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Appropriate Restructuring Strategies for the Power Generation Sector

The Case of Small Systems

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Preface

The focal point of this paper is the possibility that the net gains from restructuring a power sector in a small system may in some circumstances be small or even nonexistent. With too small a system, no true competition can be introduced by splitting generation into several firms, and separation of generation from transmission (which is usually recommended to facilitate intergenerator competition) could well result in an increase in the total costs of running the system. The advantages of removing government involvement may indeed be as important to small systems as to large systems, but the need to undertake extensive restructuring may be much less evident than in large systems. Hence, it is important that restructuring is not approached as if there were a single dominant and successful pattern to be followed. Instead, it is necessary to evaluate the options for a specific economy and the likely costs and benefits of various approaches to restructuring and reform.

The issues of reform and restructuring in the power sector are viewed in a general context in the first part of the paper. The second part of the paper then looks at the specific issues of vertical separation (generation from transmission) and horizontal separation (into several generating firms) with emphasis on the particular problems for small power systems.

The final chapter of the paper provides a list of costs and benefits of restructuring that forms the basis of a checklist for use in assessing restructuring proposals in any given country.

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Abbreviations and Acronyms

COBEE	Compañía Boliviana de Energía Eléctrica
ELEX	Electricity Exchange
ENDE	Empresa Nacional de Electricidad (Bolivia)
ESI	*Electricity Supply Industry*
JPSCo	Jamaica Public Service Corporation
kWh	kilowatt-hour
MW	megawatt
MWh	megawatt-hour
PPA	power purchase agreement
SRMC	short-run marginal cost
T&D	transmission and distribution

1

Reform and Restructuring

1.1 At present, worldwide interest is focused on the gains to be made for an economy by reforming its power sector. Under consideration are reforms ranging from ones that leave structure and ownership of the industry unaltered but corporatize and commercialize the public utility to ones that restructure the industry and privatize some or all of it.

1.2