facilities.

One key element of these reforms involves changing the existing market structure to expand the scope for competition. This can take the form of classical "competition in the market" or "competition for the market." Under the latter approach monopoly franchises are awarded through competitive bidding, this process being repeated on a regular basis which provides incentives for firms to perform well in order to retain their franchises. (Klein and Roger, 1994). In short, the role of governments is shifting from energy service provider to that of policy maker, regulator and facilitator of private investments. The private sector, especially in the form of multinational corporations, but also domestic firms, is gradually taking over service delivery. The role of civil society in this process is more muddled and still evolving. There is an emerging realization that the policy and strategy processes in the energy sector – as in other sectors – need to be guided by human rights concerns. Energy reforms and programs require attention to the effects on the environment, especially with regard to indigenous people.

Energy sector restructuring is a global phenomenon, though the direction and rate of change is country and sub-sector specific, and is motivated by different factors. This report reviews the progress so far and assesses the forces that shape the process and determine the outcomes.

1.3 Energy policy objectives

The use of fossil fuels and many renewable energy sources is associated with what economists refer to as "negative externalities". The emission of greenhouse gases and global warming were earlier primarily regarded as a concern for industrialised countries, but as economic growth and energy use have accelerated, developing countries are increasingly being called upon to take action. Indeed, it appears that China has overtaken the United States as the largest source of greenhouse gases. The International Energy Agency (2006) estimates that non-OECD countries now account for slightly more than half of all carbon dioxide emissions. However, these non-OECD countries will account for more than four-fifths of the growth in such emissions during the period up to 2030.

Increases in oil prices since 1998 have imposed a heavy burden on oil-importing, developing countries. The prospect of energy prices remaining high – or even increasing beyond their 2007 levels – has created a new impetus towards increased efficiency of energy use and expanding investments in renewable energy sources. Fortunately, new opportunities are opening up. The costs of some renewable energy technologies such as wind power and solar PV systems has been falling, and are expected to

continue to fall albeit at a more modest pace. This makes such technologies increasingly attractive. At the same time, considerable experience has been gained in the creation of institutional arrangements and the development of policies that support investment in energy efficiency improvements and renewable energy sources.

While there are doubtless new opportunities, policy makers in the energy sector also face significant challenges that are only gradually being addressed in a systematic manner. Managing a decentralised, primarily privately operated energy sector requires better use of incentives – in terms of taxes and subsidies – and regulation that not only protects consumers and promotes economic growth but also meets broader social and environmental objectives.

The purpose of this report is to describe the trends that are affecting the energy sector and the reforms that are under way. Special emphasis is placed on the changing roles of the state, private sector and civil society. The paper seeks to identify and analyse key development issues resulting from these changes, and to suggest how developing countries and their cooperation partners can best respond to these issues,

Energy policy is a part of a country's overall development policy. Thus, it needs to be consistent with overarching goals such as the promotion of economic growth, social development and poverty alleviation while ensuring sustainable use of natural resources, care for the environment, equality between women and men and security as well as reflecting respect for human rights, democracy and good governance (Box 2). These goals are complex and multi-dimensional and need to be made more concrete in order to serve as a guide for energy sector reform and policy formulation.

Energy sector objectives will vary not only from country to country but also over time. While the objectives may be expressed in quite general terms, choices between different policy, institutional or project options will typically be based on more explicit criteria, such as security of supply, and concerns regarding utilisation and environment (an example from Malaysia in Box 2).

1.4 Analytical framework

Discussions of energy sector reform – especially in the case of electricity – tend to focus on market structure, ownership and regulation. The assumption is that the virtues of competition and enlightened regulation will ensure that consumers have universal access and reliable service at the lowest possible cost while environmental and other public objectives

Box 2: Energy policy objectives and criteria

Energy policy objectives are situation specific. If properly articulated, they will reflect the government's overall development objectives, for example as reflected in its poverty reduction strategy and programme for achieving the Millennium Development Goals. Thus, the objectives will vary not only between countries but also over time.

The Government of Malaysia, for example, describes its energy sector objectives in the following terms:

> *"The Supply Objective: To ensure the provision of adequate, secure, and cost-effective energy supplies through developing indigenous energy resources both non-renewable and renewable energy resources using the least cost options and diversification of supply sources both from within and outside the country;*
> *The Utilization Objective: To promote the efficient utilization of energy and to discourage wasteful and non-productive patterns of energy consumption; and*
> *The Environmental Objective: To minimize the negative impacts of energy production, transportation, conversion, utilization and consumption on the environment."*
> (Quoted from the website of Malaysia's Ministry of Energy, Water and Communications, found at http://www.ktkm.gov.my January 20, 2007)

While energy sector objectives will often be quite general, choices between various options will typically reflect – to a greater or lesser extent – the following key concerns which need to be made more concrete in order to serve as a guide for energy sector reform and policy formulation:

- Economic growth and sustainability
  - Efficiency
  - Financial sustainability, soundness
- Impact on the poor and other vulnerable groups
  - Affordability
  - Access
  - Gender consequences
- Environmental sustainability
  - Use of renewable energy
  - Energy efficiency
  - Minimising negative environmental impacts
- Security of energy supply
  - Supply interruptions
  - Price spikes
- Democracy and good governance
  - Transparency (and minimising corruption)
  - Voice – especially for the poor
  - Human rights

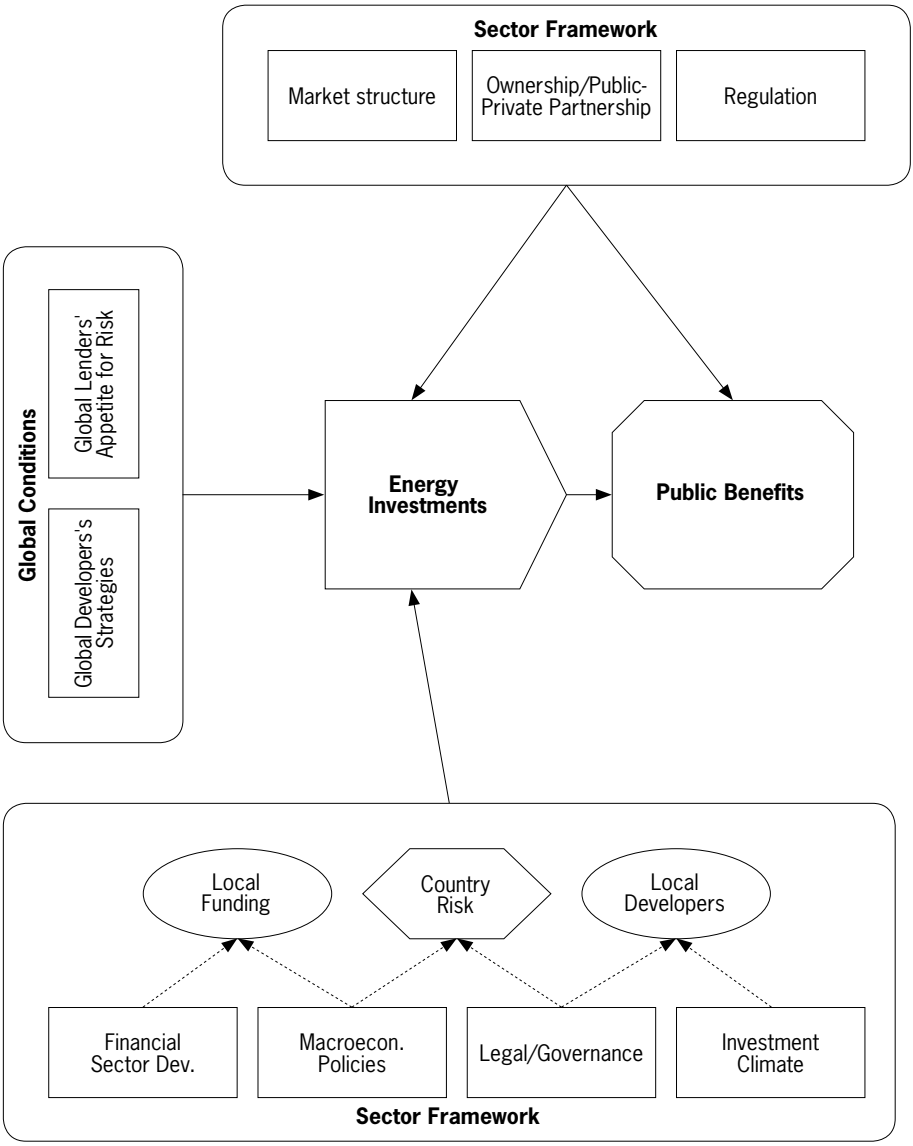
are served. The California power crisis in 2000, the spike in the Nord Pool spot prices to over US$ 0.12/kWh in early 2003, widespread blackouts in North America and Europe in recent years and sluggish development of renewable energy sources indicate that reality might not always conform to economic theory.

While it might only be minor flaws in the design of market reforms that have created problems in industrialised countries, developing countries face greater challenges in undertaking reforms. Basically, there are a number of factors that suggest that the private sector will respond differently to reform measures in, for example, Mozambique and Estonia. Also, response will not be the same at different points in time. Oil and gas exploration, for example, follows a clearly cyclical pattern. International power developers certainly have a much lower interest in building new generating plants in India today – although the policy framework has been improving – than they demonstrated in the mid-90s.

Consequently, the response to energy sector reform in a given country at a given time will depend not only on the measures taken in the sector but also on a wide array of country-specific conditions (such as the depth of financial markets, inflation, budget and balance of payment deficits, the extent of corruption, etc.) and global market conditions. Figure 4 illustrates these relationships. The relationships have important implications not only for design and sequencing of reforms in a given country but also for the type of assistance that donors such as Sida, should provide.

The emphasis of the discussion in the paper will be on the power sector because of its operational importance to Sida and its development cooperation partners, with only a brief review of reforms in the oil and gas sectors and district heating. The analysis will focus on energy delivery systems, i.e. it will follow traditional sector lines. However, this should not obscure the fact that various types of energy are substitutes. Wood, charcoal, kerosene, LPG and electricity can be used for cooking; wind, diesel or electricity – as well as animals or humans – can provide the power for groundwater pumping, etc. End users (households and enterprises) will choose whichever energy source that is most appropriate, taking into account not only the direct cost of the energy consumed but also connection charges, the cost of installation and appliances as well as the reliability of supply. This implies that the availability and price of one type of energy will influence the use of other types.

Figure 4: Conceptual framework



1.5 Outline of the report

The next chapter provides an overview of the global restructuring and reform process underway in power sector of developing countries. It examines the emerging role of private enterprises in the electricity supply industry and regulatory arrangements.

Chapter 3 reviews other factors that determine the most appropriate and/or feasible reform path for the power sector in low and lower middle-income countries. Emphasis is placed on the constraints imposed by the waning (or cyclical) interest of global power companies in developing countries and the risk aversion among international banks which limits their appetite for emerging market debt. It also notes the growing importance of local entrepreneurs in the development of the power sector.

Chapter 4 summarises various studies that have been undertaken to assess the results of various reform elements. Finally, the chapter draws appropriate conclusions regarding the most appropriate reform steps for the countries still at an early stage of the process.

Chapter 5 examines the reform process in other energy sectors, such as upstream and downstream oil and gas, and district heating.

Chapter 6 discusses the challenges associated with the provision of energy services in rural areas.

Chapter 7 addresses the issue of environmental sustainability by examining energy efficiency measures and renewable energy sources, as well as the role of the Kyoto Protocol and associated instruments, in supporting investments that reduce greenhouse gases.

Chapter 8 looks at a number of cross-cutting issues: energy and gender, energy security, regional energy cooperation, tariff policies and subsidies, and governance.

Chapter 9 concludes the report by outlining a general reform strategy for low and lower-middle income countries.

Power sector structure, ownership, regulation

CHAPTER 2

The power sector has a number of unique characteristics that affect the reform process in the power sector. (See Box 3 below). This process involves three discrete, but interrelated, elements: modifying the *structure of the industry* to enhance the prospects for competition, changing ownership patterns and/or creating various forms of *public-private partnerships* to provide stronger incentives for efficiency and growth and establishing a transparent *regulatory framework* to balance private and public interests. Each of these reform elements is discussed in the subsequent sections of this chapter.

Box 3: What makes the power sector unique?

Demand for electricity fluctuates widely not only with the seasons but also over any 24 hour period. Unfortunately, electricity can not be stored (in a commercially viable manner) and supply and demand need to be continuously balanced. Generation capacity needs to be sized to meet peak demand but will operate only intermittently or with varying load. Transmission systems must synchronize dispersed generating units into a stable network. However, flows in transmission (and distribution) networks are hard to control and any action in one part of the system can affect all other parts, with potentially disastrous results (as was illustrated by the blackout in southern Sweden in September 2003 that spread to parts of Denmark and the even more extensive blackout in north-eastern United States and nearby areas of Canada in August the same year).

Transmission and distribution networks are basically natural monopolies (since it is impractical to have several companies draw "criss-crossing" wires to consumers in a neighbourhood) while generating plants can "compete." Traditionally, there have been significant economies of scale in generation, although new technologies (especially combined cycle gas turbines) have largely removed these economies. The construction of new transmission facilities needs to be coordinated with the installation of new generating capacities and the growth of demand at the distribution system level.

This has meant that there also are economies of scope to be achieved through vertical integration (i.e. having one entity responsible for generation, transmission and distribution throughout a country, state or province).

In the short term, price signals cannot achieve a balance of supply and demand. Most consumers receive price information too late to adjust their demand in response to up-to-the-hour prices. The demand for electricity from the power grid is also highly inelastic as most consumers have no ready alternative source of electricity. Furthermore, as the available generating reserve capacity declines, the supply curve becomes increasingly steep until generation reaches the available capacity, at which point supply is completely inelastic.

2.1 Market structure – six basic models

The various organizational arrangements and modes of interaction between the entities in the power sector can be classified according to six basic models. These models are independent of the source of electricity.

- *Vertically Integrated Monopoly.* Until recently, virtually all electricity industries in developing countries were vertically integrated monopolies (i.e. they handled all generation, transmission and distribution) owned by national, state or municipal governments. Complementarities between generation, transmission and distribution resulted in economies of scale and scope, which is the main reason the industry evolved in this fashion (also in the US where the power utilities mostly are privately owned). There are some variations on this vertically integrated structure; for example distribution might be handled by local distribution companies. These vertically integrated utilities generally have full monopoly power in their service territory and operate under only weak supervision, except when it comes to tariffs that are typically set by the government. About 40% of all developing countries still follow this model.
- *Vertically Integrated Single Buyer.* The most common form of introducing private investments into the power sector is that the state-owned, vertically integrated utility buys electricity from independent power producers (IPPs). It does this by entering into long-term (typically 20–30 year) power purchase agreements (PPAs). In the early 1990s, many of these contracts were negotiated – with varying

degrees of transparency. The common practice today is that the IPPs are selected through a competitive tendering process where the main evaluation criterion is the price per kWh that bidders offer.

- *Single Buyer in Unbundled System.* The most common objective of power sector reform is to create an industrial structure that increases transparency and competition. This typically requires that the monolithic, state-owned utility be broken up into parts, a process commonly referred to as *"unbundling"*. In power generation, this involves the establishment of a number of autonomous producers ("Gencos") that are dispatched based on price/cost. Electricity distribution is split into a number of regional companies ("Discos") while the transmission network usually is kept intact as one entity ("Transco"). The central dispatch company (which may be the Transco or a separate entity) purchases all wholesale power from the Gencos under long-term PPAs, and sells it at a standard price to the Discos.
- *Cost-based Wholesale Competition.* The next step is the creation of a multi-buyer, multi-seller competitive power market. Prerequisites are that the power sector has undergone unbundling of generation, transmission, and distribution and that a regulatory authority has been established. Competition takes place at the wholesale power market level through bilateral contracts and a spot market. In smaller systems, it is difficult to prevent some larger generators from exercising market power and a modified wholesale approach is used: the system operator dispatches the plants based on the marginal cost of the last unit needed to meet demand. This is the prevailing model in Latin America (except Colombia). Because the dispatch is based on marginal cost, special arrangements are needed to ensure that generators can recover their capital costs. This is done either through contracting for capacity or through some formula adjusting payment to the generators to reflect their fixed, as well as variable, costs.
- *Bid-based Wholesale Competition.* In a bid-based system, generators provide supply curves indicating the amount of power they are willing to provide at different price levels. Major consumers and distribution companies similarly provide bids indicating the amount of power they would

like to purchase at different price levels. This is a pure competitive model where the price is determined based on market forces irrespective of the marginal cost of supply.

- *Retail Competition Model.* This involves transforming not only the transmission company but also the regional distribution companies into "common carriers" that transport the electricity (for a regulated fee) from the generating plants to the consumers. In this case, marketing companies buy the power at the wholesale level and sell it to the consumers and provide various value-added services to their customers. A functioning retail market requires a competitive wholesale market.

2.2 Main forms of public-private partnership

Electricity, like most other infrastructure services, has both positive and negative externalities. The negative externalities can often be "internalised" into the design of the scheme. The positive externalities essentially make electricity a "merit good." The implication of this is that reliance on private profit motives alone will not ensure that the power sector develops in a desirable manner.

As will be discussed later in this report, revenues and expenditures are only parts of considerations included in investment decisions by private firms in the sector; risks of various kinds are often the determining factors. Thus, depending on the circumstances, different models have evolved that provide for sharing of risks and rewards between the government, the consumers and the private sector (Table 1). The main forms of public-private partnership found in the power sector are:

- *Service Contracts.* The public enterprise employs a private contractor to undertake certain functions such as line repair or billing and collection. The contracts can be structured either to minimise the cost (for repairs) or provide incentives for improved performance (for collection).
- *Management Contracts.* A private contractor has full responsibility for day-to-day operations and routine maintenance. The public enterprise owns the assets and finances any new investments. The management contractor is typically responsible for billing and collection, but the owner controls the tariff revenues. The extent to which the contractor uses his own staff varies tends to vary from case to case

(depending on factors such as the duration of the contract and labour regulations). Typically, the contracts have performance incentives, but most of the commercial risk continues to rest with the owner.

- *Affermage Contract.* The state-owned company continues to own the assets and is responsible for capital investment but the system is operated by a private company. The operator's own staff operates and maintains the facility and undertakes all billing and collection. However, the revenues are shared – in accordance with a formula – between the owner (i.e. government utility) and the operator.
- *Lease Contracts.* The state-owned company continues to own the assets and is responsible for capital investment but leases the facility to a private contractor who pays a regular fee for the right to operate the assets. The operators own staff operates and maintains the facility and undertakes all billing and collection. The operator pays a predetermined lease fee. (If the enterprise is loss-making, the lease fee may be replaced by a payment from the state to the operator.) In general, a lease contract places more of the revenue risk on the operator than an affermage contract; in most other respects they are very similar.
- *Design-Build-Operate Contracts (DBO).* If private financing is not available, a design-build-operate contract can provide assurance that life-cycle costs are minimised and that private sector skills are also applied during the operational phase of the facility. The owner mobilises the financing and pays an annual fee to the contractor.
- *Concessions.* The state continues to be the owner of the assets, but transfers responsibility – through a concession agreement – for both financing of new facilities and daily operations and maintenance to the private concessionaire. The private concessionaire collects the revenues from the consumers to cover its capital and operating costs. At the end of the concession period (typically) 20–30 years, the private concessionaire is required to return the assets and the operating responsibility to the state-owned utility, or the concession may be renewed. "Privatisation" of distribution networks is commonly carried out through concession arrangements. A variation of the concession concept (in the form of repair-operate-transfer (ROT) contracts) is

often used to attract private capital for rehabilitation and subsequent operation of power plants.

- *Build-Own-Operate-Transfer Contracts (BOT).* Under this type of arrangement, the government entity enters into a long-term, off-take contract with the private party who builds and operates the plant for a certain number of years. At the end of the contract period, ownership of the assets is transferred to the government. Such projects are typically financed through non or limited recourse technique under which the lenders, in case of default-only have recourse to the assets and revenue streams of the project and do not have recourse back to the balance sheet of the original sponsor. Project financing is set up with a carefully crafted set of security agreements defining the rights and obligations of all parties: the utility off-taker, fuel suppliers, investors, lenders, operators, engineering construction firms, etc. There are various permutations of the BOT concept such as *Build-Operate-Own (BOO)* (if the assets are not transferred to the government) and build-lease-transfer (BLT). The BOT model is best suited for large facilities such as power plants and water treatment plants or refineries. Typically, the owner takes all commercial risks except that the off-taker assumes part or all of the market risk.
- *Divestitures.* Through the divestiture, full ownership of the assets is transferred to the private company that in turn takes full responsibility for capital investment, operations and maintenance. The assets are owned by the buyer in perpetuity. Following a divestiture, the investor takes on the maximum levels of market, legal/regulatory and operating risks. Consequently, the investors typically seek various assurances from the gov ernment, which are spelled out in the sale and purchase agreement and in other related agreements such as the tariff methodology.

2.3 Regulatory arrangements

A large number of ministries and government agencies influence the shape and magnitude of private and public investments in the power sector. An environmental protection agency might control where projects are built, the technology used and the cost and reliability of the service (for example by limiting the size of the reservoir in a hydropower project). Approval

Table 1: Key features of private participation options

Option	Asset Ownership	Operation & Maintenance Responsibility	Capital Investments	Commercial Risk	Typical Duration	Primary Application	Main Type of Facility
Service contract	Public	Public & private	Public	Public	1 – 2 years	Operations	Any
Management contract	Public	Private	Public	Public	3 – 5 years	Operations	Any
Affermage	Public	Private	Public	Shared	5 – 15 years	Operations	Network
Lease	Public	Private	Public	Shared	5 – 15 years	Operations	Network
Design-build-operate	Public	Private	Public	Shared	1 – 10 years	New construction	Generation, transmission
Concession	Public	Private	Private	Private	20 – 30 years	Operations & new construction	Network (ROT for generation)
Build-operate-transfer (BOT)	Private	Private	Private	Private	20 – 30 years	New construction	Generation, transmission
Divestiture	Private	Private	Private	Private	Indefinite	All	Any

for new large investments might be required from the Ministry of Planning. The Central Bank might need to approve debt service payments on foreign loans and expatriation of profits. The Ministry of Labour might impose requirements regarding health and safety. The judiciary provides the instruments for settlement of legal disputes, etc.

In addition to this broader regulatory framework, there is a need for special regulatory institutions and instruments governing the power sector. The nature of the institutions and the instruments used will depend on the legal and administrative traditions in the country, as well as on the market structure and forms of private participation in the sector.

In principle, the regulatory regime depends on the structure of the market and not on the ownership of the assets. In practice, however, few public sector firms respond to financial incentives and, as the World Bank (2004a, p. 9) notes:

> *"…there is no strong evidence in developing countries that independent regulation of state-owned monopolies has successfully improved commercial performance. Nonetheless, such regulation can make better known the deficiencies in performance of the public utility, and improve transparency and accountability simply by reporting and benchmarking performance and thereby increase pressures for change."*

Thus, while the state-owned utility remains vertically integrated and the role of the private sector is more limited, regulation of the private companies can often be achieved through contracts rather than through elaborate regulatory machinery. This is certainly the case for service and management contracts. It has also been the rule for independent power projects based BOO/BOT type arrangements. BOO/BOT schemes are structured around a large number of contracts (sometimes more than a hundred) between all participants. The key documents are the power purchase agreement (PPA) between the state-owned utility and the project company and the implementation agreement (IA) between the government and the power producer. The PPA defines tariffs and reliability/availability and other technical requirements. It also contains all other commercial conditions such as billing and payment as well as conflict resolution procedures. The IA defines the rights and obligations of the private power company and the government. Items such as the right to expatriate profits and access to foreign exchange for debt service are typically covered in the IA. Frequently, there is also a guarantee agreement between the government and the project company. This agreement typically commits the government to compensate the project company if the state-owned utility fails to

live up to its financial obligations, such as timely payment of the tariff agreed under the PPA.

If the public utility has been "unbundled" (broken up in parts) and the private sector participates more widely in the electricity sector, there is a need for more elaborate arrangements.[5] (For an illustration see Box 4.)

Box 4: Regulation of the power sector in Chile

In Chile, excluding the Judiciary System, five institutions govern activities in the electric industry:

The *Antitrust Commission* is devoted to preventing non competitive behaviour in all markets, including the electricity sector. The commission has an investigative branch (the Prosecutor's Office) and two independent commissions. The Preventive Commission is a regional, first-instance judiciary body allowed to punish non-competitive practices. The national Resolutive Commission is a second-instance court, also allowed to punish wrongdoing. The Supreme Court is the only instance of appeal for sanctions applied by the Antitrust Commissions.

The *Ministry of the Economy* has the right to set tariffs (as proposed by the CNE) and promote the efficient development of the generation, transmission and distribution sub-sectors.

The *Superintendency of Electricity and Fuels (SEC)* is an independent supervisory agency (related to the Ministry of the Economy) in charge of monitoring compliance with the law and regulations. It also controls the quality of service and safety of facilities, processes applications for concessions and prepares the information required to set tariff rates.

The *National Energy Commission (CNE)* is an advisory government agency on all matters related to energy (including electricity, fuels, nuclear power, etc.). Its duties include establishing sector policies and development strategies, studying and proposing economic and technical norms and calculating tariffs and prices. The CNE is made up of an Executive Council and an Executive Secretariat. The Council is presided over by a representative of the President of the Republic and consists of a committee of six ministers. The Executive Secretariat is in charge of the administration of the Commission, and the Council delegates compliance with all the tasks for which the agency is responsible to the Secretariat. Most of the proposals for the restructuring of the electricity sector have been prepared by the CNE.

The *Economic Load Dispatching Center (CDEC)* is a coordination entity designed to optimise the operation of the generation system. In the short run, the CDEC acts as a clearing house in the energy market, while in the long run it is in charge of planning the operation of the combined generation-transmission system. Its main objectives are to preserve security of service, to guarantee the most efficient operation of the electricity system facilities as a whole and to ensure the right of way on

[5] In the early stages, the main approach might remain "regulation by contract" (see Bakovic et al 2003).

transmission systems, as established by concession agreements. There are limitations to participation in the CDEC directory, though all of the generators can use the system. Only companies with a minimum generating capacity of 60 MW are allowed to participate in the Board of Directors. Its one-year presidency term rotates among its members and decisions are binding. Disagreements among members are resolved by the Ministry of the Economy within 120 days.

Source: Basañes et al (1999)

Transmission and distribution that constitute natural monopolies must be regulated to ensure that the public's interests in terms of service quality, access and tariffs are properly reflected and that generators are given equitable access to the grid and to consumers. Generation activities need to monitored and regulated to ensure that competition is actually applied and that the public benefits from lower production costs. In the early period of power sector reform, much attention was paid to the problems associated with vertical integration (and the difficulties independent generators might face in accessing the grid and customers). In recent years, more attention has been paid to problems associated with the oligopolistic structure of the generation segment and the possibility that certain firms might exercise market power and manipulate prices. The use of cost-based rather than bid-based wholesale competition is part of efforts to limit market power.

Independent regulation can be a major challenge in many developing countries. The first problem concerns the local availability of staff with appropriate training and experience to carry out these complex regulatory tasks. Tariff setting is often a sensitive political subject and even if the regulatory authority has a de jure responsibility for tariffs, the Cabinet and the line ministry concerned sometimes retain the de facto power to approve tariff increases. A third problem relates to the relative power and influence of the regulator and the regulated enterprises. For example, when the National Electric Power Regulatory Authority (NEPRA) was established in Pakistan in 1995, the new (and inexperienced) head of NEPRA would face the Chairman of WAPDA, one of the country's most powerful officials with some 180,000 employees. Finally, there is a risk that the regulator is "captured" by vested interests, possibly through outright corruption.

2.4 Patterns of reform

The driving forces, the sequencing and pace of reform vary significantly from one country to another.

As can be seen from Table 2 below, most countries have been rather cautious in reforming the structure of their power sectors. Unbundling (i.e. separating generation, transmission and distribution into different corporate

entities) has been undertaken in only one third of the countries. In the remaining two thirds the old monolithic, vertically integrated utility remains, although a few countries have either divested the utility or handed over management to a private sector entity. Only about 15% of the countries have moved beyond the single buyer model and introduced wholesale competition. Most of these countries are in Latin America and have settled for the more limited cost-based competition. A couple of the more aggressive reformers in Eastern Europe have also introduced wholesale competition.[6]

The form of private participation in the power sector is a function not only of the objectives and modalities of reform, but also of other constraints that countries face in attracting private investments in the sector. The World Bank's private participation in infrastructure (PPI) database[7] offers an insight into the choices governments have made. Table 3 is based on a special analysis of the PPI database and presents an overview of private infrastructure projects in each developing country with a population of at least 1 million people.

Divestitures. Latin America (led by Chile) pioneered power sector restructuring and privatisation in the developing world. It was driven by concern about the poor efficiency levels of state-owned utilities. This was combined with a desire to mobilise foreign equity capital to help reduce the region's heavy debt burden. (Unfortunately, it appears that a significant share of the privatisation proceeds was used to maintain government expenditures rather than to reduce debt.)

As part of the transformation of the economies of Eastern Europe and Central Asia, governments have generally sought to divest their power utilities. Most of these countries also faced problems with inefficient and wasteful use of energy and the imposition of market discipline through private ownership was – and still is – regarded as a major part of the solution. Thus in this region, four-fifths of transactions involving the private sector have been divestitures. It is worth noting, however, that government privatisation receipts have been quite limited, especially when compared to Latin America. This largely reflects the poor financial situation of most of the divested utilities (and in some cases also a less than transparent divestiture process).

The performance of the existing, state-owned utilities in East Asia was perceived as being less of a problem than the mobilisation of additional financial resources for system expansion (to meet power demands that were growing at unprecedented rates). Thus, the emphasis in East Asia was on attracting foreign investors and lenders for the construction and operation of greenfield generation projects. Most of the "divestitures" have taken

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6 All of the new EU members and EU candidates are moving in this direction.

7 The PPI database can be found at http://ppi.worldbank.org/.

place in China where provincial power companies have become listed on the stock exchanges and sold some shares to the public. The largest privatisation transaction in the region was the sale of part of the equity in Tenaga, the Malaysian utility for US$1.2 billion in 1992.

As part of state-level reforms in India, some partial divestitures have occurred. The central government sold 10.5% of the equity in the National Thermal Power Corporation through a public offering. The Kot Addu power plant in Pakistan was also partially divested in the 1990s. It was followed by a similar divestiture of the Karachi Electricity Supply Corporation in 2004. In Sub-Saharan Africa and in North Africa and the Middle East, divestitures have been rare.

Greenfield Projects. The most common form of private investment in the power sector has been the construction of new projects, commonly referred to as "greenfield projects." The great majority of these projects have been for power generation and structured along the BOO/BOT model. Only a small number has been built as "merchant" plants without any long-term power purchase agreements (and they have essentially all been in Latin America). The BOO/BOT model has been the preferred form of private participation in Asia, the Middle East and North Africa where political resistance against restructuring and privatisation has been strong. The BOO/BOT model has also been the main vehicle for attracting private financing for the power sector in Sub-Saharan Africa.

Concessions. The great majority of concession arrangements have involved repair and expansion of government-owned generating plants. However, concessions for operation of the distribution network have been awarded in Azerbaijan, Morocco, South Africa and Uganda. Private companies have essentially taken over the whole (or at least a major part of the) power system in Cameroon, Cote d'Ivoire, Gabon, Mali and Togo. In a couple of countries, concession agreements have been cancelled (Comoros and Senegal) or expired without being renewed (Guinea). In Tanzania and Uganda, the governments have awarded new concessions to previously unserved rural areas.

Management and Lease Contracts. This type of contract has been used for both generation and distribution facilities in Ghana and Kazakhstan and for integrated utilities in Guinea-Bissau, Haiti, Lesotho, Sao Tome and Tanzania. The distribution system has been operated under management contracts in Chad and Namibia.

Appendix 1 provides an analysis of the reform steps taken in 122 developing countries, all with a population of over 1 million.

Table 2: Power sector structure, by region (2005)

Region	Monopoly	Monolithic Single Buyer	Unbundled Single Buyer	Wholesale Competition
East Asia & Pacific	33.3%	41.7%	25.0%	0.0%
E. Europe & Central Asia	25.9%	7.4%	37.0%	29.6%
Latin America & Caribbean	9.1%	31.8%	13.6%	45.5%
Middle East & North Africa	46.2%	38.5%	15.4%	0.0%
South Asia	16.7%	50.0%%	33.3%	0.0%
Sub-Saharan Africa	64.3%	31.0%	4.8%	0.0%
122 Developing Countries	38.5%	28.7%	18.0%	14.8%

Table 3: Private participation forms, by region (1984–2005)

Region	Management Contracts and Leases	Concessions	Greenfield BOO/BOT Projects	Partial Divestitures	Full Divestitures	Total Private Transactions
	Number of Projects or Transactions					
East Asia & Pacific	3	14	222	52	7	298
E. Europe & Central Asia	6	7	26	135	20	194
Latin America & Caribbean	2	5	231	96	68	402
Middle East & North Africa	0	6	16	0	1	23
South Asia	0	0	100	11	0	111
Sub-Saharan Africa	15	16	29	4	1	65
122 Developing Countries	26	48	624	298	97	1,093

Factors shaping private power investments

CHAPTER 3

In deciding on which reform strategy to adopt, developing countries need to look beyond the power sector itself. Potential project sponsors, investors and lenders generally cite the following six factors that limit their ability to develop and finance private infrastructure projects in developing countries:[8]

- *High level of regulatory uncertainty,* which increases project risks and makes mobilisation of debt difficult, if not impossible;
- *Lack of buyer "creditworthiness"* (in cases where government agencies are the buyers of the project's output) or the limited ability and/or willingness of consumers to pay for the service;
- *Lack of government commitment,* which often provides vested interests with ample opportunities to effectively block private participation, delay or derail project implementation;
- *Lack of clarity in the decision making process* and resulting implementation delays (and sometimes demand for bribes and other facilitating payments);
- *Limited availability and convertibility of foreign exchange* (i.e. the host country's weak balance of payment and its associated lack of creditworthiness), which makes servicing of loans and repatriation of profits uncertain; and
- *Shallow domestic financial markets and high costs of local debt* forcing developers to raise equity and debt internationally even if a major share of project revenues and/or construction costs is in local currencies.

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8 A recent study sponsored by the World Bank (Lamech and Saeed, 2003) interviewed 48 international developers of power projects and identified 15 key country-related factors that influenced their investment decisions. These 15 factors can be combined into the six groups utilised here.

The first four factors are all related to the sector reforms discussed earlier in Chapter 2. The last two are more related to the general economic situation in the host country. To fully understand what reform options are feasible at any given time, two other factors need to be taken into account:

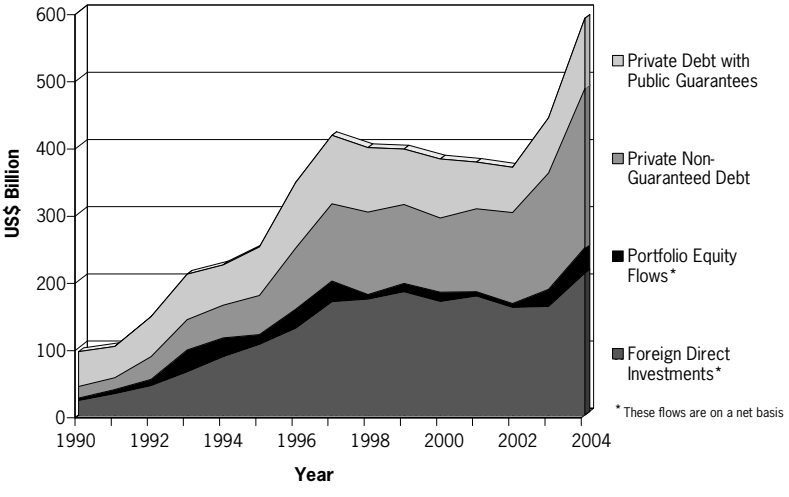
- *The willingness of lenders to take emerging market risk* tends to vary over time and between regions for a number of reasons, including "contamination" from isolated currency crises and changes in the treatment of emerging market debt by financial regulators in OECD countries; and
- *The strategic focus of global power developers* has changed drastically since 1997. They appear to have lost some of their appetite for emerging market risks and are consolidating and focusing more on closer markets (in OECD countries).

These factors are discussed further in this chapter.

3.1 Private capital flows

During the early 1990s, private capital flows to developing countries increased dramatically to reach a peak of almost US$420 billion in 1997. After the Asian crisis in 1997 and the Russian problems in 1998, private sector lending and portfolio investments were on a downward trend but direct foreign investments held up fairly well. However, since a recent low in 2002, all types of private capital flows have resumed rapid growth (Figure 5).

Figure 5: Private capital flows to developing countries 1990–2004



Source: GDF 2006

Unfortunately, these capital flows are highly concentrated with the bulk going to a few countries that have an investment grade rating and/or are classified as upper middle-income (Table 4).

A striking feature of Table 4 is not only the small absolute size of the debt flows to low income and unrated countries, but also that these flows are much smaller relative to the size of their economies. While the decline does not appear to be as dramatic for foreign direct investments, this is somewhat illusionary. Much of the direct foreign investments in low income and unrated countries are directed to a limited number of countries with new investments in export-earning oil (and to a lesser extent mining) projects.

Table 4: Private capital flows, by country grouping (average for 2002–2004)

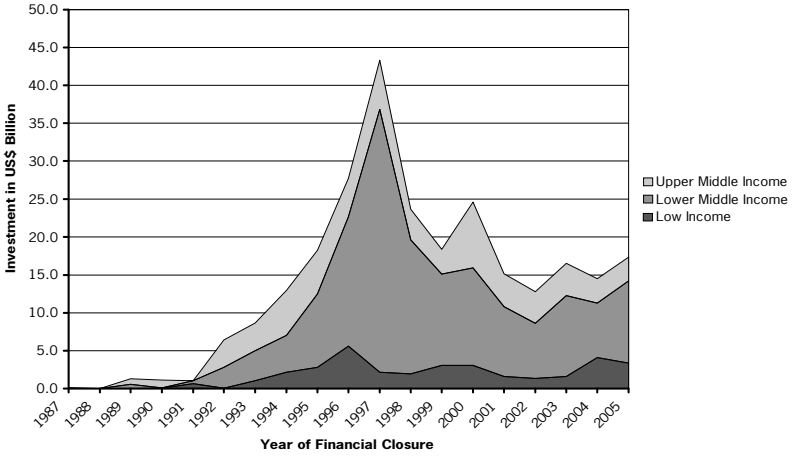
Country Classification	Private Non – Guaranteed Loans	Foreign Direct Investment	Private Non – Guaranteed Loans	Foreign Direct Investment
	US$ Billion		Percent of GDP	
By Income Level				
Upper Middle Income	109.1	63.5	4.3%	2.5%
Lower Middle Income	66.9	98.5	1.9%	2.7%
Low Income	5.4	15.6	0.5%	1.5%
By Investment Rating[1]				
Investment Grade (BBB- & higher)	103.4	100.5	3.1%	3.0%
BB and B	68.3	52.1	2.6%	2.0%
Unrated and less than B-	9.8	25.1	0.8%	2.1%
Of which with major oil investments[2]	1.8	11.2	1.4%	8.5%
Of which without major oil investments	8.0	13.9	0.7%	1.3%

Notes: [1] Credit rating in mid 2003.
[2] The countries with major oil investments are: Angola, Azarbaijan, Chad, Ecuador, Equatorial Guinea, Nigeria & Sudan
Sources: Global Development Finance 2006, WDI 2006, www.standardandpoors.com

3.2 Investor sentiment

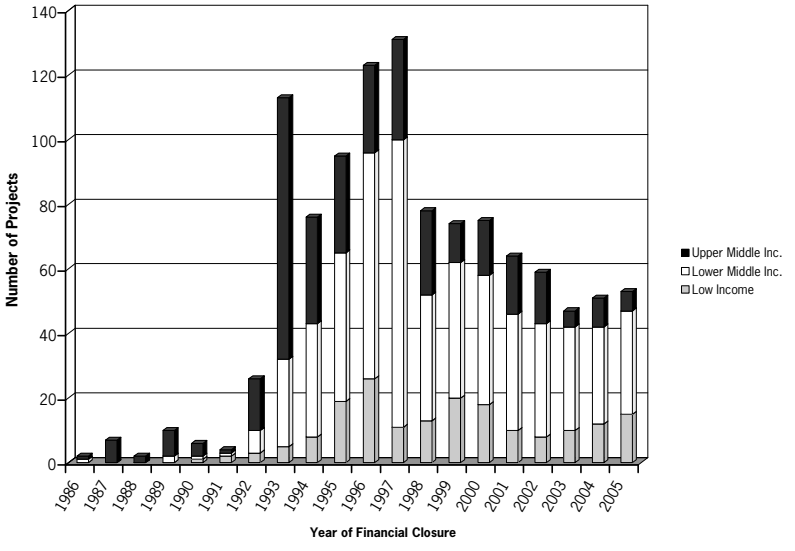
Since the Asian crisis there has been a dramatic turn in investor sentiment. While investments in private power projects virtually exploded up to an all-time high of US$44 billion in 1997, interest in new greenfield projects and divestitures has since largely evaporated, as can be seen from Figure 6.

Figure 6: Investment in power projects with private participation 1987–2005



There appears to be a slight reversal in the downward trend after 2002. The number of schemes has also shown a slight upward trend since hitting the bottom in 2003 (Figure 7).

Figure 7: Number of power projects with private participation 1987–2005



There are a number of factors behind the dramatic decline in the interest of the global power investors. The Asian crisis demonstrated that long-term PPAs backed by government guarantees provided only a limited protection against the impact of steep currency devaluations. The competitive wholesale markets in Latin America did not provide the expected returns to investors in distribution companies who suffered from poorly implemented regulatory frameworks and external shocks such as the devaluation in Argentina, or outright non-performance of the government, as in the Dominican Republic. At the same time, project developers learned that country governance problems could have a major impact on their investments in countries such as Pakistan and Georgia.

The various problems forced major project developers (such as AES and CMS of the USA, EDF and SUEZ of France) to retrench and focus more on their core markets. Enron, a major developer of projects in developing countries, went bankrupt largely due to its gamble on liberalised power trading in the USA (and associated accounting irregularities). The varying fortunes of international power developers and the need for restructuring are clearly illustrated by the evolution of the AES stock price. It went from around US$5 per share in 1993 to a peak of US$68 in September 2000 to a low of US$1.18 in October 2002.[9]

The retrenchment by most of the major global developers has opened the field for a new set of actors. Some foreign companies such as CDC Globeleq from the UK have been buying out the former owners. CDC Globeleq has, for example, acquired AES' interests in Meghnaghat and Haripur in Bangladesh, Kelvin in South Africa and Songas in Tanzania. More interesting, however, is the growing role of local investors who buy distressed companies outright as has been happening in Bolivia. About one-tenth of the equity for the 1,200 MW Hub Power Project in Pakistan was originally mobilised locally. The foreign owners have gradually sold their shares on the Karachi stock exchange and the company is now 80% locally owned. Firms from developing countries are also increasingly owning and operating infrastructure projects in other developing countries, especially within the same region (Ettinger et al. 2005).

An interesting and increasingly important phenomenon is the emergence of smaller scale power projects built by local entrepreneurs. These projects can either be small grid-connected generating plants as in Sri Lanka (Box 5) or small freestanding mini-grids served by a generator as in Cambodia (Box 6). Other models also exist in, for example, Cambodia

[9] By September 2006, the share price for AES had recovered to around US$20.

the state-owned utility has experimented with using entrepreneurs to distribute and re-sell power to local neighbourhoods.

Box 5: Mini-hydropower development in Sri Lanka

In 1993, the Ceylon Electricity Board (CEB) announced its willingness to buy power from private mini-hydro plants. A year later, DFCC Bank provided a loan and, in the absence of venture capital, also took an equity stake in Hydrotech Lanka Dick-oye (Pvt.) Ltd.. In June 1996, the 0.96 MW mini-hydro plant was commissioned after substantial work had been done to establish a suitable regulatory framework. This mini-hydro project was Sri Lanka's first private, grid-connected power plant as well as the first infrastructure project undertaken on a BOO basis.

After the first project, the mini-hydro power sector grew rapidly over subsequent years. At the end of 2002, 30 mini-hydro power projects had been launched (16 of them funded by DFCC with refinancing from the World Bank) with a total generating capacity of about 70 MW. The project costs have varied from less than US$1.0 million to around US$5.0 million, depending on plant size. Chinese equipment has been commonly used as well as British, German, Czech, local and other technologies. The mini-hydro power industry has matured and developers have brought down costs substantially with the know-how and experience gained over the past six years. A standard power supply contract has been worked out with CEB and DFCC has introduced a loan repayment scheme for mini-hydro projects based on cash flows, i.e. following rainfall patterns.

Sources: World Bank (1997, 2002a, 2003b) and the website for the website for the Renewable Energy for Rural Economic Development Project (http://www.energyservices.lk/index.htm)

Box 6: Small-scale service providers in Cambodia

Local entrepreneurs in many parts of the world have responded to market demand for electricity in unserved rural and peri-urban areas. In Cambodia, for example, it is estimated that there are some 600 rural electricity enterprises of varying sizes. On average, they serve about 200 customers. At around US$0.50 per kWh, the tariffs are high compared to what people would have to pay if they could be served from the grid. These systems are owned by village businesspeople who use their own funds to finance around half the investment costs. They borrow the balance from family members or from money lenders at an interest rate of about 1–2% per month.

Source: Kariuki and Schwartz (2005)

Foreign lenders remain especially reluctant to invest in low-income countries and typically require credit enhancements from export credit agencies and support from the multilateral development banks and their affiliated private sector entities. Indeed, multilateral organizations supported nearly one-third

of all power projects with private participation in low income countries (Table 5). Still, private power schemes remain a small fraction of the investment needed in the sector, which implies that public sector financing will have to continue to play a major role in the foreseeable future (see Section 3.4).

Table 5: Support from development finance institutions for private power schemes (2001–05)

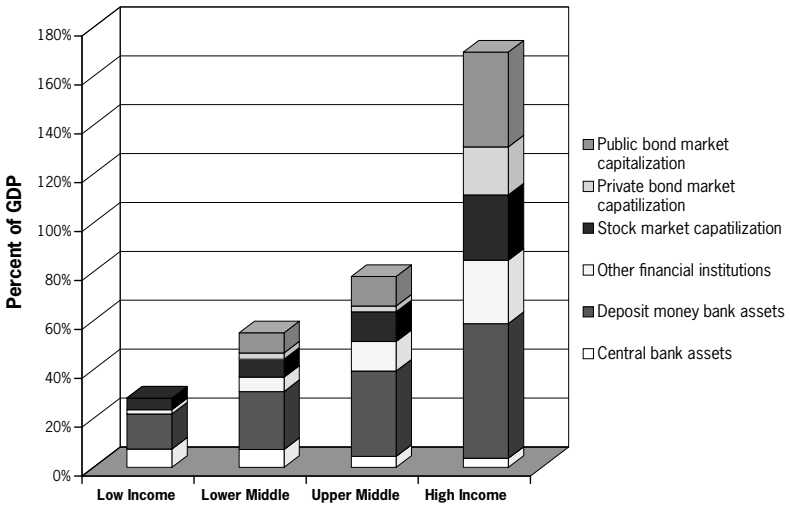
	Private Power Schemes		Development Bank Support		Development Bank Share of	
	Projects (Number)	**Investment** (US$ M)	**Projects** (Number)	**Amount** (US$ M)	**Projects** (Number)	**Investment** (US$ M)
Upper Middle Income	54	19,094.2	4	348.5	7.4%	1.8%
Lower Middle Income	165	45,282.5	23	2,814.9	13.9%	6.2%
India	20	6,070.9	2	150.0	10.0%	2.5%
Other Low Income	35	5,805.7	11	1,476.8	31.4%	25.4%
All Developing Countries	274	76,253.3	40	4,790.2	14.6%	6.3%

Source: World Bank PPI Database and WDI 2006

Recent evidence suggests that even the upper middle income countries in Latin America – i.e. exactly those countries that have gone furthest in reforms and have had most success in attracting private power investments – will face difficulties in doing so on a sufficiently large scale to sustain economic growth in the future.

A major study by Calderón, Easterly and Servén (2002) examined infrastructure investments in Latin America during the 1980s and 1990s. They found, not surprisingly, that private power investments indeed increased rapidly after various countries reformed their power markets. However, this increase was associated with an even steeper decline in public investments and, thus, overall power sector investments fell. They found no evidence that this fall in public investments was fully compensated for by efficiency and/or quality improvements in private schemes. Thus they conclude (p. 14) that: *"the opening up to private activity was not a panacea for Latin America's infrastructure woes."*

Figure 8: Depth of financial markets and economic development



Adapted from World Bank (2001)

In an accompanying paper, Calderón and Servén (2002) analysed the economic impact of a widening "infrastructure gap" between Latin America and East Asia. They concluded (p. 18) that:

> *"…this widening infrastructure gap can account for a considerable fraction of the increase in Latin America's output gap relative the successful East Asian economies over the 1980s and 1990s. Lagging telecommunication assets, power generation capacity and road networks all contributed to Latin America's loss of ground in terms of output per worker. While there is a fair degree of diversity across the region's economies regarding the magnitude of this effect, in every one of the countries analysed we find that lagging infrastructure added to the output lag vis-à-vis the East Asian tigers."*

3.3 Local financing

Most power utilities derive their revenues in local currency. Thus, it is desirable for most projects to rely on local currency financing to the greatest possible extent. Furthermore, many power projects include a large local cost component. Consequently, from a macro-economic point of view it is also desirable to mobilise at least part of the financing locally.

The ability of private infrastructure companies to mobilise long-term local currency funding depends, to a large extent, on the maturity and depth of local financial markets and on perceived macroeconomic and

commercial risks. As can be seen from Figure 8, there is a strong relationship between economic and financial sector development.

While the depth and sophistication of financial markets tend to increase with the level of economic development, major differences can be found between countries at the same income level. India and Guinea, for example, had the same nominal per capita income (US$450) in 2000 while the amount of outstanding bank loans was equivalent to 54% of GDP in India and only about 9% in Guinea. Setting aside the issue of the much larger Indian economy, it is quite clear that it would be easier to mobilise money for infrastructure projects in India than it would be in Guinea.

The constraints imposed by the shallowness of the financial markets in most low-income countries can be illustrated with data on the pattern of financing for private power generation projects in East Asia during the 1990s. A study sponsored by the World Bank (Baietti, 2000) provides data for projects in four different countries. Combining the financing data with measures on financial debt, the following picture emerges (Table 6):

Table 6: Financial depth and local financing of infrastructure projects

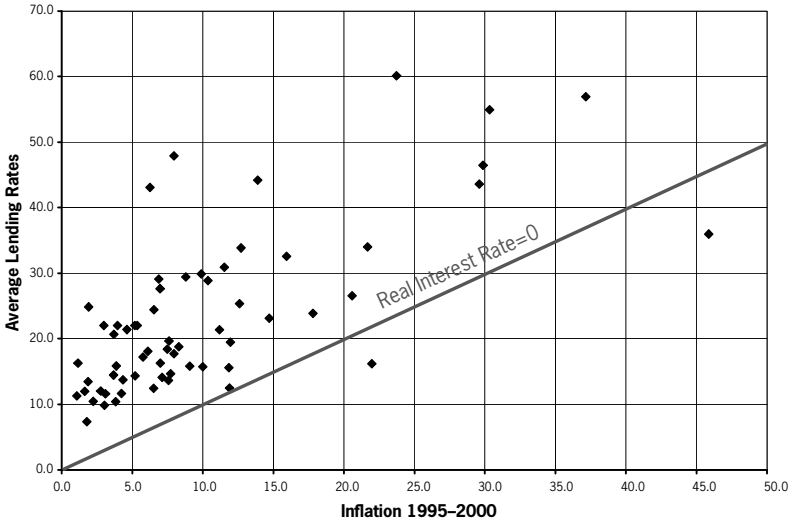
Country	Bank Credit as % of GDP (average for 1990 & 1999)	Local Financing as Percent of Total
Malaysia	113.7%	90%
Thailand	116.5%	75%
Indonesia	53.0%	14%
Philippines	47.9%	3%

Sources: World Development Indicators 2006 and Baietti (2000)

However, financial depth is not the only factor that determines the scope for local currency financing of power projects. It is well documented that macroeconomic instability associated with poor government policies leading to high (and often highly variable) inflation increases nominal and real interests rates (see Figure 9 below) and reduces maturities. Macroeconomic instability also shifts savings away from the domestic financial sector to real estate and foreign currency holdings. After a major shock including high inflation rates and drastic devaluation of currency, it typically takes a number of years of low and stable inflation for investors to regain confidence in local currency savings instruments.

Consequently, in all low-income countries (except India) and in most lower middle-income countries, it is extremely difficult to mobilise debt for large-scale power projects from local financial institutions. There is a clear role for donors in facilitating this task.

Figure 9: Inflation and lending interest rates 1995–2000



3.4 Financing needs

The International Energy Agency (IEA) has estimated that, in order to maintain present growth rates, investments for power development in emerging market would be about US $120 billion per year between 2002 and 2010 (as quoted in Deloitte Touche Tohmatsu, 2004). Fay and Yepes (2003) estimate the demand for investments in new power facilities to average about US$75 billion per year over the 2000–2010 period, with low-income countries accounting for US$18 billion (1.14% of GDP) and middle income countries for US$57 billion (0.81% of GDP).[10] In addition, they estimate that around US$65 billion would be required for maintenance of power facilities. Other estimates of infrastructure investments have tended to be higher than those provided by Fay and

[10] Fay and Yepes assume that the world economy will grow at 2.7% over the 2000–10 period. Over the last decade (1995–05) the growth rate averaged 3.1%. The latest World Bank projections for the outlook of the world economy indicate that the growth will average 3.6% during 2006–08. Thus, Fay and Yepes' basic assumption appears low. It should also be noted that achievement of the Millennium Development Goals requires an acceleration of growth in low income countries – especially in Sub-Saharan Africa.

Yepes.[11] Even using their conservative estimates, a disturbing picture emerges in Table 7 when combined with information from the World Bank's PPI database.

Table 7: How private power investments measure up against need

	Annual Investment Requirements 2000–2010 (Fay & Yepes)		Investments in Private Power Projects, Average for 2001–05	
	US$ million	*Percent of GDP*	*US$ million*	*Percent of GDP*
Low Income	18,000	1.14%	2,375	0.21%
Lower Middle Income	57,000	0.81	9,057	0.24%
Upper Middle Income			3,819	0.14%

Note: Fay and Yepes appear to use an older country classification. Thus, the best comparison is the percentage of GDP figures

Private power investments in low and lower middle-income countries make up only a small fraction of investment requirements. While some of the "gap" between investment needs and private investments can be explained by incomplete reforms, the main explanation is that private investors and lenders are unwilling to take the country risks involved. Indeed, if all the private bank loans to low income countries[12] were directed to the power sector, they would only make up about one-third of the funding needed for the power sector. As explained in the previous section, local financing cannot make up the shortfall in foreign financing for low and most lower middle income countries.

Consequently, *the public sector and the donor community will have to continue to play a major role in mobilising the financing needed for the power sector in low and lower middle income countries.*

3.5 Implications for the design of power sector reform

The limitations imposed by a country's creditworthiness, the development of its financial sector, its business environment as well as the government's

11 See for example, World Bank (1994), Easterly and Rebelo (1993). It appears that Fay and Yepes have underestimated the cost of transmission and distribution as well as the need for replacement investments. According to Kato (2003) generation is expected to make up only 42%of total power sector investments while it appears that Fay and Yepes assume that generation will account for 50–55% of the total.

12 See Table 4.

Table 8: The nature of private participation in low income countries (1984–2003)

	Distribution & Transmission		Generation Facility		Integrated Utility		All Types of Facilities	
	Number	US$ M	Number	US$ M	Number	US$ M	Number	US$ M
Management & Lease	2	0.0			11	4.7	13	4.7
Concession	2	84.0	5	581.2	10	699.6	17	1,364.8
BOO/BOT	1	269.0	129	28,468.0	2	5.7	132	28,742.7
Merchant Plant			3	103.7			3	103.7
Partial Divestiture	7	1,306.8	4	2,296.6	2	345.0	13	3,948.4
Full Divestiture	2	140.3	1	9.5			3	149.8
Total	**14**	**1,800.1**	**142**	**31,459.0**	**25**	**1,055.0**	**181**	**34,314.0**

Source: World Bank PPI Database

macroeconomic policies have clear implications for the design of power sector reforms. The sector structure and the forms of private participation need to be take into account the scope for mobilising private financing. Table 8, which shows the forms of private participation in low income countries, illustrates this point.

In interpreting Table 8 it is important to keep in mind that the investment amounts listed under concessions typically refer to estimated investments over the 20–30 year life of the concession, and the figures are often quite notional.[13] It is too early to judge if any significant investments will be made for system expansion under concession arrangements in low income countries.

More than 80% of the private power investments in low income countries have been directed to BOO/BOT type generation projects. There is little investor interest in privatisation transactions involving distribution systems.

[13] For example, roughly half of the total investment amount for concessions (US$747 million) is for Mali's integrated power and water utility.

Experience of power sector reform

CHAPTER 4

4.1 The impact of reform on financing

Between 1984 and 2005 power sector reform induced the private sector to invest around US$266 billion in almost eleven hundred power schemes in 101 developing countries, including some of the poorest and least developed (Table 9). During the 1990s, these private flows far exceeded multilateral and bilateral assistance to the electricity sector. Thus, measured in terms of additional resources that have been directed to the power sector, the results have been quite impressive. However, as noted in Section 3.2, (see figure 6 and 7) the number of new schemes and the amount invested has declined significantly since the Asian financial crisis in 1997.

4.2 The impact of reform on utility performance

One main objective of power sector restructuring and privatisation is to achieve significant efficiency improvement. Most studies[14] undertaken document significant operational improvements, as illustrated by the findings of Torero and Pasco-Font (2001) for Peru (Table 10).

Most studies have been conducted in Latin America (and Europe) where reforms generally included unbundling, privatisation and competitive wholesale markets. However, a limited number of studies from countries where reforms have been less far-reaching confirm the same conclusions. For example, Jones et al (2002) found that the concession arrangement for Compagnie Ivoirienne d' Electricite (CIE) had led to noticeable efficiency improvements.

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14 Numerous studies are summarised in Harris (2003), Kessides (2004), Kikeri and Nellis (2004) and Pollitt (1997).

Table 9: Investment in power projects with private participation, by region 1984–2005

Region	Number of Schemes (Number)	Investments in Government Assets (US$ Billion)	Investments in New Facilities (US$ Billion)	Total Investments (US$ Billion)
East Asia and Pacific	297	10.1	74.7	84.8
Europe and Central Asia	194	9.1	16.6	25.7
Latin America and the Caribbean	403	46.6	66.1	112.7
Middle East and North Africa	23	0.0	12.0	12.0
South Asia	111	2.2	23.3	25.5
Sub-Saharan Africa	65	1.1	4.8	5.9
Total for All Developing Countries	*1093*	*69.0*	*197.5*	*266.5*

Source: World Bank PPI Database (http://ppi.worldbank.org/)

Table 10: Effects of power reform in Peru

	1994 (pre reform)	1998 (post reform)
Installed power (MW)	4,379	5,515
Energy sales (GWh)	9,335	14,009
Access to electricity (%)	58.5	70.0
Number of customers (million)	2.31	3.05
Distribution losses (%)	20.6	12.4
Per capita energy consumption (kWh)	404	566
Customers per employee (Luz del Sur)	426	1,000
Time to respond to complaints (hours)	27	1a
Time to repair defects (days)	7	1a
Time to install meter (days)	45	2a

[a] Data from Edelnor for 1999

In support of a World Bank sponsored reform of the power sector in Tanzania, Sida has provided funding for NetGroup of South Africa to operate TANESCO – the state-owned, vertically integrated utility – under a management contract. The World Bank (2004b) describes the results in the following terms (p. 9–10):

> *"Under the leadership of the new management team [from NetGroup] and with support from the Government, TANESCO's operational and financial performance have improved significantly over the past two years. Since May 2002: (i) TANESCO's billing collection rate… improved from 76% to 92%; (ii) staff numbers were reduced by 1,428 to 4,991 employees; (iii) TANESCO paid down TSh33 billion of outstanding commercial debt; (iv) system losses declined from 27% to 24%; (v) administration and overhead costs were reduced by about 20% and TANESCO has obtained more competitive prices from suppliers; and (vi) TANESCO has an improved credit rating in the market, which enabled TANESCO to access the domestic capital market. … NetGroup's efforts to train and empower TANESCO staff have dramatically improved morale and productivity. When the Management Contractor first entered TANESCO, it was under police protection. Now, two years later with the contract up for renewal, TANESCO staff have publicly supported an extension."*

4.3 The impact of reform on welfare

Given the monopolistic characteristics of the power sector, efficiency improvements represent only one part of the picture. Such efficiency improvements might only benefit the private owners/operator and not the consumers, the government and society at large. Thus what is needed, from a public policy point of view, is an assessment of the overall impact on public welfare. Such assessments are, unfortunately, very hard to undertake and require an extensive data collection effort. More importantly, the analysts need to make reasonable assumptions about the "counter-factual," i.e. what would have happened without sector restructuring and private participation. The problem becomes even more complicated if the objective of the analysis is to estimate the impact on different stakeholders (for example, the impact on the poor). However, a close look at some of the studies that have been made will facilitate some general conclusions.

The first important study of welfare effects was carried out by Galal et al (1994) who examined the welfare effects of 12 enterprise privatisations in four countries. They estimated that the welfare effects of the privatisation of the two power companies in the sample (Chilgener and Enersis in Chile) were clearly positive but much smaller than the benefits associated with the three telecom firms in the sample. Galal et al (and

numerous other studies) documented that privatisation and liberalization in telecommunications during the 1990s resulted in an extremely rapid expansion of service (starting in most developing countries from a very low base). Although electricity service expanded in Chile after privatisation, the baseline was already high. Thus, the benefits of increased access were lower in the case of the two power companies in Chile than in the case of the three telecommunications firms.

Newbery and Pollitt (1997) concluded that efficiency had improved significantly after the electricity sector was privatised in the United Kingdom. However, they concluded that the new shareholders captured the bulk of the financial gains at the expense of the government and tax payers. Consumers reaped more modest gains. In a subsequent study, Domah and Pollitt (2001) estimated large gains from the privatisation of regional electricity supply and distribution in England and Wales for, primarily, the sellers but also for consumers.

Three less comprehensive studies (in terms of defining the counterfactual) examined the impact of utility privatisation in Latin America.[15] They concluded that production, service quality and access had improved following divestiture. Furthermore, even though prices had increased in most cases, consumer surplus had expanded significantly because of increased access.

McKenzie and Mookherjee (2002) looked at the distributive impact of utility privatisations in several Latin American countries. Among their case studies were three electricity divestitures (Argentina, Bolivia and Nicaragua).

In Bolivia and Argentina, the results were very clear: the poor benefited much more than the upper income groups, primarily because of the welfare gains due to increased access to electricity. The results in Nicaragua showed that all households with electricity prior to the divestiture lost welfare due to higher prices. However, the households that gained access after privatisation experienced high gains in welfare. The combined effects of price changes and improved access generally meant that the relative welfare gains for the poorest households were much higher than for the richer ones. The only exception was for the lowest expenditure decile in Nicaragua. Access for this group improved only marginally from 11.1% to 11.3 %, a gain that was not sufficient to offset welfare losses due to higher electricity tariffs.

Jones et al (2002) found that the consumers in Cote d'Ivoire appeared to have benefited more from the IPPs (that increased the availability of

[15] Barja and Urquiola (2001) focused on utility privatisation in Bolivia; Torero and Pasco-Font (2001), Peru; Delfino and Casarin (2001), Argentina.

power) than from concession arrangements for CIE (that improved the efficiency of the existing system).

Toba (2003) examined the welfare effects of the introduction of IPPs in the Philippines. During the 1980s, public power investments had lagged significantly behind the growth in demand and, as a result, the Philippines suffered severe blackouts lasting, on average, 7 hours per day. The World Bank conservatively estimated the economic cost at 1.5% of GDP and the business community put the annual cost at US$1.0–1.3 billion (in 1993 prices). In response, the government initiated a crash program for construction of IPPs on a BOT basis. Toba found that the benefits (on a net present value basis at an assumed discount rate of 15%) of the IPP program were about US$10 billion. The main gains came from two sources. One was avoided cost during the power crises, which promoted economic growth and social development and may have even saved lives by restoring vital social services such as water and sanitation. The other was efficiency gains in generation, arising from the additional competitive pressures on NPC (the state-owned utility) from the presence of IPPs, the IPPs' efficient operation and technology transfer to NPC, and the envisioned privatisation of the NPC.

In short, the various studies show that efficiency improvements resulting from private management of power systems do not necessarily lead to benefits for the consumers. However, if private participation results in a more rapid expansion of service and improved access to the poor, welfare increases can be very significant.

4.4 Market structure options

The studies quoted in the previous section provide no assessment of the relative merits of different market structures or forms of private participation. However, if these studies are taken together with some of the practical experience from the reform process in industrialised and developing countries, some tentative conclusions can be drawn. This section seeks to draw relevant conclusions and provide practical advice on the reform process.

4.4.1 Retail competition

The theoretical literature indicates that introducing competition in all market segments that not are natural monopolies would give the greatest welfare gains. (See for example Kessides, 2004) This implies that that *retail competition* should be the preferred option however, as can be seen from Appendix 1, no developing country has so far adopted this model. The merits of full retail competition (including households and small enter-

prises) are, however, controversial. Joskow (2000) argues that the efficiency benefits are likely to be small and more than exceeded by increases in marketing, advertising, settlement and transaction costs. Prices are going to change rapidly over time in competitive systems (see below) and the key choice for consumers might not be which supplier but which pricing plan (in terms of how frequently and how much retail prices can be adjusted). Furthermore, in Sweden (one of the few countries with retail competition and with some of the best educated consumers in the world) the Swedish Competition Authority (Konkurrensverket, 2002, p. 123) noted that: *"Today's electricity bills can justifiably be regarded as being very difficult to interpret for most consumers."* The logical question is that if consumers have difficulties in making sense of their bills, can they make informed decisions about which retailer and what pricing plan[16] to choose? A sensible conclusion must be that in most of the developing world, retail competition is not a viable option.

4.4.2 Bid-based wholesale competition

Bid-based wholesale competition requires a spot market where buyers and sellers "meet" to agree on the terms for deliveries the next day. Since prices reflect "supply and demand" such a competitive market is expected to decrease construction and operating costs and provide incentives to close inefficient plants. Caramanis et al. (1982) show that under ideal conditions, electricity spot markets provide efficient outcomes in both the short and the long term. However, for such a market to deliver efficient outcomes in the long-term in situations where electricity demand is growing, there has to be free entry of new generators, a condition that will be discussed later.

Economists tend to stress the workings of the "invisible hand" in bid-based systems. For example, Kessides (2004, p. 154) argues that:

> *"…in a bid-based market the owners of hydroelectric units raise the price of their electricity if they anticipate water scarcity. In response, fossil fuel units will likely run more intensively much sooner, reducing the likelihood of electricity shortages."*

This is not necessarily true. For reasons discussed below, prices tend to rise manifold in times of scarcity. Thus, hydro-plants might very well

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16 If the wholesale and retail markets are reasonable competitive, it appears that the price differences between various consumer plans – especially in terms of the frequency of tariff adjustments – are much greater than between competing retail sellers. This means that the main decision for consumers is based on their guesses about future tariff changes (and implicitly about future directions of exchange rates, fuel prices, rainfall, temperatures, etc.).

maximise revenues and profits by creating artificial shortages (or at least by not reducing generation when they anticipate water scarcity).

The highly inelastic demand for power and, when generation approaches the installed capacity, the inelastic supply[17] implies that prices can rise drastically during periods of peak demand or minor interruptions in supply. Even though the Nordic power grid is connected to the European continent and imports and exports occur, the average monthly spot prices on the Nord Pool market have ranged from a low of €6.35/MWh (June 2000) to a high of €74.43/MWh (December 2002).[18] The fluctuations in the California market in 2000–2001 were even more dramatic, exceeding US$400 /MWh in January 2001. The total cost of wholesale power in California was US$7.4 billion in 1999 and about US$27 billion in both 2000 and 2001, implying a massive transfer of wealth – amounting to around US$40 billion – from consumers, businesses and distribution companies to generators and traders (Weare, 2003). In the short run, prices are even more volatile, Newbery (2001b) notes that the English pool price has moved from £11/MWh to £1,100/MWh over a single 24 hour period, and even more extreme price spikes have been seen in the US.[19] Indeed, in spite of such price spikes, there is a clear risk that the market will not clear, with blackouts or load shedding as a result. During 2001 in California, consumers experienced rolling blackouts on 31 days, sometimes lasting more than 5 hours.

One problem with bid-based markets is that under normal demand-supply conditions, the price will equal the short-run marginal cost of operating the "marginal" plant. This means that the "marginal plant" will not receive any revenues to cover its fixed costs (including debt service and return on equity). Consequently, the "marginal" plant will only recover its fixed cost in times of shortages. Planning investments in such an environment is quite difficult since it involves, inter alia, forecasts of both the frequency and magnitude of future shortages. Ford (2002) argues that power plant construction in competitive wholesale markets is highly cyclical. Because of the long planning and construction periods for power plants, the cycles would tend to be quite long (exceeding 5 years). Price spikes and shortages follow the same pattern (with a lag). Based on his analysis for the western electricity market in the United States, he warns (p. 1):

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17 See Box 3.

18 From Nord Pool's web site: http://www.nordpool.no/

19 In any competitive system (and also in other systems where power plants are dispatched in merit order) the cost will vary with demand as generators with higher marginal costs are dispatched. However, price spikes of this magnitude have little to do with the cost of production.

"If we continue with the current market structure, we run the risk of exposing the western electricity markets to another round of reliability alerts and price spikes."

In the same vein, Newbery (2001b, p. 18) notes that:

"…a truly competitive and contestable wholesale electricity market runs the risk of producing unacceptable price volatility, not just in the short run (where contracts would eliminate the impact), but for possibly lengthy periods before new capacity comes on-line…"

Stoft (2002) agrees and adds that the distribution of price spikes might be such that investors may need several decades of data to determine average revenues from such spikes.

De Vries and Hakvoort (2004) examine more of the reasons why bid-based competitive markets might fail to perform according to economic theory. They highlight, among other things, the barriers to entry (including investors' risk aversion) that prevent a fully competitive market from operating. These barriers to entry are generally more serious in developing than in industrialised countries. They conclude (p. 14):

"In theory, it appears that there is sufficient incentive for generators in an energy-only market to invest in capacity. The recovery of investments, however, would depend upon a small chance of earning high returns during periodic episodes of power shortage. This delicate balance between investment and expected returns may easily be upset by a number of factors, some of which appear inevitable. Long-term contracts do not provide a solution, as there is an opportunity for consumers to free-ride the system and the required contract length is too great. Therefore, it appears likely that energy-only electricity markets will tend to lead to a shortfall of generation capacity over time, possibly resulting in investment cycles.

A second disadvantage of relying upon periodical price spikes to signal the need for investment in generation capacity is that these price spikes can be manipulated by generation companies. This possibility dilutes their effectiveness as an investment signal. Worse, it may result in large transfers of income from consumers to producers and reduces the operational reliability of electricity supply during these price spikes."

Bid-based wholesale competition requires adequate generating reserves, a reliable transmission network without any significant bottlenecks and a sophisticated regulatory regime, not only for the monopoly segments but also to prevent abuse of market power in generation. These are conditions that do not exist in most low and lower middle income countries.

4.4.3 Cost-based wholesale competition

The key problems associated with bid-based markets are that prices can rise far above the cost of production and that investors have little assurance that they will be able to recover the capital cost of the plant. The cost-based competitive models that have been implemented primarily in Latin America partly overcome these problems. Dispatch is based on marginal cost, which prevents prices from spiralling out of control as shortages approach. Special arrangements are made to ensure that generators can recover their capital costs, either through contracting for capacity or through some formula adjusting the payments to the generators to reflect their fixed as well as variable costs. Still, especially in systems with a significant share of hydro capacity, prices can be quite volatile.

On the whole, cost-based competition ensures economically efficient dispatch (if the reported production costs are correct) and makes it harder for generators to exercise market power. It is relatively easy to implement since it is similar to dispatch systems already in place. However, it requires administrative (auditing) procedures to verify suppliers' cost functions. It still remains doubtful whether either bid-based or cost-based wholesale competition work well in systems dominated by hydropower generation (see Box 7 for a discussion of the situation in Brazil).

Box 7: Does wholesale competition work in a hydro-based system?

Advice on privatization needs to reflect a thorough understanding of the sector and country concerned. Power generation in Brazil shows how even policy recommendations that make sense in most contexts can be inadvisable in others. Hydropower accounts for 90 percent of the country's electricity generation, relying on large, multiyear storage dams. Unlike in most countries, the long-run marginal cost of additional hydropower investment is probably lower than that of combined cycle gas turbines. The dams have multiple uses, and managing them for irrigation and other purposes requires close basin-wide coordination between water management authorities and power dispatchers. Given this situation, Newbery (2001a) has serious doubts that a competitive wholesale market will provide sufficient incentives for private investments in new generation facilities. He notes that:

> *"These conditions are the least propitious for a competitive, privately owned generation market. Investing in multi-use hydro-electric projects that need coordinated regulation creates considerable private investor risk. Dams are entirely front-end loaded, with negligible running costs but massive investment costs. The gains from private operation are thus likely to be small, and the risks that prices will be held down in periods of tight demand high, while if water is spilled, prices may fall almost to zero in a competitive market. Investing in [combined cycle gas turbines] is equally unattractive, for although from a least-cost system expansion view point, some low capital cost flexible plant may be desirable, the financial economics*

look terrible. It would only operate in drought years, and the overall load factor would probably be less than 35%. Its average cost would exceed the [long run marginal cost] of hydro, and if hydro prices are suppressed in periods of shortage, then the average price will be even lower, and hence un-remunerative without special payments for its role as emergency capacity or reserve.

The uncomfortable conclusion is that it is unlikely that private ownership of generation is an efficient way to plan, develop and finance the generation sector in Brazil. It is an open question whether it would ever be in countries requiring large-scale multiuse river basis management schemes….Private involvement in generation has a comparative advantage where timely construction and maintenance are required to deliver possible efficiency benefits, but is least likely to work in dominantly hydro systems." (pages 15–16)

Source: Newbery (2001a)

Cost-based competition requires a reliable transmission network without any significant bottlenecks, creditworthy (i.e. financially sound) distribution companies and a competent regulatory authority. In addition, the broader governance framework needs to be fairly well developed.

The World Bank has created a comprehensive set of indicators[20] covering six dimensions of governance.[21] We have added up the six dimensional scores to obtain a simple, overall governa nce score for each country and related this score to the structure of the electricity market. Table 11 clearly shows that there is a strong relationship between governance and market structure. Wholesale competition appears to be beyond the governance capacity of most developing countries.

Table 11: Market structure and governance capacity

Market Structure	Average Governance Score
Wholesale competition	– 0.1
Unbundled single buyer	– 0.9
Vertically integrated monopoly with IPPs	– 1.6
Vertically integrated monopoly without IPPs	– 4.8
All developing countries	– 2.5

20 The indicators can be found at http://info.worldbank.org/governance/kkz2005/tables.asp (accessed January 5, 2007).

21 The six dimensions are: voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law and control of corruption.

A key question in both bid-based and cost-based competitive systems is who will take the market risk associated with volatile spot prices. In California, consumer prices were essentially fixed and the distribution companies had to assume the main share of the market risk, which they did not have the balance sheets to absorb. The result was a couple of spectacular bankruptcies (by one of the two largest distribution companies and the power exchange). The alternative of letting consumers take the market risk raises some sensitive political issues: is it reasonable to ask low-income consumers (who might spend more than 5% of their budget on electricity) to face significant volatility due to, for example, a drought affecting hydropower production or a mishap at a generating plant that reduces the supply of electricity? What impact will price increases have on popular perceptions of private participation in the power (and other) sectors?

The problems with volatile spot prices can, in principle, be mitigated through long-term contracts between buyers and sellers or through hedge markets (options, futures, etc.). It is unlikely, however, that hedge markets can be established in most low and lower middle income countries that have poorly developed capital markets. New Zealand has adopted wholesale competition for its electricity market. Although it is an OECD country with a sophisticated financial market, Hansen (2004, p. 12) notes that a liquid, well functioning hedge market has not developed since:

> *"It may simply be that New Zealand has too few players to achieve and sustain a liquid market, or that the benefits of liquidity are too limited in such a small market. Sustainable trading volumes may simply be too small for market makers to justify the risks of establishing in New Zealand, and large spreads between their buy and sell prices will simply drive parties to deal directly with each other."*

The use of long-term contracts between generators and large consumers or distribution companies creates other problems relating to market power and lumpiness of generating investments. The scope for using bilateral, long-term contracts is obviously much greater in Brazil with electricity production exceeding 300,000 GWh in 2001 than in Tanzania with production of less than 3,000 GWh. In smaller systems it makes sense for distributors to pool their purchases of power, which in effect becomes a single buyer model for long-term contracts.

4.4.4 Single buyer models

The single buyer model replaces "competition in the market" with "competition for the market." It allows generators to charge prices that recover

not only their variable costs but also their capital costs. Experience clearly shows that risk-averse lenders prefer security provided by long-term Power Purchase Agreements (PPAs), especially in low income countries where overall country risks are high.[22] Newbery (2001c) argues that (p. 21):

> *"Capacity in both transmission and generation has public good-like qualities, in that it increases security, reliability, and competition, all of which benefit consumers connected to the system.*
>
> *...Compensating for the tendency to under-invest in generation requires the equivalent of a two-part tariff, with a capacity and energy element... This is easy with the Single Buyer model, but more difficult if all consumers are free to switch suppliers for this will discourage suppliers for entering into long-term strandable contracts."*

The World Bank, as well as other some other observers, regard the single buyer model with a fair degree of scepticism. The main reasons can be summarised in the following quotes from Kessides (2004, p. 152)):

> *"…in its standard form (active single buyer) the model concentrates all financial risk in the hands of a single agent. If this state-owned agent is unable to meet its obligations to generators, the government is expected to step in (an expectation formalised in a guarantee agreement). Thus power purchase agreements under the single buyer model create a contingent liability for government that can affect its creditworthiness. Effectively, taxpayers or customers – not investors – bear all the risk."*

> *"…investments in generating capacity are not driven by market incentives, but rather by bureaucratic preference. Decisions about expanding capacity are made by government officials who do not face the financial consequences of their actions. In fact, governments have often abandoned least-cost expansion alternatives because of political reasons, expediency, and outright corruption."*

> *"…the single buyer model weakens the incentives of distributors for effective demand forecast and procurement, and for collecting payments from customers. The state-owned single buyer is often politically constrained and reluctant to take action against delinquent distribution companies. Thus the lack of direct contracts between generators and distributors inevitably undermines payment discipline. When paying and non paying distributors are treated alike, their incentives for efficient performance are clearly weakened. These distorted incentives are not easy to fix."*

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[22] According to the World Bank's PPI database, between 1984 and 2005 some 70 merchant plants have been built in developing countries, representing a total investment of US$11.6 billion. Of these, only 3 merchant plants (total investment US$104 million) were built in low income countries.

While it is true that the government assumes certain contingent liabilities in most, if not all, single buyer systems, these are primarily related to factors under the government's direct control. Most important of these is the timely payment by the system operator to the generators. Generally, the PPAs include tariff formulas that allow for adjustments to the generation tariff to reflect changes in fuel costs, general inflation and devaluation. After the Asian financial crisis and the associated rapid devaluation, the indexation formulas in many countries required drastic adjustments to the generating tariffs. The state-owned utilities that acted as single buyers were unable to pass these increases on the consumers. These utilities were unable to pay and, in principal, the state needed to step in and the tax payers ultimately bore some of the burden. (This, of course, was not very different from the situation that the distribution companies faced in California, where ultimately the tax payers had to pick up some of the costs). However, the investors and the lenders to the Asian Independent Power Producers (IPPs) also suffered since the PPAs were generally renegotiated.

It should also be noted that the foreign exchange problem is not in any way unique to single buyer systems. In Argentina both wholesale and retail prices were set in US dollar to which the peso was linked under the 1991 Convertibility Law. With the abolishment of this law in 2002, the peso fell dramatically. The government imposed a rate freeze (in devalued pesos) on consumer prices and long-term contract prices for both electricity and gas. This threw the whole industry into turmoil, with many generation and distribution companies essentially becoming bankrupt. Two years later, Argentina was facing an energy crisis due to under-investment since the devaluation. At least 20 of the power companies brought their cases to the International Center for Settlement of Investment Disputes, ICSID.

In countries with state-owned utilities that have financed most of their investments through foreign loans and that import the fuel for power generation, governments face liabilities of the same type and order of magnitude as they do with IPPs having long-term PPAs.

It is noteworthy that Brazil, who during the 1990s was in the forefront of power sector reform and establishment of a competitive wholesale market, has now introduced a modified single buyer approach (Box 8).

Box 8: Brazil – from wholesale market to centralised purchasing of power

Most of Brazil's distribution entities and some generation plants were privatised during the 1990s and a competitive wholesale market was established. The distribution companies were free to negotiate long-term contracts directly with generators as well as buying power on the spot market. Brazil's generation capacity consists primarily of hydropower (see Box 7). During 2001–2002, Brazil

experienced a severe energy crisis due to a prolonged drought that depleted the hydro reservoirs. Strong incentives were put in place to reduce electricity consumption by 20%.

This led to a review of the way the power market functioned. A "pure" single buyer model was considered but the government decided on a modified approach: the Market Administrator acts as a centralized purchasing agent and buys the power on behalf of the distribution companies through a competitive auction. The distribution companies submit their long-term power requirements to the Market Administrator who aggregates the demands and conducts an "auction" where the generators put in their bids to supply the "pool." Each of the 18 generating companies and each of the 35 distribution companies supplies and buys, respectively, a share of the pool. The generating companies and the distribution companies subsequently enter into some 600 long-term (8 years) bilateral contracts. While the initial auctions were conducted to purchase power from existing generating companies, a similar auction process is put in place to purchase new generating capacity

The difference between this pool approach and the traditional single buyer model is primarily technical in nature and involves who takes the demand-supply risk. In this case, the Market Administrator never becomes owner of the power (as a normal single buyer does) but only sets the rules and manages the auction. This procedure works in Brazil where the distribution companies are financially sound and creditworthy enough to back-up long-term power purchase agreements. In countries where the distribution companies are not creditworthy (as in most low-income countries), the agreements have to be signed by a government owned (and guaranteed) centralized purchasing agency.

Sources: Arizu et al. (2006) and de Oliveira et al. (2005)

While Kessides (2004, p. 152) argues that a drawback of the single buyer model is that *investments in generating capacity are not driven by market incentives, but rather by bureaucratic preference*, this might actually be an advantage under certain circumstances. For example, Ljung et al (2001) documented that private investors are reluctant to invest in hydropower projects, given the considerable risks and high investment costs. Indeed, private investors are unlikely to undertake investments in most types of renewable energy projects in competitive markets. System operators/single buyers, however, can contract for various types of renewable projects and integrate their operation into the power system. It would be attractive for private investors to compete for renewable projects if they were sure that they will be fairly compensated through a tariff structure that properly accounts for capital and operating costs. In a competitive wholesale market, the government can encourage the construction of generating plants only through subsidies (direct or indirect). While such subsidies might work well in OECD countries with their sophisticated and transparent fiscal systems, this will be less feasible in low and lower middle income countries.

Like generating and transmission capacity, demand side management is essentially a public good. Energy savings by one consumer will

not only improve the reliability of supply for all other consumers but also reduce the need for additional peak generating capacity. The traditional integrated utilities face a choice between encouraging energy savings and installing new capacity. Thus, they often have the financial incentives to promote various demand side management measures. In a competitive market system, the incentives for consumers are such that they will always invest too little – from society's point of view – in energy saving measures. Generators, on the other hand, have incentives to encourage wasteful use of energy (which results in higher prices and greater profits). The single buyer/system operator has an incentive to encourage energy savings through various demand side management measures.

The argument that the single buyer model weakens the incentives for collecting payments from customers is also questionable. While it might be true that state-owned, single buyers are constrained politically and reluctant to take action against delinquent distribution companies, it appears to be politically impossible to cut off supplies to non-performing distribution companies even in competitive systems. This was the case in California during the 2000–2001 crisis and in Argentina after the 2002 devaluation.

4.4.5 Unbundling

There are certain advantages associated with vertically integrated power companies. Complementarities between generation, transmission and distribution result in economies of scale and scope. New power generation technologies (especially combined cycle gas turbines) have partly removed economies of scale in generation and have created a greater scope for competition in the generating market. Unbundling (i.e. separating generation, transmission and distribution, see section 2.1) is essential to reduce the scope for generators exercising vertical market power in competitive wholesale markets. Given the aim of ultimately introducing such markets, agencies like the World Bank have typically argued that unbundling is an essential step in the reform process. Bacon and Besant-Jones (2002, p. 4) express these reform steps in the following terms:

> *"The process of a full reform program therefore consists of the following four main stages: (a) formation and approval of a power policy by government that provides the broad guidelines for the reform program and the heavy political commitment needed to sustain the reform process, followed by the enactment of legislation necessary for implementing this policy; (b) development of a transparent regulatory framework for the electricity market; (c) unbundling of the integrated structure of the power supply and establishing a market in which electricity is traded at arm's length; and (d) divestiture of the state's ownership at least in most of the electricity generation and distribution segments of the market."*

This raises the question of whether there is any reason to unbundle a single-buyer system. The main argument would be that unbundling enhances transparency and enables the regulator to use yardstick competition (or "competition by comparison") to improve the performance of, especially, distribution entities. However, there seems to be some economies of scale – at least up to some point – in distribution. These economies are not so much related to the management and operating costs: doubling the number of customers will not double the cost of the computer system handling billing, increasing the size of the system will lower the relative cost of keeping critical spare parts in stock and keeping highly specialised staff on duty. Thus, there are a number of cases where horizontal mergers have occurred in distribution. For example, when the distribution system in El Salvador was privatised in 1988, it was divided into five enterprises. Two years later, AES controlled four of the five.

Similarly, there are clear benefits from vertical integration which facilitate planning and system operation and reduce risks. While many of the technical and financial arguments for vertical integration have been exhaustively discussed in the literature, less emphasis has been placed on the risk aspects. Vertical integration internalises many risks, especially price risks. This is best illustrated with the California case: in 2000 and 2001, the generators made excessive profits while the distribution companies essentially went bankrupt. In an integrated utility, the losses in distribution would have been compensated for by profits in generation.

Clearly, unbundling involves transaction costs that can be expected to be relatively higher for smaller systems. Thus, countries with larger systems are more likely to have proceeded with unbundling, as can be seen in Table 12.

Table 12: Power system size and unbundling

Size of country's power market	Percent of countries that have unbundled
Large (>50,000 GWh in 2001)	63.2%
Medium (10,000–50,000 GWh)	44.4%
Small (<10,000 GWh)	21.1%
All 122 Countries	32.8%

Two of the countries that have both unbundled and introduced wholesale competition (Bolivia and El Salvador) have power markets that are smaller in terms of electricity sales than a typical Swedish county. As was seen above AES, at least, did not believe that the service areas of the distribution companies in El Salvador were large enough for efficient operation.

Table 13: Market structure and the impact of risk on different stakeholders

	Single Buyer															
	Foreign Financed IPP				Locally Financed IPP				Wholesale – cost based				Wholesale – bid based			
	"ystem Operator	Consumers	Generator	Other Generators	System Operator	Consumers	Generator	Other Generators	System Operator	Consumers	Generator	Other Generators	System Operator	Consumers	Generator	Other Generators
Spare Capacity in the System																
Construction cost overrun			neg				neg				neg				neg	
Construction delay	neg	neg	neg		neg	neg	neg			neg	neg	pos		neg	neg	pos
O&M breakdown	neg	neg	neg		neg	neg	neg			neg	neg	pos		neg	neg	pos
O&M cost increase			neg				neg				neg				neg	
Overestimated demand	neg	neg			neg	neg				pos	neg	neg		pos	neg	neg
Fuel costs increase	neg	neg			neg	neg				neg				neg		
Devaluation	neg	neg									neg				neg	
General inflation	neg	neg			neg	neg					neg				neg	
No or Little Spare Capacity																
Construction cost overrun			neg				neg				neg				neg	
Construction delay	neg	NEG	neg		neg	NEG	neg			NEG	neg	POS		**NEG**	neg	**POS**
O&M breakdown	neg	NEG	neg		neg	NEG	neg			NEG	neg	POS		**NEG**	neg	**POS**
O&M cost increase			neg				neg				neg				neg	
Overestimated demand	neg	neg			neg	neg				pos	neg	neg		pos	neg	neg
Fuel costs increase	neg	neg			neg	neg				neg				neg		
Devaluation	neg	neg									neg				neg	
General inflation	neg	neg			neg	neg					neg				neg	

Note: neg/pos indicates a negative or positive impact
NEG/POS indicates a large negative or positive impact
NEG/POS indicates a very large negative or positive impact

The different market structures allocate risks to the stakeholders in different ways, as shown in Table 13. The matrix indicates that the impact of risks can be rather perverse, especially in a bid-based wholesale market facing capacity constraints. For example, if the implementation of a new project is delayed, the project owners correctly bear the cost of lost revenues. However, as was seen earlier in this chapter, the resulting shortage would significantly push up prices for consumers (potentially increasing the cost many times over) while other generators would make a very large windfall profit. This problem would be especially serious in small systems.

4.5 Tariffs – a key step in the reform process

One of the objectives – if not the main objective – of power sector reforms is to restore the financial health of the sector. In some cases, this can be a formidable challenge. For example, Ebinger (2006) estimates that in 2001 explicit and implicit subsidies to electricity consumers exceeded 20 percent of GDP in the Kyrgyz Republic. While this is an extreme case, most state-owned utilities keep tariffs below their true cost[23] and often use elaborate cross-subsidy schemes. Thus, it is not uncommon that industrial enterprises pay tariffs well above the full cost of generating and distributing power while domestic and agricultural customers pay only a small fraction of the long-run marginal cost (see Table 14 for an illustration from the Indian State of Gujarat).

Table 14: Electricity tariffs in state of Gujarat, India (1998)

Category	Existing Tariff (IRS/kWh)	Long-Run Marginal Cost (IRS/kWh)	Change Required to Reach Long-Run Marginal Cost
Residential	1.50	5.20	+247%
Commercial	3.20	3.72	+16%
Agricultural (Irrigation)	0.20	3.05	+1,425%
High Voltage Industrial	2.86	2.23	– 22%

Source: ADB (2002)

[23] See, for example, World Bank (1994) and ADB (2002).

One of the key steps in the reform process is to re-align tariffs so that they reflect the marginal cost of serving different categories of customers. As can be seen from Table 14, this can imply major upward adjustments in domestic tariffs (and often a downward revision for industries). Consequently, studies of the impact of sector reform and privatisation have generally found that industrial consumers have tended to benefit more from price reductions than households (see for example Steiner, 2000). The topic of tariffs and subsidies is further discussed in Section 8.4.

4.6 Overall assessment of the impact of different reform options on key development objectives

Some of the results of power sector reforms are inherent in the incentives provided by asset ownership and the market relationship between the actors. Others can be influenced through regulatory requirements. Still others are determined by the factors discussed in the preceding chapter (such as access to finance). The overall impact of these factors is summarised in the evaluation matrix that assesses the impact of different reform options on key development objectives (Table 15).

In short, it appears that a single buyer model offers the greatest advantages for most low and many lower middle income countries. Where the system is large enough, unbundling appears to be attractive. Unbundling – even if it does not involve privatisation of the assets – enhances transparency and accountability and will, in most cases, increase the overall efficiency of the system.

Thus, the general strategy for low income countries and most lower-middle income countries can be summarised as follows:

- Adopt a single buyer model for new generating capacity and enter into new contracts (based on two-part tariffs rather than take-or-pay arrangements) only after competitive bidding;
- Introduce simplified solicitation procedures and contracting models for smaller, locally owned and financed generating projects;
- Unbundle the utility only if it is sufficiently large (annual sales exceeding, say 5,000 GWh);
- Use management and lease contracts to help improve operating performance of state-owned assets;
- Encourage local entrepreneurs to set up smaller (village/neighbourhood) systems in unserved areas and simplify

concession arrangements (including permitting lower technical standards) for such schemes;
- Allocate public sector subsidies to grid extension and connection of rural and peri-urban, low-income consumers.

Table 15: Evaluation of power sector reform options for low-income countries

	Vertically Integrated, Public (1)	Vertically Integrated, Private	Single Buyer, Vertically Integrated	Single Buyer, Unbundled	Wholesale Competition Cost-based	Wholesale Competition Bid-based	Retail Competition
Economic Growth							
Resource Mobilisation (2)	0	+	+ +	+ +	+	–	–
Efficiency/Productivity (3)	0	+	+	+	+	+	+
Financial Sustainability (4, 5)	0	+	+	+	+	+	+
Environmental Objectives							
Energy Efficiency (5)	0	+	0	+	–	–	–
Renewable Energy (6)	0	–	?	?	– –	– –	– –
Reduction of Emissions (7)	0	+	+	+	0	0	0
Poverty Reduction Objectives							
Affordability (8, 9)	0	–	–	–	–	– –	– –
Access (10)	0	?	0	?	?	?	?

Key: 0 = baseline; + = positive; ++ = very positive; – = negative; – – = very negative
? = can vary from very negative to very positive depending on regulations or contracts
Note: Figures in parenthesis refer to items listed below.

The assessments above might not apply to upper middle income countries with their more developed capital markets, easier access to international financing, greater regulatory capacity, etc. The rationale for the scores is set out below:
1.A "typical" state-owned, vertically integrated utility is taken as the baseline, as indicated in the item scores of "0". This utility is assumed to be somewhat overstaffed, have moderately high technical and non-technical losses, have average tariffs below the long-run marginal cost and a fair amount of cross-subsidies between industrial and residential consumers.
2.Experience clearly demonstrates that Build-Operate-Own/Build Operate Transfer (BOO/BOT) type schemes are the most effective vehicle for mobilising private sector financing for power projects in low-income countries (Table 8). Lenders are unlikely to provide financing for projects operating under bid-based wholesale competition. Long-term power purchase agreements make it easier to mobilise financing for BOO/BOT generating projects than for generating projects operating under cost-based wholesale competition that have more uncertain revenues.

3.Private ownership is likely to improve the operation of the facilities (Section 4.1) but it is not clear that, in the long run, "competition in the market" is more effective than "competition for the market" (at least not in small countries with weak regulatory capacity, i.e. where market power would be a major concern).
4.Similarly, private ownership will ensure that the entity operates on a financially sound basis.
5.A vertically integrated, privately owned utility will have clear incentives to support demand side management measures (Section 4.2). A single buyer in an unbundled system is likely to actively consider trade-offs between Demand-Side Management (DSM) measures and investments in new capacity. Generators in competitive systems have incentives to support wasteful consumers rather than encouraging DSM. Finally, most state-owned monopolies have shown little interest in DSM.
6.The pricing signals provided through wholesale and retail competition generally discourage investments in renewable energy (Section 4.2). Similarly, privately owned vertically integrated utilities are likely to seek to minimise power production costs, which will generally work against renewables. Under the single buyer model, however, it is relatively easy to structure tariffs to make it attractive for firms to compete for the construction and operation of wind farms and other renewable generation options. Thus, the use of renewable energy sources will depend on the single buyer's preferences.
7.Private owners appear to have greater incentives to operate their plants efficiently and to reduce emissions. In terms of fuel and technology choice, it is likely that that under wholesale and retail competition, generators will have less incentive to go for a more costly option.
8.Poverty impact and, especially, affordability are difficult to assess. Typically, state-owned, vertically integrated utilities recover less than the full cost of the service (World Bank, 1994). They tend to obtain "hidden" subsidies in the form of below-market interest rates, no return earned on government equity, overdue payments to government entities, etc. These government subsidies to the utility company partly cover the cost of inefficiencies and are partly passed on to consumers. When private capital is introduced into the sector (through BOT schemes or privatisation), the hidden subsidies tend to disappear or, at least, be reduced. Thus, even though the private actors are likely to produce, transmit and distribute power at a lower real cost to the economy, private participation in the power sector and introduction of sound commercial principles are likely to increase the average tariff level and, at the same time, reduce cross-subsidies from commercial and industrial consumers to low income households (see Table 14).
9.The restructuring of tariffs and the removal of subsidies after reforms will generally mean that domestic consumers pay higher prices than under the traditional state-owned monopoly (Section 4.3), however this can be changed through "smart subsidies."
10.As was shown in Section 4.1, improving access is key to ensuring that social and economic benefits of power sector reform are maximised. The extent to which this occurs depends critically on the regulatory regime. A poorly designed regime will discourage connection of high cost rural and peri-urban consumers. On the other hand, there are numerous examples of well designed incentives for private distribution companies or integrated utilities that have dramatically expanded access. The policy framework and regulatory regime can also encourage small-scale operators to serve both rural and peri-urban areas.

Reforms in other energy sectors

CHAPTER 5

5.1 Oil and gas

The activities in the oil and gas sector comprise segments with varying scope for competition: *(i) upstream activities i.e. exploration, field development and production of oil and/or gas; (ii) oil refining; (iii) wholesale and retail distribution of petroleum products; and (iv) transmission and distribution of natural gas.* The reform process in each of these segments is discussed below.

5.1.1 Upstream activities – exploration, field development and production

Most developing countries with any significant hydro-carbon reserves have established state-owned firms with exclusive rights to the exploration for and production of oil and gas. As these activities have become increasingly capital intensive and technologically more sophisticated, virtually all developing countries have been compelled to open up the upstream market to international oil companies. However, in only a few cases has this been associated with a divestiture of the state-owned oil/gas company (Cote d'Ivoire, Hungary and to some extent Russia).

The market model that has emerged is that countries auction off exploration-production rights in certain areas (normally referred to as "blocks") to joint ventures (JVs) of foreign firms. The JV is typically required to pay a certain amount up front for the concession but the most important criterion for selection is the share of profits and/or the production that they are prepared to give to the state. The state-owned oil company is often a mandatory partner in the JV. Thus, the government receives revenues from the JV in the form of: (i) up-front payment for the concession; (ii) royalties on the amount of oil or gas pumped; (iii) a share of the profit and a share of the oil/gas produced; and (iv) taxes on the profits of the JV. Through the competition for the exploration and development rights, the

Table 16: Reform steps in refining

	Region						
	EAP	**ECA**	**LAC**	**MNA**	**SA**	**SSA**	**All**
Traditionally private participation	0	0	6	1	1	6	14
Divestiture 1990–98 (full or partial)	2	10	2	1	1	0	16
Private investment in new capacity	0	3	0	0	0	2	5
State monopoly	2	9	9	5	2	9	36
No refinery in the country	5	5	1	1	1	31	44
Countries surveyed	9	27	18	8	5	48	115

Source: Bacon et al (1999)

state maximises its revenues from the concession and through the profit or production sharing formula it will benefit from any "upside" due to rising oil/gas prices.

This model has so far proven to be successful in attracting capital for oil and gas development, even in such remote places as Chad. The key challenge has been to ensure that the revenues are used for development purposes and not squandered through corruption and/or wasteful spending. While the concession agreements are typically relatively transparent, the accounting for oil revenues tends to be rather murky. The monitoring arrangements agreed between the World Bank, the government of Chad and the international oil companies represent a major step forward in introducing transparency and accountability.

5.1.2 Oil refining

A survey undertaken by ESMAP in 1998 showed that 71 of 115 developing countries had refineries. In 14 countries, the refineries had long been owned by the private sector (Bacon et al, 1999). Another 16 countries had privatised their refineries between 1990 and 1998. A further five had allowed private investments in new refinery capacity. As can be seen from Table 16, most of the divestitures have taken place in Eastern Europe and Central Asia; indeed, it appears that further privatisation activity has taken place in this region after 1998 when this survey was conducted. In many other cases there has been strong resistance against divestiture (such as in Mexico where the constitution requires that refinery assets are

owned by the state). In other countries, the refineries are of little interest to potential buyers since they are small, old, inefficient, environmentally unsound and produce an outdated product mix. Thus, the most important reform is to allow free import of petroleum products.

5.1.3 Distribution of petroleum products

Within the oil and gas sector, the importation and distribution of petroleum products is the market segment that may potentially be most competitive. While there obviously are some economies of scale in importation and storage and some economies of scope in having vertically integrated companies, the merit of having state monopolies controlling both the wholesale and retail market is doubtful. Still, in the late 1990s, such monopolies existed in around 40% of the developing countries (Bacon et al, 1999).

Table 17: Reform steps in petroleum distribution

	Region						
	EAP	**ECA**	**LAC**	**MNA**	**SA**	**SSA**	**All**
Traditionally Private	1	1	7	3	0	31	43
Divestiture 1990–98	0	11	2	2	1	4	20
Deregulated	1	3	3	0	0	0	7
State monopoly	7	12	6	3	4	13	45
Total	9	27	18	8	5	48	115

Provided that safety aspects can be adequately handled, it appears that significant efficiency gains can be achieved by breaking down the old vertically integrated monopolies, privatizing the individual gas stations and allowing new entrants into the entire distribution chain. Especially in the cases of products such as LPG and kerosene, market liberalization is likely to significantly improve access in peri-urban and rural areas. The challenge from a policy and implementation point of view is to replace the system of implicit taxes and cross-subsidies that prevails in many state-owned oil companies with a transparent, explicit system of taxes and subsidies. These taxes and subsidies (if any) should be set within the framework of an overall policy for the energy sector as a whole, taking into account the economic, environmental and social benefits and costs of competing energy sources.

5.1.4 Transmission and distribution of natural gas

Until some 15 years ago, international oil companies had little interest in finding and producing natural gas in developing countries, largely because they saw little demand in the local market and the export potential was regarded as too limited to justify the heavy investment in both gas fields and pipelines or the complex and capital intensive transportation chain for Liquefied Natural Gas (LNG) comprising liquefaction facilities, ships and regasification terminals.[24] Advances in combined cycle gas turbines have made the use of natural gas more attractive and a handful of developing countries have entered the export market.

Outside Eastern Europe and Central Asia, few cities have gas distribution networks for domestic use. Thus, the transmission and distribution systems in most developing countries that have access to natural gas typically serve only a few major consumers such as power and fertiliser plants and smelters. In the latter case (as well as for LNG export facilities and export pipelines), the pipelines are typically built by the consortium developing the gas field (or by an associated private group). The sale is usually through long-term contracts negotiated between the parties. Little government regulation is generally needed.

The issues related to gas distribution companies serving a broad range of customers are virtually identical to those related to electricity distribution and transmission. Thus, outright divestitures have taken place predominantly in Eastern Europe, Central Asia and Latin America. The regulatory regime and the key considerations are similar to those in electricity transmission and distribution.

5.2 District heating

District heating is a system for central generation and distribution of heat to residential and commercial areas. In the simplest systems, a boiler fueled by gas, oil, coal or biomass produces hot water (or steam) that is distributed in insulated pipes to the customers. A more efficient approach is usually to combine the generation of heat with the generation of electricity (usually referred to as "cogeneration").

District heating systems – if properly designed and well managed – offer certain advantages over plants that serve individual buildings or apartments: lower overall investment costs, higher efficiencies and greater potential for economic installation of exhaust cleaning technologies. They

[24] The capital cost for one "train" comprising a liquefaction facility, two ships and a regasification terminal with an annual capacity of about 4.8 bcm is around US$1.5 billion.

are widely used in Eastern Europe and Central Asia. Indeed, heating is critical to the welfare of the people in these countries. However, the difficult transition to market economies (often associated with drastic falls in incomes) and the legacy of inefficient, wasteful energy systems have created special problems. Recent surveys show that people in the transition economies tend to spend 5–10 percent of their incomes on heating, with the poor spending about twice the amount – relative to incomes – as the non-poor (Lampietti & Meyer, 2003). Although district heating is widespread in the major cities of the region, the poor generally rely on other heating sources. In urban areas of Moldova, for example, 17% of the poor and 57% of the non-poor use district heating.

It is universally acknowledged that most of the district heating systems are inefficient and lose a significant amount of the energy on the way to the consumers. Although district heating systems in Northern Europe are cost-effective (especially when they combine heat with power generation), the financial viability of the systems in many cities in Eastern Europe and Central Asia is more questionable. Lampietti & Meyer (2003, p. 21–22) notes that:

> *"When putting together information on the costs of various heating options and the effective low level of heat demand in many of the poorer countries in Eastern Europe and Central Asia, it becomes obvious that the traditional provision of heat at a full service level of 180 Celsius is too expensive in several countries of the region to enable district heat utilities to achieve cost recovery. The high fixed costs of centralised heating systems make them relatively slow to react to a heterogeneous heat demand. Decentralised heating options are less risky in this respect since they are modular."*

Still, where such systems exist, rehabilitation often makes sense. However, reducing losses in the generation and distribution of heat is only one – perhaps the minor – part of the solution to the problem of ensuring adequate heat for low income groups. A large part of the problem is associated with poorly insulated buildings and a lack of demand side management instruments. Interventions such as reducing draft s and weather stripping windows, installing heat meters at building level and installing meters for domestic hot water at apartment level can be highly cost-effective and have pay-back periods of 1–2 years.

In short, actions are required at system, building and apartment levels. Consequently the system for charging for heat has to change (taking into account potential free-rider problems). It also means that solutions must be consistent with the transition that is taking place on the housing market. There also appears to be a need to develop energy service companies

Energy Service Companies (ESCOs) (see Box 105 in Chapter 7.) that can support individual households and building owners (private and cooperative) in addressing the need for improved energy efficiency at these levels.

Furthermore, the district heating sector often needs to become commercially sound and better governed, given the monopoly characteristics of individual systems.

The challenge of rural energy

CHAPTER 6

6.1 About 1.6 billion people without access to electricity

Energy plays an important role in enabling agricultural growth and alleviation of rural poverty. Still, in spite of the progress made in recent decades, there remain 1.6 billion people without access to electricity[25] (IEA, 2002). There are great variations in the coverage between urban and rural areas, as can be seen from Figure 10 below.

Most countries in Eastern Europe and the former Soviet Union have basically achieved universal access to electricity. In other regions, rural areas lag far behind cities and towns. Indeed, the International Energy Agency (2002) has estimated that, in 2000, around 92% of the rural population (370 million people[26]) in Sub-Saharan Africa lacked access to electricity; 70% (690 million) in South Asia; 48% (60 million) in Latin America; 22% (30 million) in North Africa and the Middle East; and 19% (220 million) in East Asia. China and the other countries in East Asia have made tremendous progress in providing electricity to rural areas over the last couple of decades. This progress is captured in Figure 11 below.

East Asia is also the region that has made the greatest progress in reducing rural (and overall) poverty. This leads to a key question: what role did rural electrification play in the reduction of rural poverty in the region? Recent research indicates that it was not industrial growth and employment that caused poverty to decline in East Asia (and, to a lesser extent, in South Asia), but successful agricultural transformation. Technological

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25 I.e. they are not connected to the power grid. In urban and peri-urban areas, the grid might be available nearby while in many rural areas, there is a complete lack of transmission and distribution facilities.

26 The number of people has been calculated by applying IEA's coverage figures and the World Bank's estimate of the rural population as given in WDI 2003.

Figure 10: Access to electricity in rural and urban areas

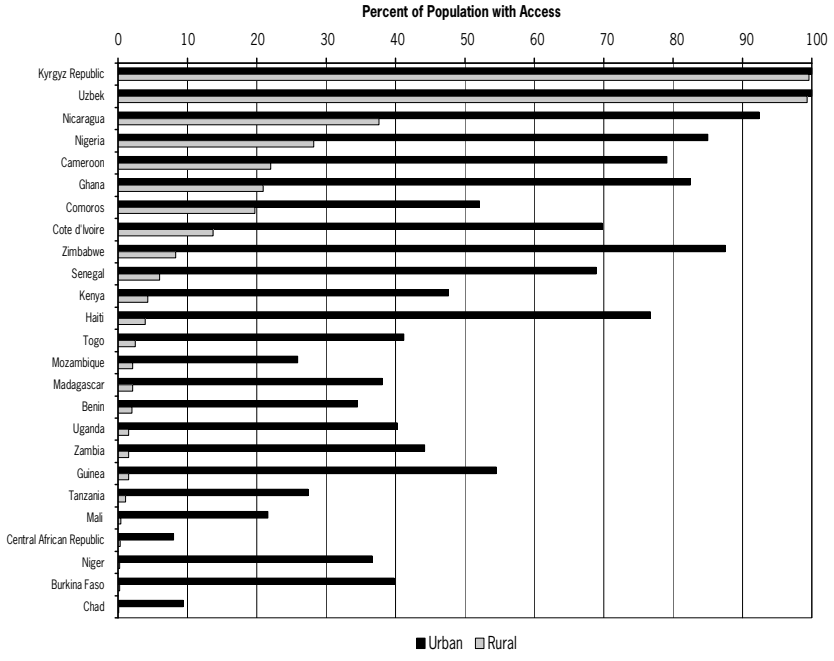
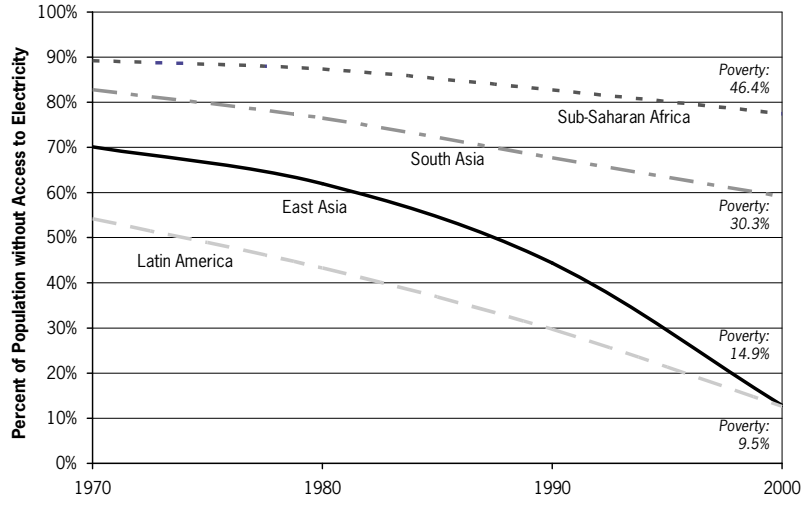


Figure 11: Progress in providing access to electricity 1970–2000



Sources: Data on access to electricity from IEA (2002) and population data from WDI 2003. Poverty figures for 2001 are from the World Bank's MDG monitoring website (http://ddp-ext.worldbank.org/ext/GMIS/home.do?siteId=2)

change, resulting in higher yields, as well as shifts to higher value crops increased farm incomes. A large portion of this income was spent on locally produced, labour intensive, goods and services. Mellor (1999, p. 18) shows that agricultural growth typically generates twice as much employment in local non-farm activities as it does in farming. He concludes that:

> *"the labor market tightens surprisingly quickly. Why? Because of the immense increase in employment in the local non-farm sector. The poor benefit as employment increases and then again as real wages rise. That is why poverty declines so rapidly with increased agricultural output."*

The International Food Policy Research Institute (IFPRI) has undertaken a set of careful studies of the relationship between public expenditure and agricultural growth and rural poverty alleviation. Not surprisingly, IFPRI found that agricultural research, education and infrastructure expenditures exerted major impact on the rate of agricultural growth and poverty alleviation. The relative importance of various infrastructure sectors varied not only between countries but also between different regions within a country. In Thailand, public investments in electrification had by far the greatest impact on rural poverty (and the second highest benefit-cost ratio after research). In other countries (with lower per capita incomes), transport investments seemed to have a greater impact than investments in rural electrification (Fan, 2003 and Fan et al, 2004).

A possible explanation for this finding is that research (and education) provides the underpinning for technological change. Transport investments improve market access and enable farmers to take advantage of new opportunities. Rural roads also increase the effective "farm gate" price for the produce and lower the delivered price of modern inputs and, thus, provide stronger incentives and higher profits. Electricity facilitates the agricultural transformation process and supports the development of (demand-driven) non-farm activities.[27] Saghir (2005, p. 5) expresses it in the following terms:

> *"For example, in a rapidly developing agricultural region, the introduction of electricity will help raise the productivity of local agro- industrial and commercial activities by supplying motive power, refrigeration, lighting, and process heating. Higher productivity, in turn, will lead to higher earnings, which will create greater household demand for electricity. But when development efforts fail because of poor crop pricing and marketing policies*

[27] In the report on the Thailand study (Fan et al, 2004), IFPRI notes that Thailand has a well developed road network and, thus, implicitly supports this explanation.

[as well as a lack of appropriate technologies and farm-to-market roads][28], improving electricity supplies alone will have little effect on local welfare.

Another explanation for the more modest impact of rural electrification observed in other country studies is that they capture only public investment and rely on official data on investments and service levels. They do not include private investments, neither do they capture "informal" connections to the power system. Most importantly, they focus narrowly on electricity and not on other forms of energy. In India, for example, IFPRI found relatively small impact of electricity investments on poverty and agricultural output (Fan et al, 1999). Most of the electricity in rural India is used for irrigation. In the areas where groundwater is ample, farmers have long used diesel and gasoline driven pumps for irrigation. Because electricity is either free or highly subsidised[29], farmers generally found it profitable to switch from petrol to electricity for their wells. Clearly, under such circumstances, a rural electrification programme will have little impact on agricultural output or on poverty. Thus, it can be concluded that the IFPRI studies tend to underestimate the importance of modern energy for the rural transformation process and poverty alleviation.

In short, access to modern energy sources is a necessary, but not sufficient, condition for economic development.[30] Only in rare circumstances can energy, per se, "jump-start" agricultural growth and rural poverty alleviation. On the other hand, a lack of modern energy can severely thwart government and donor efforts to promote rural development. The high cost of providing electricity and other energy in rural areas can make policy and investment mistakes very expensive – both from a budget and macro-economic point of view. The changing role of the state has implications for government strategies to promote the use of modern energy in rural areas. This chapter briefly reviews some of the lessons learned and outlines some policies that seem to work.

6.2 Costs and subsidies

Low population densities and low levels of household demand typically cause extension of the power grid into remote areas to become very costly. This is illustrated in an analysis carried out for Indonesia (Table 18).[31]

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28 The parenthesis has been inserted by the authors for fuller explanation of factors affecting agricultural development.

29 For an illustration, see Table 14 in Section 4.2.

30 See also Section 1.1 for a discussion of energy in economic development.

31 Source: World Bank (1996).

Table 18: Effects of line length and consumption levels on the relative costs of rural electrification in Indonesia

Cost component	Cost by Component (US¢/kWh)	Total Unit Cost (US¢/kWh)
Generation and transmission	10	
Medium-voltage extension and low-voltage distribution		
3-kilometer spur line, 20 households	45	55
3-kilometer spur line, 50 households	20	30
1-kilometer spur line, 50 households	15	25
1-kilometer spur line, 50 households	7	17

Source: World Bank 1996

There is significant scope for reducing the capital costs of rural electrification schemes by adopting more appropriate design standards (NRECA 2000). For example, many rural electrification schemes are designed for household loads of 1000–3000 W but loads are often only in the range of 200–500 W. Management of rural systems can also be improved though adoption of a decentralised approach with considerable user participation. The rural electrification cooperatives in Bangladesh, for example, perform much better than the state-owned utilities (Bangladesh Power Development Board, BPDB, and Dhaka Electricity Supply Authority, DESA). These cooperatives have put in place special safeguards to minimise theft and corruption. The rural consumers pay higher tariffs than people in urban areas served by BPDB and DESA and receive less (direct and indirect) subsidies. Still, the recovery rate for the cooperatives is around 97% as compared with less than 75% for BPDB and DESA. (Murshid and Wiig 2001).

The high capital costs associated with rural electrification often justify subsidies. As a general rule, these subsidies should be directed at lowering the capital cost rather than operating costs (see Section 6.4 below). Also, the subsidies should not be so high that they cause households and enterprises to switch from more economical energy sources. Where the power sector has been "unbundled" and the strategy is that private enterprises will provide electricity in rural areas, additional support from the government might be required, especially in countries with poorly developed banking systems.

In Uganda, for example, the government has established the Rural Electricity Board to promote rural electrification. The Board manages a

special fund that channels grants/subsidies to private rural electrification schemes. While these capital subsidies help ensure the financial viability of the individual schemes, Uganda's weak banks find it difficult to take the risks associated with untested rural electrification projects. To overcome this problem, the government – with support from the World Bank – is in the process of creating a Credit Support Facility that would mitigate some of the risks faced by the lenders. (See Box 9).

Box 9: Supporting rural electrification in Uganda

Uganda has one of the lowest rates of electrification in the world with only about 5% of households served with power from the grid. In order to overcome this problem, the government decided to undertake far-reaching reforms. The Electricity Act of 1999 un-bundled the utility into a generation, a transmission and a distribution company. Private companies have taken over the generation and distribution companies under concession arrangements. Barriers to entry for new private generation and distribution companies have been removed and a regulatory agency has been created.

Special emphasis has been placed on rural electrification. The Rural Electrification Board has been established to guide the development of the sector. Besides formulating policies and strategies, the Board controls the Rural Electrification Fund. The Fund provides capital subsidies to private companies investing in rural electrification. It is funded through donor funds, government grants and a levy on bulk power sales from the grid (in practice a cross subsidy from urban consumers and enterprises). A basic principle is that tariffs should ensure that individual schemes are financially viable (after allowing for the capital subsidy). This means that the tariffs will vary from area to area. By the end of 2004, one private mini-grid was in operation.

Experience has shown that Uganda's banks are reluctant to take the considerable risks associated with long-term lending to rural electrification enterprises that are entering an untested market where little information exists on consumer demand and willingness/ability to pay.

In order to overcome this problem, the government is in the process of establishing the Credit Support Facility (CSF). The CSF will provide various types of credit enhancements, including partial credit guarantees (in case of default) and refinancing guarantees (to help extend maturities).

Sources: World Bank (2001) and communications with World Bank staff.

Small-scale private or cooperative service providers can play a critical role in making electricity available to rural and peri-urban areas. Successful models are discussed in Section 3.2 and, especially in Boxes 5 and 6 above (page 59). Besides creating an enabling environment – which often involves removing the monopoly for the main utility, simplifying

licensing and approval processes and adopting appropriate low-cost standards – governments and donors can support such schemes through output-based aid, a topic further discussed in Section 8.4 and Box 20 (see page 134).

6.3 Small scale, off-grid electricity

"Off-grid" solutions range from solar PV panels, micro-hydropower, biogas or petrol fuelled generators serving individual households or enterprises to mini-grids serving a village or group of households. There are a number of variations on these arrangements, for example, micro-hydro plants or solar PV panels used to recharge batteries for a fee. Table 19 summarises the typical cost of generating electricity from renewable sources. While these cos ts might appear high when compared to the cost of power generation from large power plants (or with the often highly subsidised tariffs for rural electrification), they are often comparable to, or lower than, the cost of extending the grid (see Table 18 above).

Table 19: Typical costs for off-grid renewable energy

Technology	Size	Energy Cost (US cents/kWh)
Micro-hydro	Plant capacity: 1–100 kW	7–20
Pico-hydro	Plant capacity: 0.1–1 kW	20–40
Biomass gasifier	Size: 20–5,000 kW	8–12
Small wind turbine	Turbine size: 3–100 kW	15–30
Household wind turbine	Turbine size: 0.1–1 kW	20–40
Solar home system	System size: 20–100W	40–60
Rooftop solar PV	Peak capacity: 2–5 kW	20–40

Source: Worldwatch Institute (2005)

Experience has shown that previous "top-down" government and donor sponsored schemes often failed when maintenance needs increased after a couple of years. Thus, successful small scale schemes need to be demand driven. The basic strategy involves the removal of regulatory constraints (such as forbidding private mini-grids within the concession area of a distribution company) as well as price distortions (such as high import duties or taxes and "biased" or selective subsidies). Various approaches

have evolved to both provide incentives to private entrepreneurs or NGOs to assist in the spread of off-grid electricity and, in some cases, provide subsidies to end users (Barnes and Halpern, 2000). These approaches are summarised in Box 10.

Box 10: Approaches for promoting off-grid electrification

The *dealer model* applies to the development of equipment dealers that sell equipment to off-grid rural areas. The subsidy is offered to the equipment dealers to lower the product cost and thereby increase demand. Although subsidies should provide financial incentive to service rural areas, in the initial stages the subsidies will be applied to the more wealthy households in the area, leaving rural electrification for the poor as a long term goal. Along with the subsidies, programmes have been established to strengthen dealer networks but have resulted in mixed success. Programmes have failed in countries without strong dealer networks such as Sri Lanka and Indonesia. Countries with strong existing dealer networks such as Kenya have had more success and have begun offering equipment on lease which has been more effective than offering loans to purchase equipment.

The purpose of the *concession model* is to minimize budgetary subsidies and encourage private sector participation in rural electrification. The model ensures scale economies but depends on contract regulation, not the market forces. The cost effectiveness of the concession model is dependent on the competition in the bidding process. If there are two few service providers bidding on the contract, or if they ask for too large a subsidy, the model is probably not cost effective. The subsidies are not applied directly to the rural areas without service so there is an inherent question in the effectiveness of the model; however it is clearly directed at the poorest part of the population. The concession model has met with success in Argentina, a country with a high level of competition for service territories.

The *retailer model* employs a decentralized approach to rural electrification. In this model, a private party creates a business plan on how it will service demand for electricity and submits it to an off-grid electrification committee. Approval of the plan results in either a loan or a subsidy granted to the private company. The company then applies its business plan in a fee-based service arrangement used to recover costs, repay the loan amount and earn profit. The retailer model ensures local involvement and prevents costly monopolies through consumer choice. The retailer model supports the private sector participation trend in rural electrification, however there is always the chance that the service provider will not meet all the terms of the original contract.

Source: Barnes and Halpern (2000)

6.4 Energy for rural households without electricity

In most low-income countries, the majority of rural households will have to manage without electricity for many years to come. Indeed, the number of people relying on traditional biomass fuels for cooking and heating might increase from 2.4 billion in 2000 to 2.6 billion in 2030 (Modi et al, 2006). Indoor airpollution from using biomass in traditional stove is a serious health hazard for women and children. Significant health benefits and other social benefits can be achieved through improved stoves and a switch from wood and dung to modern fuels. For example, it has been estimated that switching from cooking with wood to coal will reduce health risks by a factor of four. A shift to kerosene results in a reduction by a factor of six. Using LPG reduces the overall health risk by a factor of more than 100 (IEA 2002). Kerosene and LPG are also suitable sources of light when electricity is not available.

Policies aimed at subsidizing equipment or modern fuels to help the poor (as well as policies to tax fuels used by the rich) have typically exerted minor effects on consumption patterns and have occasionally caused perverse effects. A tax on kerosene (primarily used by the rich) can cause a switch back to wood and push up the price for the poor. Conversely, kerosene subsidies can lead to its use as motor fuel and reduce availability. In short, the best approach is often a neutral subsidy/taxation policy. The strategy should instead be to improve the availability of the fuels and the necessary equipment. For example, the introduction of 6 kg LPG containers and stoves that fit traditional pots and pans have led to a rapid increase in the use of LPG for cooking in Senegal. In conclusion, for any sustainable and effective programme for rural energy modernisation, NGOs and private businesses, such as local manufacturers and dealers, must be a part of the strategy.

Energy efficiency and renewable energy sources

CHAPTER 7

7.1 Efficiency brings opportunities for sustainable development and financial benefit

In many developing countries, numerous opportunities exist to improve energy efficiency through cost-effective commercial technologies with short payback periods on the investment. Energy efficiency offers significant opportunities to reduce both urban air pollution and greenhouse gas emissions, enhancing the positive environmental impact of these investments. Energy efficiency technologies can bring sustainable development and financial benefits, such as reduced need for new power plants and increased competitiveness of the energy product produced. It has emerged as a growing market. However, with some notable exceptions like the Electricity Generating Authority of Thailand (EGAT) in Thailand (Box 11), most public monopolies have tended to neglect energy efficiency measures.

Box 11: Demand side management (DSM) in Thailand

In 1993, the Electricity Generating Authority of Thailand (EGAT), the national generation and transmission utility, established a national DSM program to improve the capability of the power sector to deliver cost-effective energy services and promote the adoption of energy-efficient equipment throughout the country. The US$189 million DSM Program was primarily financed from an automatic tariff mechanism. A DSM Office (DSMO) was established within EGAT to develop, implement and evaluate national DSM programs and measures

The initial program was largely based on the U.S. experience, relying on manufacturer and consumer rebates. During early implementation, DSMO staff determined such approaches to be inconsistent with Thai culture, fearing that financial incentives to manufacturers and participating customers may

be perceived as inequitable. The DSMO thus shifted its strategy during implementation to focus more on voluntary manufacturer negotiations than financial rebates, using its financial resources to support major marketing and publicity campaigns, bulk purchase of high-efficiency products, and other information dissemination activities.

Given the low number of domestic manufacturers of fluorescent tube lights, the DSMO decided to negotiate directly with manufacturers to switch production to more energy efficient "thin tubes." EGAT agreed to support the cost of a US$8 million public relations campaign, using major stars and TV advertisements, to educate the public about the benefits of these "thin tubes" in exchange for the manufacturers' agreement to phase out production of the old lamps. Since the production technology was readily available and the incremental cost for the new tubes was minimal (they required less material to produce), no additional financial incentives were offered to the manufacturers or consumers. The results were dramatic. Within one year, all manufacturers had completely switched production to thin tube lights. Later, EGAT also supported the introduction and use of compact fluorescent lamps through publicity campaigns.

Building upon this experience, the DSMO approached the five domestic manufacturers of refrigerators in early 1994 and negotiated a voluntary labelling scheme for all single-door models. In early 1998, the DSMO worked with the Thai Consumer Protection Agency and made single-door refrigerator labelling mandatory. In 1994, only 2% of single-door models sold were level 5. All single-door refrigerators sold in 2000 meet the level 5 requirements.

In late 1995, the DSMO targeted air conditioners and proposed a similar voluntary label system similar to the refrigerator scheme. Despite initial positive indications from the label program, the DSMO found that "level 5" air conditioners were substantially more challenging to promote than the refrigerators, largely because the incremental cost for higher level units was significant. Therefore, the DSMO worked with local credit card companies to offer interest free loans for the incremental cost of level 5 units. The DSMO also offered 500 Baht rebates to shop owners (under a Green Shop initiative) who sold level 5 models during promotional summer periods. Still, by 2000, only about 38% of the units sold have a level 5 label.

By 2000, an independent evaluation estimated that the program had reduced the peak demand by some 566 MW and achieved an annual energy saving of 3,140 MWh and reduced CO2 emissions by 2.3 million tons per year. The program was highly cost-effective, generating substantial saving for both EGAT and consumers.

Source: Singh and Mulholland (2000)

Government owned public utilities generally had no incentives for to carry out efficiency measures, and without any incentives, delivery of services tended to be of substandard quality and operational inefficiencies (measured by high technical and non-technical losses) were commonplace. As

economic and sector reforms became more widespread, the traditional energy efficiency project characteristics (government-financed, state agency implemented, and supply driven) are becoming unsustainable. The private sector is taking on an increasingly central role as counterparts that intermediate and deliver energy efficiency projects.

Energy efficiency projects have been successfully implemented in water utilities, industrial enterprises, household energy, electric utilities and urban heating. In Brazil, implementation of an energy efficiency program by Agua do Imperador, a municipal water company resulted in the reduction of annual expenditures of electricity by about 50% by deploying additional water and electricity metering systems and implementing low-cost measures such as resizing of pumps and power factor correction (ESMAP 2003). In Ukraine, an ESMAP district heating project implemented energy conservation measures, including reducing the heat load, improving the heat distribution with a building and controlling the heat resulted in significant improvement in the quality of heat and hot water supply, and a reduction of an estimated 27% in energy consumption. There are many other examples of the cost effectiveness and benefits of energy efficiency projects.

7.2 Financing schemes for energy efficiency projects and renewable energy funds

7.2.1 Support to Energy Service Companies (ESCOs)

A key emerging factor in supporting cost-effective energy efficiency investments is how to broaden the impact of energy efficiency investments and catalyzing these beyond the project level. Thought should be given to supporting a sustainable institutional infrastructure that makes energy conservation and efficiency a profitable commercial business rather than investing directly in energy efficiency projects. As such, energy service providers or energy service companies (ESCOs) should be supported to offer a broad range of options not only to satisfy customers' needs but to take advantage of alternative energy sources, renewable resources and energy-efficient services already in use.

Box 12: Energy Service Companies

Energy Service Companies (ESCOs) come in many shapes and forms. In industrialised countries, ESCOs primarily assist industries and other clients (such as hospitals, water utilities or building owners) to use energy more efficiently. In their simplest form, ECSOs work like any consulting firm, advising their clients on what measures to take. Many ESCOs will guarantee energy savings and take a share of the risks associated with energy efficiency investments. In some cases, the ESCOs will

also finance these investments. ESCOs focusing on energy savings are increasingly common in the more advanced developing countries, e.g. Brazil, China, India, Malaysia and Thailand.

In developing countries other ESCO models are emerging. These companies help households obtain access to modern energy services. In the Philippines and Dominican Republic, for example, ESCOs provide solar PV systems in rural areas. ESCOs buy such systems in bulk and install them in customers' homes and then charge a monthly rental fee.

Organisationally, ESCOs may also take many forms. They may be a subsidiary or department of a regular electricity company, a cooperative, a NGO or a private sector company.

7.2.2 Addressing constraints on financing

However, there are key constraints in the availability of financing for energy efficiency projects from domestic sources, especially commercial banks. Among the reasons for this are the unfamiliarity of many financial institutions with many aspects of energy efficiency projects, weak credit standing of prospective energy efficiency sponsors and the perception of limited profitability. In order to address these constraints, the International Finance Corporation (IFC) initiated different financing schemes, including renewable energy funds such as the Renewable Energy and Energy Efficiency Fund for ESCOs, end-users, manufacturers and specialised financial intermediaries, the Small and Medium-Scale Enterprise Program which lends to financial intermediaries supporting energy efficiency projects, and energy-efficiency guarantees and lines of credit that provide partial guarantees, technical assistance and advisory services.

Aside from ESCO investments in energy efficiency projects, demand-side management (DSM) projects are also cost-effective investments that result in electricity savings. Some DSM programmes include expanded time-of-use metering, direct load control programs, promotion of compact fluorescent lamps and fluorescent tube lamps. (Box 11).

Because of the positive environmental impact, cost savings and financial opportunities offered by energy efficiency projects, strong support from governments, international financial institutions and bilateral agencies for development and implementation of energy efficiency projects is needed. Energy efficiency requires a policy framework that fosters competition, rational pricing, appropriate standards and that provides a stable legal system, adequate procurement rules and cost-effective subsidies. Finally, incentives for ESCOs to implement more energy efficiency projects should be developed to broaden the application of technologies, and to expand the reach of these projects to as many countries as possible.

7.3 Biofuels

Given growing concerns about global warming, developed countries have, over the last decade, placed increased emphasis on the use of renewable energy. However, the costs of many of these sources have long remained well above the cost of fossil fuel-based alternatives. Although some developing countries (such as Brazil, China, India and Thailand) have long promoted the use of various renewable technologies, the recent rise in oil prices has rekindled interest in biofuels in many other developing countries.

As can be seen from Figure 14 (see chapter 8), crude oil prices have generally been below the US$50–60 level and both US Energy Information Administration (in the base projection) and the World Bank anticipate that they will fall from their 2006 highs to below US$50 per barrel. However, for landlocked countries with high transport costs for imported fuel and good agricultural potential, the production of biofuels may be attractive, even at lower oil prices on the world market. In the longer run, manufacturing of ethanol from cellulose (such as forest products, wood waste, crop residues and energy crops such as switch grass) holds the greatest promise.

Two types of *biofuels* are used for cars and trucks: ethanol and biodiesel.

7.3.1 Ethanol

Ethanol is a substitute for gasoline and is primarily produced from sugarcane and corn, and also from forest- and crop-products, see below. Brazil, utilizing sugarcane, appears to be the lowest cost producer in the world. The economics of ethanol production depends on a number of factors: the cost of the cane, the recovery rate of sucrose from the cane (i.e. the "sugar content"), the cost of extracting the sucrose and converting it into ethanol and the potential use/value of bi-products. In addition, sugar producing countries face an economic opportunity cost for the sucrose i.e. instead of producing ethanol, they could produce raw sugar and export it. When comparing ethanol and gasoline, it is also important to keep in mind that ethanol burns less efficiently and, thus, 1.3 litres of ethanol are needed to replace one litre of gasoline. If a country produces raw sugar at a cost of around US$200 per metric ton, it should be able to produce ethanol at a cost that is competitive with gasoline when the price of crude is around US$50 per barrel. In most developing countries, however, production cost is more like US$300 per ton of raw sugar. Given prevailing price levels, it is more expensive to produce ethanol from corn and other cereals than from sugarcane. Other developing countries that produce ethanol for fuel are China, Columbia, the Dominican Republic, India, Jamaica, Malawi, South Africa, Thailand and Zambia.

7.3.2 Biodiesel

Biodiesel is produced by reacting vegetable oils with methanol. A litre of vegetable oil (weighing about 0.92 kg) typically produces a litre of biodiesel. Generally, palm oil is the cheapest of the major vegetable oils. Since 1995, the world market price for palm oil has fluctuated between US$250 and US$700, with an average of about US$450 per metric ton. At a price of around US$450 for the feedstock, biodiesel is competitive with regular diesel fuel when crude oil prices are in the range of US$55–60 per barrel. Germany is the largest producer. Malaysia and Indonesia (efficient producers of vegetable oil) have started producing and using biodiesel.

7.4 Solar and wind power

Besides transport, *power generation* is the largest consumer of fossil fuels in the developing world. However, developing countries that are outside the Kyoto Protocol framework have generally adopted least cost technologies for the generation of electricity. This strategy makes sense, as Modi et al (2006, p. 31) point out in a recent study sponsored by the Millennium Project, World Bank, UNDP and ESMAP:

> *"When considered on a global scale, the energy source choices of the poorest countries are not the most threatening from an environmental perspective. Meeting domestic economic growth and social development requirements in line with the sustainability of the domestic resource base should be the overriding concern in these cases."*

Technological advances and economies of scale in manufacturing have significantly reduced the cost of electricity generation using solar and wind power.[32] With high oil prices and a renewed feeling of energy insecurity, many developing countries find that renewable energy sources are attractive alternatives to fossil-based power generation plants (Table 20).

7.5 Targets for the use of renewable energy sources

Responding to these trends, a growing number of governments have established targets for the use of renewable energy sources for power generation (Table 21).

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[32] The costs of wind and solar power are now half of what they were 10–15 years ago (Worldwatch Institute, 2005).

Table 20: Cost of electricity generated from renewable sources

Technology	Size	Energy Cost (US cents/kWh)
Large hydro	Plant size: 10 MW–18,000 MW	3–4
Small hydro	Plant size: 1–10 MW	4–7
On-shore wind	Turbine size: 1–3 MW	4–6
Off-shore wind	Turbine size: 1.5–5 MW	6–10
Biomass power	Plant size: 1–20 MW	5–12
Geothermal power	Plant size: 1–100 MW	4–7
Solar thermal power (CSP)	Plant size: 1–100 MW	12–18

Note that costs in most developing countries would be 10–50% higher due to more expensive construction and transport to the site as well as higher cost of capital.
Source: Worldwatch Institute (2005)

Table 21: Renewable energy targets for power generation in selected developing countries

Country	Target(s)
Brazil	3.3 GW added by 2006 from wind, biomass, small hydro.
China	10% of electric power capacity by 2010 (expected 60 GW); 5% of primary energy by 2010 and 10% of primary energy by 2020.
Dominican Republic	500 MW wind power capacity by 2015.
Egypt	3% of electricity by 2010 and 14% by 2020.
India	10% of added electric power capacity during 2003–2012 (expected 10 GW)
Malaysia	5% of electricity by 2005.
Mali	15% of energy by 2020.
Philippines	4.7 GW total existing capacity by 201 3.
South Africa	10 TWh added final energy by 201 3.
Thailand	8% of total primary energy by 2011 (excluding traditional rural biomass)

Source: Worldwatch Institute (2005)

7.6 Policy instruments for renewable energy generation

Quite naturally the level of interest in, and the orientation of, policies and programmes promoting the use of renewable energy sources depends on the local resource base. Instruments used to achieve these targets depend on a number of factors such as budgetary resources, as well as the structure of the power sector and the market model adopted. In some cases, the energy ministry can simply issue instructions to the state-owned power utility. Generally, however, the government needs to provide financial incentives and/or change the principles for risk sharing to suit private owners of power plants. Thus, there is a whole menu of policy options that developing countries have or may put in place to encourage the development of wind, solar, hydro and waste generating plants (Table 22).

The most common approach is the adoption of a feed-in tariff that enables generating plants using renewable sources to sell to the grid. As was seen in Sri Lanka (see Box 5), this policy can be highly successful in attracting private investment in renewable generation. The effectiveness of such an arrangement depends on the attractiveness of the tariff. Since the cost of renewable generation has fallen, there is a risk that the "single buyer" (see Section 2.1) and the public become trapped with excessive subsidies for a long period of time. Thus, when the objective is to encourage the construction of large scale facilities, it is appropriate to set the feed-in tariff for planned facilities through competitive bidding. This would minimise the implicit subsidy. Net metering achieves some of the same objectives as feed-in tariffs, but is most appropriate for small-scale industrial and household types of generating facilities.

Most of the other instruments for encouraging renewable fuel-based generation involve direct or indirect subsidies (through reduced taxes). While some of them reduce capital cost, most are non-transparent and recurrent. Thus, they do not conform with the basic principle for subsidies outlined in Section 8.4.

7.7 Hydropower

7.7.1 High rewards – and risks

Hydropower is the most important renewable energy source in developing countries, accounting for almost one quarter of all electricity generated in low and lower middle income countries. However, hydropower schemes often have far-reaching environmental, social, cultural, technical, financial and economic impacts. Without mitigating measures, these impacts are unevenly distributed, potentially creating both winners and losers. Hy-

Table 22: Policy instruments for renewable energy generation in selected countries

	Feed-in Tariff	Renewable Portfolio Standard	Capital Subsidies, Grants, or Rebates	Investment Excise, or Other Tax Credits	Sales Tax, Energy Tax, or VAT Reduction	Energy Production Payments or Tax Credits	Net Metering	Public Investment, Loans, or Financing	Public Competitive Bidding
Argentina			√			√			
Brazil	√							√	
Cambodia			√						
China	√		√	√	√			√	√
Costa Rica	√								
Guatemala				√	√				
India	(√)	(√)	√	√	√			√	√
Indonesia	√								
Mexico				√			√		
Nicaragua	√			√					
Philippines				√	√			√	
Sri Lanka	√								
Thailand	√	√	√				√		
Turkey	√		√						

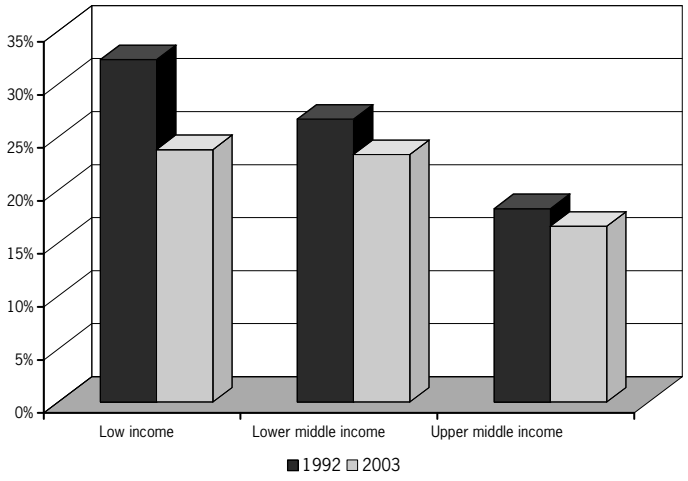
Notes: (√) = In some of the states
Feed-in tariff: A policy that sets a fixed price at which power producers can sell renewable power into the electric power network. Some policies provide a fixed tariff while others provide fixed premiums added to market or cost-related tariffs. Some provide both.
Net metering: Allows a two-way flow of electricity between the electricity distribution grid and customers with their own generation. The customer pays for the net amount of electricity used.
Source: Worldwatch Institute (2005)

dropower projects not only offer the prospects of high rewards but also carry high risks.

The perceived negative social and environmental consequences led a gradual withdrawal of both multilateral and bilateral donors from the financing of large dams. In the second half of the 1990s, for example, the Asian Development Bank did not finance a single hydropower project (Ljung et al., 2001). In real terms, bilateral funding for hydropower schemes fell by more than 60% between the 1980–84 and the 2000–04 periods. As fuel prices declined and the need to reduce government expenditures grew

during the same period, governments also curtailed their investments in capital intensive hydropower projects and allocated a larger share to thermal projects. Thus, the importance of hydropower in electricity generation has declined significantly since the early 1990s (Figure 12).

Figure 12: The share of hydropower in electricity generation 1992 and 2003



Data Source: World Development Indicators 2006

7.7.2 The World Commission on Dams and UNEP's Dams and Development Project

In order to reverse this trend, the World Bank and the World Conservation Union (IUNC) took the initiative to establish the World Commission on Dams. The Commission was an independent body comprising 12 members from governments, the private sector and civil society and chaired by Professor Kader Asmal, Minister of Water Affairs and Forestry in South Africa. Its mandate was to:

- Review the development effectiveness of dams and assess alternatives for water resources and energy development, and
- Develop internationally accepted standards, guidelines and criteria for decision-making in the planning, design, construction, monitoring, operation and decommissioning of dams.

The Commission's work was based on in-depth analyses of all relevant aspects – social, environmental, economic, financial and institutional – of

large dams for power generation, irrigation and water supply as well as extensive consultations. Its report was issued in June 2000. It provided a framework for dealing with large dams from the initial planning at the energy and water resources sector level to day-to-day project operation and, finally, decommissioning.

A project of the United Nations Environment Programme (UNEP), the Dams and Development Project (DDP)[33] promotes dialogue on improving decision-making, planning and management of dams and their alternatives based on DSM core values and strategic priorities.

7.7.3 Recommendations following national consensus building (Sweden)

The Swedish Committee for Water and Dam Issues (comprising representatives of developers, consultancy companies, government authorities, financiers, non-governmental organizations, research organizations and indigenous peoples) is an example of national level consensus building. Its recommendations, presented in Box 13, summarise quite well the latest thinking on how to address issues regarding large dams and hydropower development.

Box 13: Dealing with social and environmental impacts of large dams

Strategic priority 1: Gaining Public Acceptance

Ensure that no one experiences powerlessness in the face of a water infrastructure project. Related problems must be solved at an early stage in order to minimize harm to human livelihoods, to nature and ecosystems, and to social and cultural values. All stakeholders affected must be given the opportunity to participate in the decision-making process. Compensation and benefit-sharing agreements must be completed before the decision to start construction.

Strategic priority 2: Comprehensive Options Assessment

Ensure that a detailed comprehensive options assessment (COA) will be performed at policy, programme and project levels. Development alternatives which, after such an assessment are considered viable, will then be subjected to a more detailed examination where each individual project is assessed on the basis of sustainability aspects. Environmental and social/cultural aspects should carry the same weight as economic and technical aspects in the choice between different alternatives

Strategic priority 3: Addressing Existing Dams

Ensure that the water infrastructure's benefit contra harm is continually evaluated in light of changing priorities and norms in society. Detailed, on-going monitoring of the dam's effectiveness will

[33] See www.unep-dams.org for information about follow-up initiatives around the world, reactions to the World Commission on Dams Report and submissions on good practice.

be carried out in order to enable early identification of changes in the relationship between harm and benefit. A negative shift will trigger implementation of mitigating measures, such as changes in operational guidelines or decommissioning.

Strategic priority 4: Sustaining Rivers and Livelihoods

Ensure the understanding, protection and restoration of ecosystems at the catchment level in order to facilitate fair and sustainable development and for the benefits of biodiversity. Option assessment and decisions on river development first prioritise the avoidance of impact, followed by the minimising and mitigation of threats and damage to the health and integrity of the river system. Since large water infrastructure projects, among them dams, seriously affect ecosystems project planning must be directed to the minimisation of negative impact on the environment – in particular, irreversible impact – through careful site selection and environmental impact assessments (EIA) in accordance with international standards. Well-planned water infrastructure means positive development opportunities for the local population through improved cultivation (irrigation) or access to electricity. However, ecosystem services and traditional benefits may disappear and the cultural landscape may change. Thus, considerations regarding balance – to find the most favourable development approach for the local population, energy services and the protection of ecosystems which depend on natural flow variations – are in order."

Strategic priority 5: Recognizing Entitlements and Sharing Benefits

Ensure that all of the project's partners are regarded as co-owners of the project. The local population must have better livelihoods during and after the project's completion than before it began.

Strategic priority 6: Ensuring Compliance

Ensure that relevant laws, regulations, recommendations as well as project-specific agreements are followed.

Strategic priority 7: Sharing Rivers for Peace, Development and Security

Ensure that no conflicts between states are created or expanded due to water infrastructure projects. Water infrastructure projects that affect more than one country must promote peace, cooperation, development and security.

Source: Swedish Water House (2005)

7.7.4 The importance of participatory approaches

While the planning, construction and operation of most energy projects primarily involve the (public or private) owners and the government, hydropower projects require an extensive consultation process involving the various stakeholders.

Economic cost-benefit has been the traditional way of evaluating and comparing options. Unfortunately cost-benefit analysis, as commonly applied, handles externalities and distributional impacts quite inadequately.

While economists have developed tools, such as contingent evaluation techniques[34] or income distribution weights[35], in order to place monetary value on some of these impacts, others are by their very nature not quantifiable. Ultimately, the decisions related to the construction of dams are political, and must take into account the tradeoffs between different water users' interests. Broad-based stakeholder participation in option assessments, project planning, implementation and operation is a way of informing and enlightening the political decision makers of all stakeholder interests and the degree of their consensus. Indeed, it might be argued that the bargaining and consensus building among stakeholders will reflect a multi-dimensional social welfare function. Thus, any agreement or decision that emerges from a stakeholder-driven process can be regarded as "optimal" from a welfare economic point of view (although a traditional cost-benefit analysis might indicate otherwise)

Participatory approaches to hydropower development have often been resisted by governments and project developers, arguing that such approaches are costly and, especially, time consuming. However Ljung (2003) notes that the experience has often been the opposite: a failure to involve all stakeholders at an early stage has often brought very costly delays and design changes later on (Box 14).

Box 14: Not involving stakeholders in hydropower planning can be costly

Recent history is replete with examples of projects that have experienced serious and extremely costly delays due to a failure to involve stakeholders in the project preparation and implementation process. In the case of the Sardar Saravor Dam (part of the Narmada Basin development) in India, a popular movement against the dam led to fatalities and a court order that halted construction of the half-finished dam for five years. The interest on the half-finished dam and other project works, lost power generation and lost irrigation benefits appear to exceed US$200 million per year, or more than US$1 billion in aggregate.

The Yacyreta hydropower project on the Parana River between Argentina and Paraguay tells a similar story. Planning for this 3,100 MW project started in the 1970s. The World Bank and Inter-American Development Bank have in aggregate provided more than US$1.7 billion in support for the project. Filling of the large reservoir started in 1994 and the reservoir level was supposed to be raised in stages to reach 83 meters in 1998. However, amid controversy over environmental and resettlement issues, the filling of the reservoir was limited, in 1995, to a maximum water level of 76 meters, where it has remained to date. Because of the lower head, the turbine generators are operating at only two-thirds of their capacity. The annual loss in power benefits exceeds US$200 million dollars.

Source: Ljung (2003)

34 See for example: Mitchell and Carson. (1989).

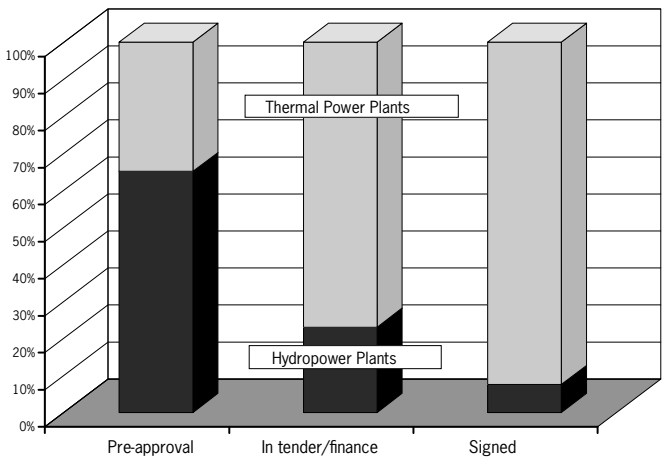
35 See for example: Squire and van der Tak. (1975).

7.7.5 Risk sharing and incentives

Hydropower projects are inherently more risky than thermal generation projects. The design and construction of thermal projects is generally quite standardised. A 300 MW combined cycle plant in Bangladesh can be virtually identical to a plant in Tanzania. Hydropower projects, on the other hand, tend to be "tailor made" for a specific site. The cost will vary with geology, topography, hydrology, ecology and a host of other factors. Private developers of hydropower projects and the equity investors in such projects operate under a different set of incentives to governments and publicly owned enterprises. The incentives for private developers largely depend on how risks, as well as financial benefits and costs, are allocated through the regulatory regime and/or contractual arrangements. Typically, all expenses and risks during the development stage are born by the project sponsors. While the risks associated with private infrastructure projects always are highest at the early development stage, this is especially the case with dam projects.

Figure 13, which is based on data prepared for the World Commission on Dams,[36] clearly demonstrates how difficult it is to bring dam projects to fruition. Hydropower projects account for some 65% of all private power projects that are at an early stage of preparation (i.e. before any approval has been received from the government). Hydropower makes up less than one quarter of the projects that are at an advanced development stage (i.e. the government has invited tenders and/or the private sponsors are seeking finance). Only about 7% of all private power projects that have reached financial closure (i.e. all relevant agreements have been signed) are hydro.

Figure 13: Hydropower's share of private power projects at different stages of development (2000)



36 Background data collected by Manrique Rojas for Thematic Review III.2 on Trends in the Financing of Water and Energy Resources Projects.

The up-front costs – in terms of time and money – for planning and design of hydropower projects are typically several times larger than the corresponding costs for thermal generating plants, which explains why so many private hydro schemes are terminated at an early stage. In order to overcome this hurdle, the public sector must play a much more active role in the planning and design phase for large hydropower development than it does in the development of thermal generation. The planning needs to start with a comprehensive assessment of options (generation technology, new capacity versus demand management, etc.). If hydropower turns out to be an attractive option, a systematic screening of potential hydropower projects should be undertaken. Experience has shown that it is essential to include all potential stakeholders in the screening process. The top ranked projects would then be subject to detailed surveys, in-depth feasibility studies and preliminary designs. If the project appears viable, comprehensive environmental and social impact assessments would be undertaken. Stakeholder consultations would continue throughout this process.

When this point has been reached, the government can invite bids from private enterprises – based on detailed performance specifications. The private bidders should be allowed to propose alternative designs.

The sharing of risks between the private owner/operator, the government, the state-owned utility (or "single buyer") and the power consumers is more complex in hydropower projects than thermal generating plants. One obvious risk factor is the hydrology of the site where the project is located. This is a matter of more than a question of the year-to-year variations in the stream flows. Long-term historical data are required for proper sizing and operation of the project. Such data are typically collected by government agencies – using methods of uncertain quality and consistently – for sites other than the exact location of the proposed project. Even when accurate data are available for a nearby site, the question arises whether the historical records are representative of likely future flows. Besides climate change, the run-offs can have changed or might change in the future due to upstream developments such as other dams, deforestation, increased groundwater use, etc. For example, there were major controversies regarding the expected water flows and power generation for the Bujagali Dam in Uganda. The expected technical and economic life of hydropower dams also depends on the rate of siltation. Once again, this is a variable where developers have to rely on data collected by government agencies. Similarly, the rate of siltation will depend on future land use upstream of the proposed project. Private developers have little ability to verify the accuracy of the basic data and to control future changes in hydrology and silt loads.

Given this, agreements for private hydropower projects typically protect the private developers from these risks.

7.8 The main Kyoto mechanisms to reduce greenhouse gases

The Kyoto Protocol has created various instruments that encourage developing countries to reduce greenhouse gases. The main mechanisms are the Joint Implementation (JI) procedure and, especially, the Clean Development Mechanism (CDM). Initially, these mechanisms are supported by the Prototype Carbon Fund (PCF) established at the initiative and with the sponsorship of the World Bank (Box 15). JI and CDM are commonly referred to as project-based transactions.

Box 15: Kyoto mechanisms

The Kyoto Protocol to the United Nations Framework Convention on Climate Change is an amendment that took effect on February 16, 2005. Countries operating under the protocol have committed to reducing carbon dioxide and five other greenhouse gases connected to global warming. The Kyoto Protocol also provides a framework and regulations for emissions trading between Annex 1 (industrialized) countries and non-Annex 1 countries. These flexible mechanisms include the Clean Development Mechanism (CDM), Joint Implementation (JI) and Emissions Trading.

The *Clean Development Mechanism* allows advanced Annex 1 countries to provide capital and technology for emission reducing projects inside a developing or non-Annex 1 country. The emissions reduction of the project is totalled and calculated as certified emissions reduction (CER) credits which are distributed to both the advanced country and the developing country. Inspection, approval and distribution of the CER credits is controlled by the Clean Development Mechanism, a regulatory third party. The Annex 1 countries may use the CER credits to help meet their emission target as defined by the Kyoto Protocol or to buy and sell on the CER market. The non-Annex 1 countries may also buy and sell their credits.

Joint Implementation allows Annex 1 countries to provide capital and technology to emission reducing projects inside another Annex 1 country. The emissions reduction of the project is totalled and calculated as emissions reduction units (ERU) which are distributed to both countries involved. The credits can be applied towards an emission target under the Kyoto protocol or bought and sold on the ERU market. There are two possible ways in which a JI project can be implemented.

The first situation is where the project host country meets all the eligibility requirements of a joint implementation project. If all requirements are met, the host country's national regulations and procedures govern the project and the estimate of emissions reduction units produced by the project. If the host country does not meet all the eligibility requirements, a third party supervisory commit-

tee must verify all project decisions and the ERUs generated. The ERU credits are allocated by the government in charge of the project or the third party supervisory committee. A country that qualifies under the eligibility requirements can also decide to be supervised by a third party committee.

Emissions trading allows Annex 1 countries to directly trade emissions units (in addition to buying and selling in the emission market) with other Annex 1 countries to meet their emission targets as defined by the Kyoto Protocol. This trading allows countries to take advantage of lower cost emissions reductions of other Annex 1 countries. Trade of these emission units must be tracked by a registry system required of all the countries involved.

The *Prototype Carbon Fund* (PCF) was created – with the sponsorship of the World Bank–to pilot production of Emissions reductions within the framework of Joint Implementation (JI) and the Clean Development Mechanism (CDM). The PCF invests contributions made by companies and governments in projects designed to produce Emissions reductions fully consistent with the Kyoto Protocol and the emerging framework of JI and the CDM. Contributors, or "Participants" in the PCF, will receive a pro rata share of the Emissions reductions, verified and certified in accordance with agreements reached with the respective countries "hosting" the projects.

Sources: The websites of United Nations Framework Convention on Climate Change (http://unfccc.int) and the World Bank Carbon Finance Unit (http://carbonfinance.org/).

7.8.1 The emissions trading market

In addition, the Kyoto Protocol set the framework for emissions trading of allowances, primarily between entities in the developed countries subject to the emissions reductions (ER) targets. Various exchanges have now been established for emissions trading, including the European Emissions Trading Scheme (EU ETS) that started operation on January 1, 2005.

The market for project-based emissions reductions – especially through the CDM – is expanding rapidly and in 2005 involved transactions amounting to 380 million metric tons of carbon dioxide equivalent (tCO_2e)[37]. The supply of emissions reductions is heavily concentrated to a few countries, notably China – by far the largest supplier of project-based ERs on the market – India, Brazil and Chile. Apart from a few small-scale deals, poorer or smaller countries have seen limited activity. Africa, in particular, has seen only one new large-scale transaction during this period and, in comparison with other regions, has relatively few projects under preparation.

Due to the heterogeneity of the underlying projects and contract terms, the prices of project based emissions reductions vary significantly. In 2004 and the first four months of 2005, the prices ranged between US$3 and

[37] See Lecocq and Capoor (2005) and Capoor and Ambrosi (2006).

US$7. In the first 9 months of 2006, the price averaged US$10.50. EU's emissions allowances (EUAs) have been quite volatile, but averaged about US$25 per tCO_2e in 2005 and the first 9 months of 2006 (Capoor and Ambrosi, 2006).

The recent EU ETS prices might be higher than the long-term equilibrium price. However, it is still likely that project-based emissions reductions will be "worth" less than EUAs. The two markets are quite different: project-based emissions reductions, as long as they have not been registered and delivered, are subject to important registration and delivery risks. By contrast, EUAs are government-issued, compliance-grade assets. Furthermore, delivery risks in forward contracts for EUAs within Europe are likely to be smaller, on average, than in contracts for forward delivery of project-based emissions reductions from developing countries.

7.8.2 High institutional capacity necessary for emissions reduction regime

In principle, the JI and CDM mechanisms are open to both private and public sector energy companies. Thus, these mechanisms will strengthen incentives for private energy enterprises to adopt technologies that limit the emission of greenhouse gases. However, both mechanisms are subject to complex international and national negotiation and verification regimes, which explains why project-based emissions transactions have been concentrated to a small number of countries with high institutional capacity. The bureaucratic nature of the process might limit the ability of small private companies in low-income countries to take advantage of the Kyoto mechanisms. Both long term capacity building and short term technical assistance are needed to enable a broader group of countries and projects to take advantage of the CDM mechanism.

Cross-cutting issues

CHAPTER 8

8.1 Energy and gender

8.1.1 Mainstreaming gender concerns in development planning

As countries have moved to mainstream gender issues into their development planning, it has become clear that women must not only be regarded as consumers of energy services, they must also play a role as energy suppliers, i.e. as decision makers, entrepreneurs and workers.

Women's entrepreneurial activities into the energy sector are often successful. On the island of Char Montaz in southern Bangladesh, for example, a women's cooperative of thirty-five members manufactures high quality direct current (DC) lamps and charge controllers suitable for solar home systems. The cooperative also provides other energy related services including battery charging, selling, installing and maintaining solar home systems as well as selling electrical goods (UNDP 2004).[38] Women are managing half of the local outlets ("Microcenters ") of Soluz Honduras, a company that assembles, sells, leases and services solar PV systems.

Government policy is important in facilitating and encouraging various initiatives, as well as in creating expanded opportunities for women in the sector. In South Africa, for example, the policy of Black Economic Empowerment in the energy field also targets women. As a result, a number of black women now own and operate petrol stations.

Rural electrification cooperatives in Bangladesh have seats reserved for women on their boards. Still, the system is heavily male dominated: a study undertaken in 2003 revealed that only one of 152 assistant engineers was female and only one of 591 Class I officers (senior managers) was a woman (Clancy et al 2004). Addressing a gender imbalance of this type generally

[38] See also http://www.psldhaka.net/enterprice.htm.

begins with a "gender audit." Unlike financial audits that are external, gender audits are generally internal exercises undertaken jointly by managers and staff (Moser 2005). They examine how an organization's policies and procedures promote or hinder gender equality both within the organization and in its programmes serving the public. As such, the audits are forward-looking instruments that form the basis of concrete action programmes for mainstreaming of gender issues into all aspects of the organization's operations. One good example is the gender audit of energy policies and programmes in Botswana (Botswana Technology Centre 2006).

Besides increasing the incomes of women and expanding their economic opportunities, modern energy can empower women in many ways; for example, electricity creates safer streets at night, enabling women to attend meetings, participate in education classes, gain a feeling of self-worth and link to the outside world through access to television. In short, access to modern energy will help empower women.

8.1.2 Experiences from programmes in rural areas

In Chapter 6 on the challenges of rural energy, we noted that cooking with wood and dung in traditional stoves had serious negative impacts on women and children. Responses by governments and NGOs have basically followed two different lines: (i) programmes to improve the biomass fuelled stoves so that they are more efficient and the smoke is channelled out of the house (sometimes combined with a switch from wood to charcoal) and (ii) introducing modern fuels such as kerosene and LPG. Improved stoves can have twice the energy efficiency of the common three-stone cooking fire, thus significantly reducing the time, drudgery (and often negative environmental impact) of firewood collection for women and girls. In Bangladesh and many parts of India, poor women and girls collect cow dung, form them into cakes and let the dry. The dung cakes are subsequently sold, providing an important supplemental income for the household. Obviously, programs resulting in reduced demand for dung cakes may exert serious negative impact on the income of poor women.

Government and donor supported programmes to introduce improved stoves have met with varying success. In some countries, such as China, Kenya and Sri Lanka, there has been widespread adoption of improved stoves. In others, women have showed little interest, often because the design was narrowly focused on reducing energy needs (perhaps in a situation where availability of biomass was not a significant problem) or that it was not suitable for the utensils that the family owned. Bhogle (2003) describes how a government programme to introduce improved stoves had met little acceptance. A small NGO, Technology Informatics Design

Endeavour (TIDE), engaged rural women in a dialogue about their needs and expectations. This led to a redesign (to, inter alia, reduce smoke) and a dissemination strategy involving neither a subsidy nor any other government intervention. This approach, conceived and executed by women, led to rapid adoption.

The preceding examples illustrate the need for a different approach in energy planning, project design and implementation. Such an approach needs to be based on a thorough understanding of the gender dimension of the energy-poverty nexus.[39] Men and women not only have different energy needs but also different access to resources and input into the decision making process – be it at the household, community or society level. Some of this can be studied and analysed, but studies are no substitute for the active involvement of, and consultations with, the stakeholders. This means, as noted by Clancy et al. (2002, p. 20), a different planning paradigm for the energy sector:

> *"The supply of energy to meet gender needs requires an approach to energy planning that focuses on energy services, that is to say on a comprehensive demand-side analysis of all the energy needs of poor people to support all their livelihood functions, taking into account their particular constraints and opportunities. This approach would be better than the current supply-side approach that simply takes as its starting point the provision of modern energy carriers such as electricity, petroleum or gas, or of equipment of a particular type (solar technology, biogas)."*

8.1.3 A gender-aware policy matrix

When gender has been taken into account in energy planning, the concern has typically been narrowly focused on women's role in cooking, collecting firewood and fetching water. However, again, there is a need to take a much broader approach and consider all economic activities undertaken by women and also to consider and promote potential activities. Khamati-Njenga and Clancy (2005, p. 36) notes that:

> *"When designing energy strategies that are intended to assist people to move out of poverty the gender dimension of the routes into poverty must be taken into account, since these will influence not only what has to be done but the strategies that can be employed. For example, men are more easily able to migrate while women stay put managing the household and creating informal sector business they can run from home."*

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39 ENERGIA, an international network on gender and sustainable energy, is an excellent resource on the gender-energy-poverty nexus. Topics range from integration of gender into national energy policy to in-depth studies of women's energy use and to practical training manuals and tool kits. For more information see ENERGIA's website at http://www.energia.org/.

Consequently, energy planning and policy formulation need to include an explicit gender dimension. UNDP and ENERGIA International Network on Gender and Sustainable Energy have developed a framework for addressing energy-gender linkages at the policy level (UNDP 2004). This framework is presented in Table 23.

8.1.4 Micro-credits – an important tool

Micro-credit has been an important tool for enhancing the income earning potential of poor women. While the Grameen Bank in Bangladesh might be the most well known institution, micro-finance "banks" have had impressive impacts in Asia and Latin America and are making inroads in Sub-Saharan Africa. Often adoption of new energy sources requires significant outlays that may be beyond the reach of the poor and, thus, access to micro-finance can help play a critical, catalytic role (see Box 16).

Box 16: Modern energy and micro-credits

The Financing Energy Services and Income-Generating Opportunities for the Poor (ENSIGN) project was implemented in eight countries in Asia in a UNDP-financed project by the Asia-Pacific Development Center. Energy-linked micro-enterprise portfolios were developed through micro-credit banks and institutions in each country. In urban areas, connecting to the grid and more efficient appliances were most important. In rural areas, however, renewable energy, coal briquettes and diesel fuels were preferred. In both rural and urban contexts, process heat and motive power were more crucial to income-generation than lighting. The ENSIGN Revolving Fund offered 36 percent of total loan funds, national financing institutions 50 percent, and borrowers' equity 14 percent. Interest rates were 15 to 20 percent, somewhat below market rates, with repayment periods of 2–6 years. Both individuals and communities were financed, with average increase in income of 124 percent (higher for the community projects).

Myriad activities were financed: garment making, embroidery, felt and leather goods manufacturing, copper welding, manufacturing of utensils, baking, cold storage, rubber stamp making, beauty salon, grain grinding, threshing, fish drying and powdering, soybean processing, rice husk cook stove, spice drying, *beedi* (flavored handmade cigarettes) wrapping, cinnamon peeling, rice processing…

Below are some lessons from the ENSIGN project:

- Although this was not planned, the vast majority of borrowers were women, who proved enterprising, innovative and creditworthy. Significant benefits for women, in addition to income impacts, were time savings and enhanced self-confidence from improved ability to support household income and greater control over self-generated finances.

Table 23: A gender-aware policy matrix, developed by UNDP and Energia International Network on Gender and Sustainable Energy

Issues	Policy Dimension			
	Political	**Economic**	**Environmental Sustainability**	**Social Equity & Empowerment**
Availability	Instruments to provide wide choice of energy forms for household and informal sector (e.g., biomass and LPG are part of supply mix)	Mechanisms to stimulate suppliers to enter the market supplying household energy (e.g., women are trained and supported to establish their own ESCOs)	Promotion of clean energy sources and technologies (e.g., incentives for developing household energy supplies around modern biomass forms)	Equal distribution and access to energy services (e.g., women are involved at senior level in energy sector decision making)
Affordability	Mechanisms to reflect women's incomes and cash flows in the cost of fuels (e.g., requirement for LPG suppliers to provide different size cylinders)	Pricing policy reflects women's incomes and cash flows (e.g., in electricity connection tariffs and payment methods)	Mechanisms stimulate switch to renewable energy sources and technologies (e.g., women have access to credit sources sufficient to purchase solar home systems)	Increased purchase power through reduced energy bills for households and informal/small businesses
Safety	Safety regulations apply to household labour-saving equipment	Pricing policies and tariffs encourage switch to safer fuels and technologies (e.g., from kerosene to LPG or biogas for cooking)	Promotion of non-polluting technologies (e.g., information campaigns about the benefits of smokeless biomass stoves or solar cookers)	Promotion of increased wellbeing and personal safety (e.g., through street lighting enabling women to participate in events after dark)

- A need to account for transaction costs of intermediaries. There is need for a "Business Facilitator," possibly NGOs, in future replication efforts
- Borrowers for ENSIGN-type loans are not usually the bottom poor however, bottom poor were often employed as labour in the pilot projects

Source: Cecelski (2003)

8.2 Energy security

8.2.1 Price volatility

The issue of global energy security came about as a result of the 1970s oil shock which altered the economic thinking of many oil importing countries. Few of these countries had the necessary foreign exchange reserves to absorb the enormous price increases which significantly impacted their macro-economic position and fiscal balance. While energy security was enhanced in some countries in response to this phenomenon through greater reliance on domestic resources, bilateral energy trading and access to regional markets, a great number of countries exposed their vulnerability to significant price fluctuations. Thus, so far, the whole question of energy security lay more on price volatility which, in turn, was seriously dependent on geopolitical developments in the oil-producing countries, rather than the physical availability of energy (Box 17, Box 18 and Figure 14).

Box 17: Coping with oil price volatility

In 1998, oil prices reached more or less their lowest level since the Second World War. From there onwards, prices increased rapidly to exceed US$70 per barrel in early 2006, the highest level in 25 years (if adjusted for inflation). However, the two oil price "shocks" are fundamentally different. In 1973, OPEC accounted for about 54% of global production and decided to limit and subsequently reduce production. In the period up to 1985, OPEC production fell from around 30 million barrels per day to only about 16 million barrels per day. Thus, when prices finally fell, there was a very large surplus production capacity in the world. When prices started to rise after 1998, it was more a reflection of a fundamental change in the balance of supply and demand. Rapid economic growth, especially in China and India, has increased global demand for oil at a faster pace than new discoveries and production. Non-OPEC producers are now basically operating at their capacity limits while OPEC's spare capacity has declined significantly (according to some estimates to as little as one million barrels per day). The question is what implications this has for future prices.

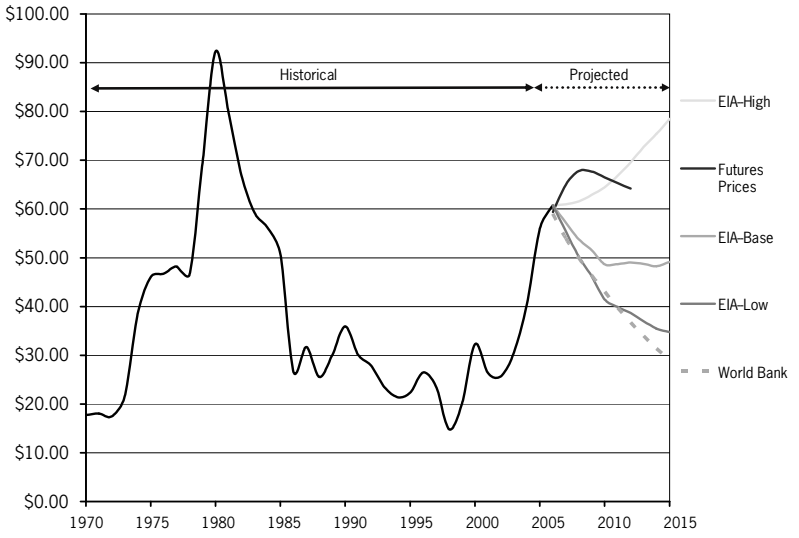
The US Energy Information Administration has extensive analytical capability and an overview of the global energy market. In its "Annual Energy Outlook 2006" EIA provides crude oil price projections to 2030, according to three different scenarios of world production. The World Bank makes long-term projections of oil and other commodity prices. Its latest projections are provided in "Global Economic

Prospects 2006." However, there is a significant difference between what the economists in EIA and the World Bank believe about future prices and what the oil professionals (i.e. the companies that produce and/or trade oil) think will happen. The opinion of the latter is reflected in oil futures prices (Figure 12). In October 2006, the futures prices for delivery between 2007 and 2012 were consistently in the US$60–70 per barrel range i.e. the "market" believes that prices will remain at present levels for the foreseeable future. Given this outlook, developing countries should heed the advice of a recent ESMAP study (Bacon and Kojima, p. 9, 2006):

"…oil-importing countries need to plan for the possibility that the oil price may rise even higher. Policies of not planning for such an eventuality and instead waiting for the oil price to fall by a considerable amount to some "historical mean" could seriously exacerbate the problems of adjustment."

Sources: Bacon and Kojima (2006), EIA (2006) and World Bank (2006)

Figure 14: Oil price volatility and outlook



Box 18: Energy trade and security

Oil and coal are widely traded and relatively easy to store. If one supplier experiences temporary problems, shortfalls can generally be made up either from stocks or from other suppliers. Problems increase if oil is supplied through a single pipeline, but often there are alternative modes that can make up at least part of the shortfall. In the case of natural gas, there are generally no alternative supply sources and storage is extremely limited. In 2004, Argentina experienced a severe energy

crisis and, in order to safeguard domestic industry and households, the government mandated a drastic curtailment of gas supplies to Chile, resulting in curtailed power generation in this country. Fortunately, some of the power shortage in Chile could be overcome through electricity imports from Brazil. On January 1, 2006 Russia's Gazprom cut off gas supplies to Ukraine. Although supply was restored four days later, this event has increased concerns that monopoly suppliers of gas can use the "on-off valve" for political purposes.

Source: Various press reports

8.2.2 Dependency problems

Another concern, which affects energy security is the inability of many oil-importing countries to adapt technologies to local conditions (thereby increasing dependence on imports), and continuing dependence on foreign technical know-how. Many countries rely on what has been most convenient, i.e. to utilise foreign technology and/or imports, rather than developing in-country capability to exploit indigenous resources. Finally, the vulnerability of a country's energy infrastructure to disruption by natural or man-made events also impacts on energy security. The extensive losses of the electric transmission and distribution facilities at Orissa in India due to cyclones and Gujarat due to a powerful earthquake are examples of this vulnerability. Some man-made disasters are also a threat, including insurrection, civil war and more recently, terrorist threats and activities, particularly on producing oil fields as well as the vulnerability of transportation "chokepoints" such as the Strait of Hormuz, Suez Canal, Malacca Strait, etc.

8.2.3 Strategies to reduce the vulnerability of oil-importing countries

There are several steps that can be taken to reduce the vulnerability of oil-importing countries and enhance energy security. The first is to diversify fuel types and sources, similar to portfolio diversification among astute investors. The objective of diversification is to spread the risk that the supply of a certain fuel or from a certain source may become a problem. It is a known fact that there is only a limited source of supply for the world's oil. Large consuming countries (US, China, Japan, India and the member states of the EU) rely heavily on the same oil and gas resources in Russia, the Caspian Sea and the Persian Gulf for their supplies. Thus, the development of new and indigenous renewable energy sources is a good move to diversify fuel source and become less vulnerable to disruptions in fuel supply. Recent studies point to the fact that reduction in risk through the introduction of a modest amount of renewable energy often outweighs the increased cost for developing the fuel.

Reducing energy infrastructure vulnerability through distributed energy is a second step in enhancing energy security. Centralised energy

infrastructure, while efficiently exploiting economies of scale in construction and operation, is also vulnerable to large-scale disaster and loss. Newer technology available through distributed energy now captures the efficiency and economy of centralised energy infrastructures, e.g. efficient micro-turbines, fuel cells and solar converters as complements to large central facilities. These distributed energy resources provide inherent security advantages through their modularity and geographical diversity.

Thirdly, promoting good governance in energy delivery helps to prevent unrest and violence, which ultimately threatens sustainable energy delivery. The traditional delivery of energy through monolithic structures is fraught with inefficiencies that drain government resources that could be used for social development expenditures such as health and education. Resources are instead used to subsidise the inefficient monopoly utility, ultimately benefiting the urban elites at the expense of energy-poor rural or urban populations. The poor are usually the most vulnerable to the shocks provoked by energy market instabilities because energy already accounts for a higher share of their meagre cash income.

A fourth strategy to enhance energy security is to promote regional cooperation in energy supply. Regional programmes involve the participation of several governments in planning, development and implementation of policies and projects that benefit all the participants. While the level of cooperation has been active in trade and economic development in many countries in Asia, e.g. the Mekong region, the Central Asian Republics and in Sub-Saharan Africa, e.g. NEPAD, ECOWAS, etc. regional cooperation in the energy sector is still in its infancy. There are still some constraints to overcome (e.g. countries with a high level of energy resources have small populations and low demand and vice versa).

However, the potential benefits of regional cooperation in enhancing energy security are great – in the power sector, these could result in reduced domestic physical infrastructure vulnerability. In the hydrocarbon sector, freer trade and reduced tariff barriers could lead to a more rationalised and efficient market for domestic consumers and enhance the supply of energy.

The outlook for energy security worldwide is particularly troubling, with rising levels of oil consumption. Dependence on a few country alignments (Middle East, Russia and individual country exporters such as Venezuela and Indonesia), makes the reliability of supply of energy at affordable prices extremely vulnerable. Therefore, oil-importing countries should take measures to reduce dependence on fossil fuels, improve governance and adopt policies to improve regional energy infrastructure and transportation networks (e.g. regional cooperation).

8.3 Trade issues in energy sector reform

The liberalization of domestic coal and petroleum markets described in Chapter 5 has not had any major impact on regional cooperation and international trade. Increased private sector involvement in gas exploration and development, however, appears to have been a major factor in boosting international trade in natural gas, both through pipelines and in the form of Liquefied Natural Gas (LNG). State-owned gas companies appear to have been mostly focused on serving the domestic market while the multinational oil and gas companies are more aggressively pursuing export opportunities. There are a number of factors explaining this: large private actors possess a superior ability to identify market opportunities and to plan and finance large scale international projects (that can cost billions of dollars). Furthermore, export revenues help mitigate risks associated with foreign debt for heavy exploration and development expenditures.

The power sector reforms discussed in Chapter 2 both facilitate and complicate cross-border trade in electricity. Historically, many state-owned power companies have realised the advantages of cooperating and trading with their neighbours (Box 19). For example, Vattenfall and Statkraft – the large, state-owned power companies in Sweden and Norway – were the driving forces behind the interconnection of the two countries' power grids. These interconnections were a precondition for the establishment of the competitive Nordic electricity market. Similarly ESKOM, the large state-owned utility in South Africa, has been the driving force behind the creation of the Southern Africa Power Pool. The development of the West African Power Pool has been moving ahead at a slower pace, perhaps because a inter-governmental body – ECOWAS – rather than a major utility has been the driving force.

There are a few examples of private sector generating projects that have been built to primarily sell electricity to a neighbouring country. Most well-known are the two hydropower projects in Laos (Houay Ho and Theun Hinboun) that export electricity to Thailand. There is also a private transmission line that was built to export power from Argentina to Brazil.

8.3.1 Privatisation – a complicating factor in regional power integration

On the whole, however, it appears that power sector restructuring, unbundling and privatisation complicate, rather than facilitate, regional integration. One reason appears to be the disappearance of the old state-owned monopolies that could make friendly deals with their counterparts across the border. Second, the natural proponents of regional trade – the system

operators and regulators – have so far been preoccupied with making sure that the new domestic system functions.

Long-term power sales work fairly well under both state-owned monopoly regimes (e.g. Cahora Basa in Mozambique that sells power to ESKOM) and private Independent Power Producer (IPP) arrangements (e.g. Theun Hinboun). Short-term power trading between countries with competitive markets can be quite problematic unless there is great uniformity of the regulatory regimes.

Box 19: The economics of regional power grids

Regional integration of energy grids through oil and gas pipelines and power transmission lines can have significant benefits. The benefits are of four types: (i) enhanced security of supply (through diversification of energy sources); (ii) enhanced reliability of supply (through purchases from neighbors if there are domestic shortfalls); (iii) lower combined peak demand; and (iv) use of cheaper energy sources in another country. However, these benefits depend, to a large extent, on the specific situation in the participating countries.

Regional power interconnections have been built extensively in North America and Europe resulting in significant cost savings (through more economical dispatch and reduced need for reserve generating capacity). In developing countries, international transmission lines have been built in South and Central America and are under way in Sub-Saharan Africa and South East Asia. (The transition economies in Eastern Europe and Central Asia are generally interconnected.)

The benefits regional transmission networks in terms of enhanced energy security are difficult to quantify. In order to realize any major benefits from improved reliability of electricity supply, the trading countries need to have – in aggregate terms – surplus capacity. Most low and lower middle-income countries, however, tend to have significant unsatisfied demand for power. The economic benefits of "sharing shortages" may be positive but, on the whole, the political costs of doing so are likely to be prohibitive. Neighbouring countries tend to have similar climates and economic structures and, thus, the demand peaks tend to coincide. For example, a detailed study of power integration in the Greater Mekong Sub-Region in South East Asia found that the aggregate peak generation demand in 2020 would fall by only 2.5% if the electricity grids were interconnected. Put another way: without regional integration, an installed capacity of 99,000 MW would be required in September 2020 rather than in December 2020 if interconnections were in place.

This means that, in general, major investments in international transmission lines are justified primarily when one (or several) of the countries have abundant cheap energy sources, such as hydropower. For other energy sources, the question is rather what is cheapest to transport: electricity or coal, gas and oil. In some cases, the benefits have been estimated to be quite large, in other cases, they are more modest and highly sensitive to assumptions regarding fuel prices, cost of capital,

etc. In the Mekong study, for example, the savings were about US$ 900 million or a mere 2% of the expected cost of generating plants and interconnections (probably about 1% of total system expansion costs when other transmission and distribution investments are included). Clearly, cost savings of this order of magnitude is well within the error margins for the cost assumptions.

Sources: Author and Lefevre et al (2005)

8.4 Tariffs and subsidies

8.4.1 Tariffs

Rational pricing of energy is perhaps one of the most important elements of energy reform and an important factor in sustainable delivery of energy services. Cost-reflective tariffs enable infrastructure operators to maintain, replace, modernise and expand their facilities and services, benefiting consumers and the economy. Most prevailing tariffs involve a cost-plus structure which follows certain pricing principles [40]. These principles ensure that the rate of return earned by a firm or utility is at least equal to the returns earned by firms with similar risks elsewhere in the economy. They also attract investments to the facilities because investors know that they will recover their operating and investment costs with a return that exceeds their cost of capital. However, cost-plus systems also have shortcomings, as firms then have an incentive to engage in accounting manipulation of costs in order to obtain higher prices. It also provides no incentives to firms to minimise its costs and capital expenditures. Given the shortcomings of cost-plus pricing structures, other pricing mechanisms have been developed, such as price caps and profit-sharing schemes.[41] Regardless of the tariff structure, tariffs, as a rule, should provide adequate revenue for the power utility or company to be in sound financial health in order to ensure sustainable system expansion to meet increasing demand. However, this is more the exception than the rule for most developing countries. For example, in Zimbabwe frequent changes of ministers of energy and weak policy commitment to tariff reform in 2000 undermined efforts to attract private sector participation for its plant expansion at Gokwe North (Mangwewende, 2002).

[40] Cost-plus pricing principles: (i) capacity costs and energy costs reflecting long and short-run marginal costs and covering the replacement cost of all facilities and the cost of capital; (ii) tariffs for different classes of customers based on the cost of supply; (iii) tariffs reflecting load and power factors, and (iv) avoidance of cross-subsidies which distort the market.

[41] Price caps are prescribed by regulators for firms to control prices and the earnings where the firms are allowed to charge for their services at or below these prices. Other pricing schemes allow some profit-sharing for the firm, for example, where a firm is allowed to keep profits when the rate of return is within a certain agreed range.

Despite the predominance of "commercial or near-commercial tariffs", many governments continue to utilise subsidies to benefit certain classes of consumers (such as the poor, rural and residential consumers) or certain industries deemed to be critical to the economic development of a country (irrigation or fertiliser production). These traditional ways of delivering subsidies, particularly cross-subsidization of consumption, however often fail to really help the poor. Experience proves that such subsidies have often failed to benefit the target end-users, promoted inefficient consumption and proved to be a fiscal burden to the government. The mistargeting of subsidies occurs often. ESMAP, in several studies (ESMAP 2000), cites this shortcoming as in Indonesia's policy of subsidising kerosene to encourage its use by the poor for cooking, but where many middle and higher income people took advantage of the subsidies. In Ecuador, subsidised kerosene was diverted to the transport sector, and much of it never reached the poor especially in rural areas. Another risk is that lifeline rates in the electricity sector (a cross-subsidy that enables the poor who use minimal services to pay a lower price than wealthier households), may be abused such as in the case of Yemen where the consumption level for lifeline rates were set at 200 kilowatt-hours per month, a consumption level that includes most of the population. Finally, subsidies meant to encourage the development of a new activity (e.g. agricultural subsidies for irrigation) may not be phased out when productivity gains in agricultural production exceeded the cost of electricity for irrigation.

8.4.2 Subsidies

The goal of most subsidy programs is to promote some "social good", such as improving the quality of life of a group of people or redistributing income to less fortunate groups (targeting). Subsidies can also be used to promote the development of the market for new products or services, for example, connections to rural areas. Subsidies may be inevitable because of the inability of the poor to access affordable energy, but there are better ways of delivering these types of "smart subsidies". Many studies show that the poor are often willing to pay for higher-quality energy services (such as electricity, LPG and kerosene) but are deterred from obtaining service by high access costs (high connection fees, deposits for LPG bottles, etc.), or unavailability of services (e.g. in rural areas). As such, the benefits of access may justify some form of subsidy for the front-end costs, such as lower connection fees or credits for new connections for electricity, and smaller initial service fees and smaller bottles for LPG users. Subsidies can also be regarded from the broader point of view of substitution of different energy sources, e.g. using subsidies to promote higher quality energy serv-

ices to the poorest households to replace dung and straw for cooking and candles for lighting. There are other considerations to introducing smart subsidies, e.g. where subsidies reach those for whom they are intended (e.g. direct consumption subsidy to low power users), and where subsidies are structured in the form of business incentives to encourage provision of new services; e.g. extension of electricity services to rural areas. Especially when it is desirable to extend service to previously unserved groups, the subsidy can be structured along the principles of output-based aid, as has been done in Mozambique for rural electrification (Box 20).

Box 20: Output-based aid to rural electrification in Mozambique

Rural electrification – especially in the early stages – is very costly and the true cost typically exceeds the willingness and ability of households and small enterprises to pay. National utilities have usually overcome this through cross-subsidies. Small private providers in rural areas do not have this ability, which limits (or destroys) their potential markets. The obvious solution to this dilemma is to channel subsidies either directly to consumers (which involves severe targeting problems) or to the producers. Experience as well as economic theory tells us that up-front capital subsidies are easiest to target and have the least distortive effects. One way of doing so is through output-based aid (OBA).

OBA is a strategy for using explicit performance-based subsidies to support the delivery of basic services where policy concerns would justify public funding to complement or replace user-fees. The subsidy can take the form of "X dollars per new connection."

Cockburn and Low (2005) describe how this approach has been applied to rural electrification in Mozambique:

> *"Mozambique's first privately operated concession to generate, distribute, and sell electricity is now up and running in a rural area of Inhambane Province isolated from the country's main transmission grid. The contract was won through competitive bidding by a Mozambican and South African consortium and leaves the private operator free to develop the power system in the concession area in the way most cost-effective…" (p. 1).*

> *"Fewer than 6 percent of Mozambican households are connected to the main grid operated by the national utility, Electricidade de Moçambique (EdM), or to isolated mini grids run by local municipalities... Meanwhile households without access to electricity typically pay as much as 40¢ per kWh for energy from alternative sources such as kerosene or batteries – far more than the 7¢ per kWh charged by EdM (which nearly covers costs) or the 15–20¢ in areas relying on diesel-generated power. This suggests that, once connected, these households would be willing and able to pay for their electricity use. But the up-front cost of connection is out*

of reach for the typical household. Nor is it realistic to assume that an investor might finance new distribution assets with the idea of recovering the full investment through tariffs over time since many households, at least initially, would probably consume only enough electricity to power a radio and one or two light bulbs…" (p. 1).

"An energy fund, set up to finance rural electrification schemes, has been given responsibility for monitoring the payments of OBA subsidies. So far, output-based aid in the Mozambican electricity sector has been targeted at all households, not just the poor, in part for simplicity and also because of the need to establish a sustainable base business in areas with low connectivity…" (p. 2).

"A subsidy agreement between the concessionaire and the government provides for the payment of a $400 subsidy for each new residential connection made. No subsidy is paid for business connections." (p. 3).

Source: Cockburn and Low (2005)

In some cases, private power operators have saved governments heavy operating subsidies. The World Bank reports that in Peru, private operators have taken over retail supply, drastically reducing payment delays, theft and unpaid bills (from 30% to 12% in Buenos Aires, and about the same in Cote d'Ivoire (World Bank, 2003a). A lot of gains have stemmed from good asset management where, over a five-year period, plant availability increased from 10% to 40%, the number of customers per employee increased 50%, and outage indicators decreased by more than half.

8.5 Governance

Governance is a major problem in the energy sector, with its continued dominance of state owned enterprises that are used as instruments for government political, social, and economic objectives. This obfuscates the commercial objectives of the enterprises and dilutes management controls, transparency of operations and the accountability of the enterprise managers. Gradually this can lead to corruption, inefficiency, overstaffing, poor standards of supply and service, poor financial performance of the enterprises and a fiscal burden on the state.

8.5.1 Corruption

Transparency International (2002a) puts the petroleum sector next to "public works/construction" and "arms and defence" as being the sector where cor-

ruption is most prevalent. The power sector is only marginally better than the petroleum sector. The energy sector in developing countries[42] suffers from both "petty" and "grand" corruption.[43] The so called "petty" corruption involves such things as illegal connections carried out with the connivance of the line men, bribes to meter readers to under-record the amount of power used or facilitating payments to obtain new connections. "Grand" corruption is what tends to get the headlines: kickbacks on major contracts to sell or buy oil, construction of power plants, etc. It appears, however, that the aggregate amounts involved in "petty" corruption are significantly larger than those collected through "grand" corruption (see Box 21 and Gulati & Rao, 2006).

Box 21: The cost of poor governance of the power sector in Bangladesh

A recent survey of households in Bangladesh undertaken by Transparency International's Bangladesh Chapter (2005) found that:

- 10.4% of households who have an electricity connection are illegally connected;
- 70% of households who were connected to electricity during the last year had to pay 1174 taka (US$20) on an average as bribes; and
- 4.3% of households who had an electricity connection paid an average amount of 1445 taka (US$25) to tamper with meter reading to avoid paying the correct amount due.

By 2002, Bangladesh had around 6.5 million households connected to the electricity grid; a number growing by 10–12% per year. This meant that illicit payments for new connections amounted to around US$10 million. The households bribing meter readers paid around US$7 million. Presumably, the cost of an illegal connection was higher than the amount paid for "under-metering." If we assume that the annual cost for an illegal connection was US$30, the total amount collected by the line men and/or meter readers would be around US$20 million. Thus, in round numbers, we can expect that Bangladeshi households in 2002 paid around US$37 million in bribes. To this should be added payments for correction of billing errors, repairs of faults, etc. While no data are available on bribe paying by industrial and commercial consumers, indications from other countries in South Asia are that such entities bribe and steal more than households. Since households consume around 41% of the electricity billed in Bangladesh, it seems reasonable to assume that "petty" corruption in Bangladesh power sector is a US$100 million a year business.

The World Bank (2002b) in a report on governance in Bangladesh quotes a local businessman who reported that the prevailing bribe to obtain an equipment supply contract was 6–8% of the contract

42 Of course, corruption also occurs in industrialised countries, but by all indicators it is more widespread in the developing world. (See, for example, Transparency International, 2006.)

43 For an overview of the nature of corruption in the energy sector, see Lovei and Mc Kechnie (2000) and Ruth (2002). Transparency International's Bangladesh Chapter (2005) provides an interesting description of corruption in the power sector in Bangladesh.

value. For works contracts, the price was much higher "as much as 20%." Assuming that 10% is a reasonable average for the annual US$300 million investment programme in the electricity sector would indicate that "grand" corruption amounts to around US$30 million annually. (It should be noted, however, that TI-Bangladesh (2005) quotes higher figures: *"The rate of corruption is generally thought to be between 15 to 20 % of the value of procurement contracts, although in limited cases it was reportedly as high as 30%.")*

However, this is only the tip of the iceberg. On September 28, 2006, FoxNews.com (and other news organizations) reported:

> *"Riot police fired rubber bullets and tear gas Thursday at demonstrators violently protesting two days of near-constant power outages in Bangladesh's capital, witnesses said. About 200 protesters were injured in the clashes, which saw government offices attacked and vehicles smashed in Dhaka, the United News of Bangladesh agency reported… Some Dhaka residents have been getting just two hours of electricity a day"*

Indeed, in 2002, there were more than 1,000 hours of planned load shedding and numerous hours of random black-outs. A survey of the investment climate in the country found that that erratic and poor quality of electricity supply was the dominant constraint to business development and growth in Bangladesh (Bangladesh Enterprise Institute and World Bank (2003). Another study carried out by USAID in 2002 valued lost production from power outages at US$772 million a year, equivalent to 1.7 percent of GDP (Nexant et al. 2003a).

Sources: Various as noted in the text.

Much of the effort to reduce grand corruption is driven by governments and NGOs in the developed world and focuses on reducing the payment of bribes by companies operating internationally.[44] Naturally, developing countries also have legislation aimed at combating corruption, however frequently the political will to enforce it is lacking. Transparency International (TI) is working actively through its country chapters to increase public awareness and pressure on the government. One of the instruments that TI recommends is an "integrity pact" signed by the government and all bidders.[45]

Because of its nature, petty corruption is even harder to combat than grand corruption. Traditional management techniques (better accounting

44 Examples are: the US Foreign Corrupt Practices Act and similar legislation in other countries, the OECD Convention on Combating Bribery of Foreign Public Officials in International Business Transactions and the OECD Principles of Corporate Governance Compliance, the 10th Anti-Corruption Principle in the UN Global Compact and Transparency International's Business Principles for Countering Bribery.

45 See http://www.transparency.org/global_priorities/public_contracting/integrity_pacts

and auditing, supervision, "zero tolerance" policies, regular rotation of staff, etc.) need to be complemented by tools such as Citizen Report Cards and Community Score Cards for monitoring and reporting on the quality and reliability of service delivery at ground level.[46]

8.5.2 Hidden costs due to flawed policy and poor implementation

However, poor governance in the energy sector involves much more than corruption. In simple terms, "governance" comprises a myriad of factors that influence access to and price, quality and reliability of service. One way of capturing part of these factors is to estimate the unrecorded or "hidden cost" due to a flawed infrastructure policy and poor implementation decisions. Ebinger (2006) has undertaken an analysis of the power, gas and water sectors in 20 countries in Eastern Europe and Central Asia. She identifies three major categories of hidden costs: poor bill collection rates, excessive losses due to inefficient operations or theft from the networks, and tariffs set below cost-recovery rates. Ebinger notes (p. 5) that:

> *"Typically utilities compensate for these hidden costs by reducing investment…; they may also delay or forego essential maintenance and repairs or reduce the workforce, actions that trigger a downward spiral of significant deterioration in the value of assets, declining service quality, and increasing cost for each unit of service provided."*

Figure 15 combines her data on hidden costs in the electricity sector (expressed as percent of GDP) with the World Bank's governance indicators.[47] It is striking that not only the overall cost declines when governance improves but also that the various components decline with better governance.

In simple terms, the figure shows that if the countries in the 4th governance quartile[48] improved their score to the same level as the countries in the 1st governance quartile,[49] the reduction in hidden costs would be equivalent to 6.7% of GDP. It can be argued that the cost associated with tariffs below costs is a reflection of policy decisions regarding the pace of change from a cheap (and wasteful) energy policy prior to 1990. The un-

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46 See Paul (2002) for an application of such approaches.

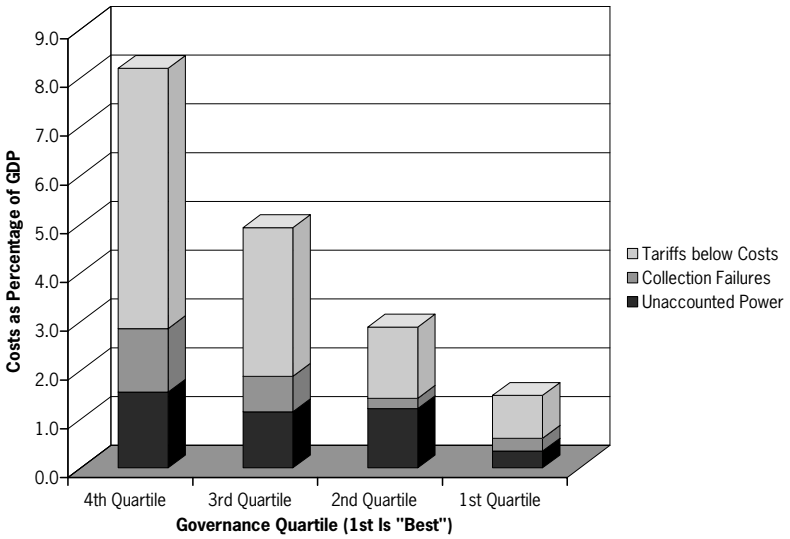
47 The World Bank measures the quality of governance with six variables: (i) voice and accountability; (ii) political stability; (iii) government effectiveness; (iv) regulatory quality; (v) rule of law; and (vi) control of corruption (see www.worldbank.org/wbi/governance). The scale of each variable is set so that +2.5 is the highest and -2.5 is the lowest score. For the purpose of Figure 15, a straight arithmetic sum of the six variables has been used.

48 Azerbaijan, Belarus, Georgia, Tajikistan and Uzbekistan.

49 Bulgaria, Croatia, Poland, Romania and Turkey.

accounted losses and the poor collection performance are largely the results of management failures. A move from 4th to 1st quartile would lower the hidden costs of these management-related items by 2.2% of GDP.

Figure 15: Governance and "hidden costs" of the power sector in Eastern Europe and Central Asia



Source: Ebinger (2006) and World Bank Governance Indicators

8.5.3 Strengthening governance

Strengthening governance in the energy sector is a multifaceted task. It involves creation of legal and regulatory frameworks that not only looks good on paper but actually work in practice, creating an efficient and responsive industry structure, building institutions with an appropriate culture and capable staff, providing appropriate incentives at all levels etc. In defining a reform agenda, it is important to consider both formal and informal institutional frameworks (Sida 2005). Formal frameworks are defined by laws and ordinances, official strategies and policies, responsibility structures, administrative systems and procedures. Informal institutional frameworks are less tangible and comprise values, attitudes, traditions, power relationships, action norms, beliefs and behaviour. Thus, energy sector reform cannot be treated in isolation but needs to be considered within the country's social, political and economic environment.

Over the last couple of decades, efforts to improve governance in energy and other infrastructure sectors have generally consisted of one or more of the following elements: (i) privatisation (ii) regulation (iii) decen-

tralization and (iv) adoption of participatory processes for project selection, design and implementation.

Privatisation

As described in Section 4.2, private ownership and/or operation of energy facilities has almost universally led to improved operational efficiency and generally better quality of service. The extent to which access and affordability have improved is less clear cut. It primarily depended on the regulatory regime – and associated incentives – under which the private entity operated. A few recent research studies seem to confirm the "common wisdom" that private owners and managers make greater efforts to control petty corruption. In a survey of around 2000 enterprises in 21 countries in Eastern Europe and Central Asia, Clarke and Xu (2002, p. 23) found:

> *"…strong evidence that bribes paid to utilities are lower in countries with greater capacity and competition in the utility sector and where the utility has been privatised."*

While it is quite natural that private sector managers would seek to minimise corruption among its employees in the day-to-day operation of the entity, it does not immediately follow that private infrastructure companies do not pay bribes to obtain or keep their franchises. Indeed, there are many allegations that private operators have engaged in corrupt practices to obtain their contracts or concessions. The most prominent case is Enron's Dhabol generating plant in India. By all indications, the tariff (and the power purchase agreement in general) was overly generous to the project company, but no corruption was ever proven. Similarly, after a regime change the government of Pakistan alleged corruption in a number of IPPs, but no evidence was ever presented in court (Fraser, 2005). It would be surprising if corrupt practices had not been used in some projects although, as Woodhouse (2005, p. 33) notes in a major survey of IPP experience in 12 countries: *"To date, no allegation of corruption related to an IPP in any of twelve sample countries examined here (or any other country) has resulted in a full public adjudication."* In general, it is likely that the magnitude of corruption associated with private infrastructure projects is lower than in traditional public sector procurement. The intense scrutiny of the lenders and their technical and legal advisors simply makes it more difficult for project sponsors to "hide" major bribes.

Still, most observers, such as Fraser (2005), recommend that energy franchises be awarded through a transparent competitive process. Such a process was put in place Bangladesh – typically ranked by Transparency International as one of the most corrupt countries in the world – with sup-

port from the World Bank and ADB for the contracting of two combined-cycle, gas-fired power plants in 1997. The tariff offered by the winning bidders was less than 3 US cents per kWh,[50] a price that sent shockwaves through the international power community.

Regulation

Evidence on the impact of utilities regulation in developing countries is still limited, but a study of the electricity sector in 25 developing countries (Zhang et al, 2005) demonstrated that privatisation brings greater benefits when it is accompanied by an effective regulatory regime. However, it is difficult to create well-functioning regulatory authorities in developing countries. In industrialised countries where virtually everybody has access to electricity, the main focus is on regulating tariffs to control monopoly profits. In developing countries, where affordability is a major concern, few people have access to electricity, voltage variations are major and blackouts frequent, regulation becomes more complex: it has to deal not only with average tariff levels and corporate profits but also with distributional issues, access and service quality. The information gap between the regulated and the regulator tends to be wide in environments where few budget norms exist and accounting and auditing are weak. At the same time, it is difficult for the regulators to find qualified staff and they are often under-funded.

There have been few indications that regulatory authorities in developing countries suffer from corruption. Given that many country surveys undertaken by the local chapters of Transparency International have demonstrated that the judiciary is affected by corruption, there is little reason to assume that it does not exist in some regulatory agencies. However, the literature seems to indicate that "regulatory capture"[51] is a more pervasive problem. Kirkpatrick and Parker (2004) points out that in many developing countries "political capture"[52] is an even greater risk and thus the need for an independent regulator.

Traditionally, the US has regulated the "rate-of-return" that utilities can earn. Many of the recent reforms in Europe have introduced "price

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50 The cost of generating power depends on a large number of factors (inter alia, the cost of fuel and the plant's load factor). Thus, great caution should be employed when comparing quoted tariffs for private generating projects.

51 "Regulatory capture" implies that the regulatory process becomes biased in favour of the regulated companies. A classic example was the Interstate Commerce Commission in the US, which was commonly referred to as "the trucker's best friend."

52 "Political capture" occurs when regulatory goals and processes are distorted to pursue political ends. This is most likely to occur when the regulator is directly under the control of government ministers.

cap" regulation. A majority of developing countries that have established new regulatory regimes have adopted the "price cap" approach. Both approaches have merits and problems that are extensively discussed in the literature. However, based on extensive research, Kirkpatrick and Parker (2004) argue that "sliding scale" regulation is the best approach in most developing countries. This type of regulation is also referred to as "hybrid price caps," "earnings sharing" or "revenue sharing." In its simplest form, the regulated company works under a price cap but if it manages to improve efficiency to such an extent that its profits rise above a benchmark, the tariffs will be automatically lowered to transfer some of the benefits of increased productivity to the consumers.

Conclusions and recommendations

CHAPTER 9

Modern energy services play a critical role in achieving most of the Millennium Development Goals related to poverty alleviation, education and health. Thus, the fundamental objective that governments should address in their energy policies is to provide access to electricity or other modern energy sources for the 1.5–2 billion people who presently lack access. As discussed in Chapter 6, the problem of access is especially acute in rural areas.

Improving access for rural and low-income urban populations requires action on many levels. The private sector – local entrepreneurs, global power developers, domestic capital markets and multinational financial institutions – has a definite role to play in providing both skills and financing. Energy sector reforms are generally designed to enhance efficiency and encourage private participation. However, especially in low-income countries, private participation is no panacea for the development of the energy sector. The public sector, donors, NGOs and community-based organizations all have important roles to play.

Maintaining stable macro-economic policies, removing price distortions and trade barriers, liberalisation of the investment climate will help create an environment conducive to investments in energy services by foreign and local firms as well as by households and micro-entrepreneurs. The development of the local financial sector is also essential to encourage and enable investments in energy production and distribution and in energy-using machinery.

Experience shows that many low-income people fail to use modern energy sources even if they are available. Often this is not because of the un-affordability of energy per se, but because of the high capital outlays for installation, appliances and equipment needed to make productive use of the available energy. Thus, micro-finance, as well as the "formal"

commercial financial institution, is needed to support the use of modern energy sources.

The strategy for the energy sector needs to be articulated within the framework of the government's broader policy for social and economic development. The energy sector should be a core element of the poverty alleviation strategy and in the programmes to achieve the millennium development goals. National development strategies that promote sustainable, pro-poor growth are generally preconditions for equitable and affordable development of the energy sector. (See Section 1.3)

Given that country conditions vary dramatically, there is no standard formula or "cookie-cutter" approach that can be used everywhere. Rather, this diversity calls for creativity in identifying the right solutions as well as the use of a broad range of instruments. The "stylised" recommendations presented below should be read with this caveat in mind. These recommendations are especially geared towards low income countries but also apply to many lower middle-income countries.

First, as noted above, energy services should be instruments for achieving broader developmental objectives. This means that energy planning and policy formulation should start from the "bottom" with the energy needs of people and enterprises, acknowledging that there are alternative ways of meeting these needs. Solar panels might be the best way of meeting the needs of remote health clinics. Diesel rather than electrical pumps might be the most cost-efficient way of providing irrigation or drinking water etc. In developing and articulating a national energy strategy, the government needs to consult with actual and potential energy users and with civil society at large. The strategy must be consistent with the macroeconomic framework and with the programmes of other ministries, such as education, health, industry, transport and agriculture/rural development – which probably best can be achieved through an inter-ministerial working group.

A differentiated strategy is often needed: grid electricity might be most appropriate for unserved urban and peri-urban areas (where population densities are high and the cost of building distribution networks is correspondingly low). Local mini-grids and non-grid electricity solutions (solar PV systems, wind, mini hydro, etc.) or hydrocarbon (LPG, kerosene, diesel, etc.) might be more appropriate for light and motive power in remote rural areas. (See Sections 6.2–6.4) Access, affordability and financial viability of energy enterprises should be key objectives for various sub-programmes covered by the energy strategy. Where subsidies are required to meet these objectives, they should be explicit and transparent, well targeted, fully budgeted and aimed at reducing up-front, "first use" costs,

especially for the poor. Subsidies aimed at reducing capital cost are preferable over recurrent subsidies (say reducing the price per litre or kWh) or interest rate subsidies. Capital cost subsidies should be based on the "output-based aid" approach (i.e. in rural electrification schemes the subsidy might be a fixed sum per new connection rather than a percentage of the investment cost). (See Section 8.4)

Many energy policies have focused too narrowly on government investment programmes. Given limited government and donor resources in most developing countries, there is a need to ensure that contributions by the local and foreign private sector and non governmental organizations are maximised. This means that an appropriate legal and regulatory framework needs to be put in place. (See Section 2.3) It might also mean that existing public sector entities should be restructured and/or put under private sector management in one form or another.

In the power sector, reform can be summarised as follows (see Section 4.6):

- Adopt a single buyer model for new generating capacity and enter into new contracts (based on two part tariffs rather than take-or-pay arrangements) only after competitive bidding;
- Introduce simplified solicitation procedures and contracting models for smaller, locally owned and financed generating projects;
- Unbundle the utility only if it is sufficiently large (annual sales exceeding, say 5,000 GWh);
- Use management and lease contracts to help improve operating performance of state-owned assets;
- Encourage local entrepreneurs to set up smaller (village/neighbourhood) systems in unserved areas and simplify concession arrangements (including permitting lower technical standards) for such schemes;
- Allocate public sector subsidies to grid extension and connection of rural and peri-urban low-income consumers.
- Build regulatory capacity gradually as the electricity supply industry becomes more complex. Initially, use can be made of "regulation by contract."

For countries without significant hydrocarbon resources, the main policy objective would be to make the importation and distribution of petroleum products as efficient as possible. Experience has shown

that this can generally be done best by liberalising the sector and creating a competitive environment. Simply speaking, governments have no comparative advantage in operating petrol refineries or petroleum related industries. The focus of government interventions should be tax and subsidy policies and on making sure that the necessary infrastructure facilities (oil terminals, pipelines, etc.) are put in place. Working in partnership with the private sector and civil society, the government can encourage innovations to improve access for the poor (LPG bottles, redesigned stoves etc.) as well as promoting energy efficiency. (See Section 5.1)

The energy strategy in low income countries also needs to address the affordability, availability and safety of cooking fuels and practices. In part, this involves the steps outlined above. It also involves partnerships with entrepreneurs and civil society (including the expected beneficiaries) to improve the efficiency of traditional fuels and stoves. (See Section 6.4)

Women and men not only have different energy needs but also different access to resources and inputs into the decision making process – be it at the household, community or society level. This has significant impact on their access to, and use of, appropriate energy services. Some of this can be studied and analysed, but studies are no substitute for the active involvement of, and consultations with, stakeholders. Previously when gender has been taken into account in energy planning, concerns have typically been narrowly focused on women's role in cooking, collecting firewood and fetching water. There is a need to take a much broader approach. In order to mainstream gender concerns into the sector, women must not only be regarded as consumers of energy services, they must also play a role as energy suppliers, i.e. as decision-makers, entrepreneurs and workers. (See Section 8.1)

Energy security is best achieved – in a cost-effective manner – through diversification of energy supply and prudent use of long-term supply contracts. Development of renewable energy can also help countries become less susceptible to price hikes and supply interruptions of imported fossil fuels. (See Sections 8.2 & 8.3)

A key emerging factor in supporting cost-effective energy efficiency investments is how to broaden the impact of energy efficiency investments and catalyzing these beyond the project level. Governments should focus on creating a sustainable institutional infrastructure that makes energy conservation and efficiency a profitable commercial business rather than investing directly in energy efficiency projects. As such, energy service providers or energy service companies (ESCOS) should be supported to

offer a broad range of options not only to satisfy customers' needs but to take advantage of alternative energy sources, renewable resources and energy-efficient services already in use. (See Section 7.2)

Renewable energy sources are becoming increasingly competitive and should be actively pursued. Governments should build up their capacity to take advantage of various programmes under the Kyoto Protocol to help improve the financial and economic viability of investments in renewable energy sources. (See Section 7.8) However, the poorest countries – who contribute little to the emission of greenhouse gases – should be cautious about pursuing renewable technologies that are not financially viable. Rather, in the words of Modi et al (2006, p. 31): "*Meeting domestic economic growth and social development requirements in line with the sustainability of the domestic resource base should be the overriding concern in these cases.*" (See Section 7.4)

Quite naturally the interest in, and orientation of, policies and programmes promoting the use of renewable energy sources depend on the local resource base. The instruments used to achieve these targets depend on a number of factors such as budgetary resources, as well as the structure of the power sector and the market model adopted. In some cases, the energy ministry can simply issue instructions to the state-owned power utility. Generally, however, the government needs to provide financial incentives and/or change the principles for risk sharing for private owners of power plants. Thus, there is a whole menu of policy options that developing countries have or can put in place to encourage the development of wind, solar, hydro and waste generating plants. (See Section 7.6)

Besides traditional biomass (wood, dung, etc.) the most important renewable energy resource in many developing countries is hydropower. In many cases, hydropower is the cheapest form of electricity, but such projects can have far reaching negative social and environmental impacts. Thus, hydropower projects need to be planned, designed and operated in close consultation with the communities involved and with civil society at large. In order to attract donor or commercial funding for public and private sector hydropower projects, these must follow the "best practices" that have emerged after the work of the World Commission on Dams. (See Section 7.7)

There is significant scope for using energy more efficiently in most developing countries. While investments in energy efficiency improvements often yield high financial returns, low income countries generally have little institutional capacity to find the right technical solutions and mobilise the required financing. Since such investments typically takes place in the private sector (hotels, factories, homes, etc.) the role of the government is rather limited. It can play an advocacy role (in part by leading the way

and "setting an example") and it can help establish energy service companies that work with private and public sector clients. (See Section 7.2)

As discussed e.g. in Section 8.5, strengthening governance in the energy sector is a multifaceted task. It involves creation of legal and regulatory frameworks, creating an efficient and responsive industry structure, building institutions with an appropriate culture and capable staff, providing appropriate incentives at all levels etc. In defining a reform agenda, it is important to consider both formal and informal institutional frameworks. Furthermore, corruption is a serious problem in the energy sector. It ranges from "petty corruption" by meter readers and "grand corruption" in the award of contracts to misguided policies. This undermines the financial viability of the enterprises in the sector (and, thus, reduces investments and access) and increases the cost to consumers (directly through tariffs and indirectly through the cost of blackouts and brownouts). The governance problem needs to be addressed at many different levels in order to enable the energy sector to play its proper role in promoting propoor, sustainable development.

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Note on data sources

Four major data sources have been used for this paper:

World Development Indicators (WDI) 2006. The WDI is published annually by the World Bank, both in book form and in digital form on compact disks (CD) for use on personal computers. The data is more comprehensive on the CDs. It comprises 695 variables of social, economic and environmental data for 208 developed and developing countries. The data cover the period from 1960 onwards, although not all data are available for all countries for all years. Because much of the data are collected from secondary sources and subject to various validity checks, the last year for most of the data sets is 2004 (and even 2003 for some variables).

Global Development Finance (GDF) 2006. The GDF is published annually by the World Bank, both in book form and in digital form on compact disks (CD) for use on personal computers. The data is more comprehensive on the CDs. It comprises 220 variables of data on aid flows, commercial borrowing, foreign direct investments etc. for 135 developing countries. The data cover the period from 1970 onwards, although not all data are available for all countries for all years. Because much of the data are collected from secondary sources and subject to various validity checks, the last year for most of the data sets is 2004. Projections are provided for a small number of variables for the period up to 2014.

The *Private Participation in Infrastructure (PPI) Project Database* is maintained and published by the World Bank. The PPI Database has data on 3,100 projects in 150 low and middle-income countries. It covers projects in the energy, telecommunications, transport and water and sewerage sectors. The data go back to 1984. The data for one year are typically available in the fall of the following year. Thus, the data for 2005 became available in September 2006. The data can be found at http://ppi.worldbank.org/.

The *Worldwide Governance Indicators* are regularly collected and published by the World Bank. They cover six dimensions of governance: (i) voice and accountability; (ii) political stability and absence of violence; (iii) government effectiveness; (iv) regulatory quality; (v) rule of law and (vi) control of corruption. These indicators can be found at http://info.worldbank.org/governance/kkz2005/tables.asp

Appendix 1

Status of power sector reform

Region/ Country	Market Structure					Private Ownership/ Involvement			Legal/ Regulatory	
	Monopoly	Monolithic Single Buyer	UnbundledSingle Buyer	WholesaleCompetition	Retail Competition	Generation	Transmission	Distribution	Adequacy ofLegislation	IndependentRegulators
East Asia & Pacific										
Cambodia		x				Prt	Pub	Prt	No	Yes
China		x				Prt	Pub	Pub	Yes	No
Indonesia			x			Prt	Pub	Pub	No	No
Korea, Dem. Rep.	x					Pub	Pub	Pub	No	No
Lao PDR		x				Prt	Pub	Pub	Yes	No
Malaysia			x			Prt	Pub	Pub	Yes	Yes
Mongolia	x					Pub	Pub	Pub	No	Yes
Myanmar	x					Pub	Pub	Pub	No	No
Papua New Guinea	x					Prt	Pub	Pub	No	No
Philippines			x			Prt	Pub	Prt	Yes	Yes
Thailand		x				Prt	Pub	Pub	No	Yes
Vietnam		x				Prt	Pub	Pub	No	No
Eastern Europe & Central Asia										
Albania			x			Prt	Pub	Pub	Yes	Yes
Armenia		x				Prt	Pub	Priv	Yes	Yes
Azerbaijan	x					Pub	Pub	Priv	No	Yes
Belarus	x					Pub	Pub	Pub	No	No
Bosnia and Herzegovina		x				Prt	Pub	Pub	Yes	Yes
Bulgaria			x			Prt	Pub	Priv	Yes	Yes
Croatia			x			Prt	Pub	Pub	Yes	Yes
Czech Republic				x		Prt	Prt	Prt	Yes	Yes
Estonia				x		Prt	Prt	Prt	Yes	Yes
Georgia				x		Prt	Pub	Prt	Yes	Yes
Hungary			x			Priv	Pub	Priv	Yes	Yes
Kazakhstan				x		Priv	Pub	Prt	Yes	Yes
Kyrgyz Republic	x					Pub	Pub	Pub	No	Yes
Latvia			x			Prt	Pub	Pub	Yes	Yes

Region/ Country	Market Structure					Private Ownership/ Involvement			Legal/ Regulatory	
	Monopoly	Monolithic Single Buyer	UnbundledSingle Buyer	WholesaleCompetition	Retail Competition	Generation	Transmission	Distribution	Adequacy ofLegislation	IndependentRegulators
Lithuania			x			Prt	Prt	Prt	No	Yes
Macedonia, FYR	x					Pub	Pub	Pub		Yes
Moldova			x			Pub	Pub	Prt	No	Yes
Poland				x		Priv	Pub	Prt	Yes	Yes
Romania				x		Prt	Pub	Prt	Yes	Yes
Russian Federation				x		Prt	Prt	Prt	Yes	Yes
Serbia and Montenegro			x			Pub	Pub	Pub		Yes
Slovak Republic			x			Pub	Pub	Prt	Yes	Yes
Tajikistan	x					Pub	Pub	Pub	No	No
Turkey			x			Prt	Pub	Prt	Yes	Yes
Turkmenistan	x					Pub	Pub	Pub	No	No
Ukraine				x		Prt	Pub	Priv	Yes	Yes
Uzbekistan	x					Pub	Pub	Pub	No	No
Latin America & Caribbean										
Argentina				x		Priv	Priv	Priv	Yes	Yes
Bolivia				x		Prt	Prt	Prt	Yes	Yes
Brazil				x		Priv	Priv	Priv	No	Yes
Chile				x		Priv	Priv	Priv	Yes	Yes
Colombia				x		Prt	Prt	Prt	Yes	Yes
Costa Rica		x				Prt	Pub	Pub	No	Yes
Cuba		x				Prt	Pub	Pub	Yes	No
Dominican Republic			x			Prt	Pub	Prt	No	Yes
Ecuador			x			Prt	Pub	Pub	Yes	Yes
El Salvador				x		Prt	Pub	Priv	Yes	Yes
Guatemala				x		Priv	Pub	Priv	Yes	Yes
Haiti	x					Mgmt	Mgmt	Mgmt		No
Honduras			x			Prt	Pub	Pub	Yes	No
Jamaica		x				Priv	Priv	Priv	Yes	Yes
Mexico		x				Prt	Pub	Pub	Yes	Yes
Nicaragua				x		Prt	Pub	Prt	Yes	Yes
Panama				x		Priv	Pub	Priv	Yes	Yes
Paraguay	x					Pub	Pub	Pub	No	No
Peru				x		Priv	Priv	Priv	Yes	Yes
Trinidad and Tobago		x				Priv	Pub	Pub		Yes
Uruguay		x				Prt	Pub	Pub		Yes
Venezuela, RB		x				Prt	Pub	Prt		Yes
Middle East & North Africa										
Algeria		x				Prt	Pub	Pub	No	Yes
Egypt, Arab Rep.			x			Prt	Pub	Pub	No	No

Region/ Country	Market Structure					Private Ownership/ Involvement			Legal/ Regulatory	
	Monopoly	Monolithic Single Buyer	UnbundledSingle Buyer	WholesaleCompetition	Retail Competition	Generation	Transmission	Distribution	Adequacy ofLegislation	IndependentRegulators
Iran, Islamic Rep.		x				Prt	Pub	Pub		No
Iraq	x					Pub	Pub	Pub		No
Jordan	x					Pub	Pub	Prt		Yes
Lebanon	x					Pub	Pub	Pub		No
Libya	x					Pub	Pub	Pub		No
Morocco		x				Prt	Pub	Prt	No	No
Oman			x			Prt	Prt	Prt	No	No
Saudi Arabia		x				Prt	Prt	Prt		
Syrian Arab Republic	x					Pub	Pub	Pub		No
Tunisia		x				Prt	Pub	Pub	No	No
Yemen, Rep.	x					Prt	Pub	Pub		No
South Asia										
Afghanistan	x					Pub	Pub	Pub		No
Bangladesh			x			Prt	Pub	Pub	Yes	Yes
India		x				Prt	Pub	Prt	~Yes	~Yes
Nepal		x				Prt	Pub	Pub	No	No
Pakistan			x			Prt	Pub	Prt	Yes	Yes
Sri Lanka		x				Prt	Pub	Pub	No	No
Sub-Saharan Africa										
Angola		x				Prt	Pub	Prt		No
Benin	x					Pub	Pub	Pub		No
Botswana	x					Pub	Pub	Pub		
Burkina Faso		x				Prt	Pub	Pub	No	No
Burundi	x					Pub	Pub	Pub		No
Cameroon	x					Priv	Priv	Priv	No	Yes
Central African Republic	x					Pub	Pub	Pub		No
Chad	x					Mgmt	Mgmt	Mgmt	No	No
Congo, Dem. Rep.	x					Pub	Pub	Pub		
Congo, Rep.	x					Pub	Pub	Pub		No
Cote d'Ivoire		x				Priv	Priv	Priv	No	Yes
Eritrea	x					Pub	Pub	Pub		No
Ethiopia		x				Prt	Pub	Pub		
Gabon	x					Priv	Priv	Priv	Yes	No
Gambia, The	x					Pub	Pub	Pub		No
Ghana		x				Prt	Pub	Pub	No	No
Guinea	x					Pub	Prt	Prt	No	No
Guinea-Bissau	x					Pub	Pub	Pub	No	No
Kenya			x			Prt	Pub	Pub	Yes	Yes
Lesotho	x					Mgmt	Mgmt	Mgmt	No	No

Region/ Country	Market Structure					Private Ownership/ Involvement			Legal/ Regulatory	
	Monopoly	Monolithic Single Buyer	UnbundledSingle Buyer	WholesaleCompetition	Retail Competition	Generation	Transmission	Distribution	Adequacy ofLegislation	IndependentRegulators
Liberia	x					Pub	Pub	Pub		No
Madagascar	x					Mgmt	Mgmt	Mgmt		No
Malawi	x					Pub	Pub	Pub		No
Mali	x					Prt	Prt	Prt	Yes	Yes
Mauritania	x					Pub	Pub	Pub		Yes
Mauritius		x				Prt	Pub	Pub	No	No
Mozambique		x				Prt	Pub	Prt		Yes
Namibia		x				Pub	Pub	Mgmt		Yes
Niger	x					Prt	Prt	Prt		Yes
Nigeria		x				Prt	Pub	Pub	No	Yes
Rwanda	x					Mgmt	Mgmt	Mgmt		
Senegal		x				Pub	Pub	Pub	Yes	Yes
Sierra Leone	x					Pub	Pub	Pub		No
Somalia	x					Pub	Pub	Pub		
South Africa		x				Prt	Pub	Pub		Yes
Sudan	x					Pub	Pub	Pub		No
Swaziland	x					Pub	Pub	Pub		No
Tanzania		x				Prt	Mgmt	Mgmt	Yes	Yes
Togo	x					Priv	Priv	Priv		
Uganda			x			Priv	Pub	Priv	Yes	Yes
Zambia	x					Pub	Prt	Prt	No	Yes
Zimbabwe		x				Prt	Pub	Pub	No	No

Key
Market Structure x – Denotes Structure Type
Private Ownership/Involve Pub – Public Ownership
Prt – Partial Private Ownership
Priv -Predominantly Private Ownership
Mgmt – Private Management/Public Ownership Legal/Regulatory
Yes – Denotes Legislation/Regulatior
No – Denotes No Legislation/Regulator
Sources: ABS (2006), Estache & Goicoecia (2005), Bacon & others (1999), news articles and interviews

Acronyms

AfDB	African Development Bank
ADB	Asian Development Bank
BLT	Build-Lease-Transfer
BOO	Build-Operate-Own
BOT	Build-Operate-Transfer
BPDB	Bangladesh Power Development Board
CDM	Clean Development Mechanism
CEB	Ceylon Electricity Board
CER	Certified Emissions Reductions
COA	Comprehensive Options Assessment
CPI	Consumer Price Index
DC	Direct current
DDP	The Dams and Development Project
DBO	Design-Build-Operate
DESA	Dhaka Electricity Supply Authority
DSM	Demand-Side Management
ECA	Export Credit Agency
ECOWAS	Economic Community for West African States
EIA	Environmental Impact Assessment
ER	Emissions Reduction
ERU	Emissions Reduction Units
ESCO	Energy Service Company
ESMAP	Energy Sector Management Assistance Programme
EUA	EU Emissions Allowance (under the EU ETS)
EU ETS	European Union Emissions Trading Scheme
FDI	Foreign Direct Investments

GDP	Gross Domestic Product
GNI	Gross National Income
GWh	Gigawatt-hour (one million kilowatt-hours)
IA	Implementation Agreement
IBRD	International Bank for Reconstruction and Development (the World Bank)
ICSID	International Center for Settlement of Investment Disputes
IDA	International Development Association
IDB	Inter-American Development Bank
IEA	International Energy Agency
IFC	International Finance Corporation
IMF	International Monetary Fund
IPP	Independent Power Producer
ITC	Intermediate Technology Consultants
JI	Joint Implementation (under the Kyoto Protocol)
JV	Joint Venture
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MW	Megawatt (one million watts)
NEPAD	New Partnership for African Development
O&M	Operation and Maintenance
PCF	Prototype Carbon Fund
PPA	Power Purchase Agreement
PPI	Private Participation in Infrastructure
PPIAF	Public-Private Advisory Facility
ROT	Repair-Operate-Transfer
Sida	Swedish International Development Cooperation Agency
SME	Small and Medium sized Enterprises
SOE	State-owned Enterprise

SSA	Sub-Saharan Africa
tCO_2e	Metric tons of carbon dioxide equivalent
TI	Transparency International
TIDE	Technology Informatics Design Endeavour
WCD	The World Commission of Dams
WEHAB	Water, Energy, Health, Agriculture and Biodiversity

Explanation of selected energy terms

ANNEX I COUNTRY. An Annex I Country is an industrialised, high income country, or an economy in transition, which has agreed to reduce its emissions of greenhouse gases (particularly carbon dioxide) to target levels below their 1990 emission levels. These countries are listed in Annex I of the United Nations Framework Convention on Climate Change. The Annex I countries are: Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Monaco, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom and United States.

BIODIESEL refers to a diesel-equivalent, processed fuel derived from biological sources (such as vegetable oils), which can be used in unmodified diesel engine vehicles.

BIOFUEL is sometimes used to denote any organic material of plant or animal origin used as fuel (see "biomass fuel" below). The narrower definition used in this book is a liquid or gas fuel derived from biomass and used as a fuel in transportation. The two most common types of biofuel are biodiesel and ethanol. By their very nature, biofuels are renewable energy sources. However, they can also produce environmental benefits. Like fossil fuels they generate carbon dioxide when they burn but since plants absorb carbon dioxide when they grow, net contribution to global warming of burning biofuels is smaller than that produced by burning fossil fuels. The amount of reduction in the emission of greenhouse gases depends on how the plants have been grown and harvested and the amount of energy used in their production.

BIOGAS is a combustible gas formed by natural processes of anaerobic digestion in which micro-organisms convert organic material into a gas which has composition and combustion characteristics similar to natural gas.

BIOMASS FUELS include any organic material of plant or animal origin used as a fuel. They comprise solid fuels (wood, charcoal, wood waste and agricultural residue and dung), gas (biogas, landfill gas and other gases

from biomass), liquid fuels (alcohols, bio-additives and other liquid fuels) and industrial and municipal waste.

CLEAN DEVELOPMENT MECHANISM (CDM). The Clean Development Mechanism (CDM) is an arrangement under the Kyoto Protocol allowing industrialised countries with a greenhouse gas reduction commitment (Annex I countries, see above) to invest in projects that reduce emissions in developing countries as an alternative to more expensive emissions reductions in their own countries.

DISCO is an abbreviation of "distribution company". A disco operates the distribution system within a certain geographical region.

DISTRIBUTION SYSTEM is the medium voltage (about 2 kV to 50 kV) network and the final low voltage lines that connect the consumers to the transmission network (and ultimately to the electricity generating plants).

DISTRICT HEATING is a system for central generation and distribution of heat to residential and commercial areas. In the simplest systems, a boiler fuelled by gas, oil, coal or biomass produces hot water (or steam) that is distributed through insulated pipes to customers. A more efficient approach is usually to combine the generation of heat with the generation of electricity (usually referred to as "cogeneration").

DOWNSTREAM activities in the petroleum sector include transportation, distribution, marketing and refining of petroleum products. In simple terms, downstream activities concern gas and oil once they have come out of the ground and left the field where they were produced.

EMISSIONS TRADING is aimed at reducing pollutants (typically greenhouse gas emissions) at the lowest economic cost. The common form is that a government entity establishes a limit on how much of a certain pollutant that a certain company (or other entity) may emit. This company receives an allowance or "credit" that represents the right to emit this amount. A company that reduces its pollution below the limit is then able to sell the corresponding credits to companies that exceed their limits. In this manner, a company that reduces pollution is rewarded through the sale of emission credits while companies that fail to achieve their targets have to buy credits and, thus, are penalised for polluting.

ENERGY SERVICES are the desired and useful products, processes or services that result from the use of energy; for example illumination, comfortable indoor climate, refrigerated storage, transportation, appropriate heat for cooking.

ETHANOL, also known as ethyl alcohol, is the key ingredient in alcoholic beverages. In order to produce ethanol from starchy materials such as cereal grains, the starch must first be broken down into sugars. For fuel ethanol, this hydrolysis of starch into glucose is accomplished more rapidly by treatment with dilute sulfuric acid, fungal amylase enzymes or some combination of the two.

EXHAUST CLEANING TECHNOLOGIES are aimed at reducing the emission of air pollutants from power plants, factories and vehicles.

GENCO is an abbreviation of "generation company". A genco operates one or several power generation plants.

GREENFIELD PROJECT. A greenfield project is a newly constructed facility.

HYDROCARBONS are organic compounds consisting entirely of hydrogen and carbon. Depending on the size of the molecule, hydrocarbons may be gases (e.g. methane and propane), liquids (e.g. hexane and benzene), waxes or low melting solids (e.g. paraffin wax and naphthalene) or polymers (e.g. polyethylene, polypropylene and polystyrene).

JOINT IMPLEMENTATION is a programme under the Kyoto Protocol that allows industrialised countries (Annex I countries, see above) to meet part of their required cuts in greenhouse gas emissions by paying for projects that reduce emissions in other Annex I countries. In practice, this will likely mean facilities built in the countries of Eastern Europe and the former Soviet Union – the "transition economies" – paid for by Western European and North American countries. The sponsoring governments will receive credits that may then be applied to their emission targets; the recipient nations will gain foreign investment and advanced technology (but not credits to apply to their own emission caps; this they must achieve themselves).

KEROSENE is a mixture of various liquid hydrocarbons. Because the length of the molecules is longer than those found in gasoline, kerosene is less flammable and easier/safer to handle. Kerosene is commonly used as a

fuel for lamps and simple stoves in developing countries (and for campers in developed countries).

KILOGRAMS OF OIL EQUIVALENT (KGOE) is the unit used as a common metric to quantify energy supplied using a variety of sources and carriers by converting them into oil equivalent units.

LIQUEFIED NATURAL GAS (LNG) is natural gas that has been cooled to a temperature of approximately −160°C (−260°F) to condense it into a liquid. LNG takes up about 1/600th the volume of natural gas at a stove burner tip. LNG is only about 45% the density of water. Natural gas is liquefied for transport by specially-designed LNG tankers when the construction of a pipeline is infeasible or uneconomical. The liquefaction process also removes oxygen, carbon dioxide, sulfur compounds and water that may be found in natural gas. Storage tanks and a regasification plant are required at port of destination.

LIQUEFIED PETROLEUM GAS (LPG) is a mixture of propane and butane, gases that can be easily liquefied under pressure for ease of storage and transport in specialised canisters (commonly referred to as "bottles.")

NATURAL GAS is a gaseous fossil fuel consisting primarily of methane (CH_4) but including significant quantities of ethane (C_2H_6), propane (C_3H_8), butane (C_4H_{10}). Natural gas frequently includes "impurities" in the form of carbon dioxide, nitrogen, helium and hydrogen sulfide.

PETROLEUM is a generic term for naturally occurring hydrocarbons, including natural gas and crude oils, as well as derivatives such as kerosene or gasoline. (It should be noted that petroleum sometimes is taken to mean liquid hydrocarbons only.)

PHOTOVOLTAIC (PV) CELL (also called solar cell) is a semiconductor device that converts the energy of sunlight into electric energy.

PROJECT-BASED TRANSACTIONS of emission credits occur when a buyer purchases emission credits from a project that reduces greenhouse gas emissions compared with what would have happened otherwise. The Clean Development Mechanism and Joint Implementation (see above) are the two dominant types of project-based transactions.

PROTOTYPE CARBON FUND. The Prototype Carbon Fund was created – with the sponsorship of the World Bank – in order to pilot production of Emissions Reductions within the framework of Joint Implementation (JI) and the Clean Development Mechanism (CDM). The PCF invests contributions made by companies and governments in projects designed to produce Emissions Reductions fully consistent with the Kyoto Protocol and the emerging framework of JI and the CDM. Contributors, or "Participants" in the PCF, will receive a pro rata share of the emissions reductions, verified and certified in accordance with agreements reached with each country "hosting" the projects.

SPOT MARKET. A spot market is a market where commodities such as grain, oil or electricity are sold for immediate delivery (or delivery in less than one month). Payment is due as soon as the order is placed. A futures market, on the other hand, involves trades for delivery at a future date with payment due only when delivery takes place (i.e. in six months, three years time etc.).

TRANSCO is an abbreviation of "transmission company". A transco operates all or a part of the transmission network (see below) in a country.

TRANSMISSION LINES carry large volumes of electric power from generating plants to the distribution system. There is no universal definition of where the border between the transmission system and the distribution system is located. However, transmission systems typically operate at high voltage levels (higher than about 50 kV).

UNBUNDLING involves "breaking-up" a vertically integrated utility into separate corporate units handling generation, distribution and transmission. Typically, several generation companies would be created to allow competition. Although distribution (within a certain geographical area) is essentially a natural monopoly, several discos are generally created, each with responsibility for distribution within a region. This facilitates regulation through the use of "yardstick competition" (see below). All transmission lines are typically kept in a single company that also is responsible for balancing supply and demand in the entire power system.

UPSTREAM activities in the petroleum sector are all those activities necessary to discover, develop and exploit oil and natural gas fields. In simple terms, upstream activities take place before the gas and oil has come out of the ground.

YARDSTICK COMPETITION is an instrument for regulation of regional monopolies, for example discos. The regulator collects performance data (price, reliability etc.) for all companies and uses the best performer as a "yardstick" to guide decisions concerning the tariffs and performance targets of the other companies.

Notes on the author

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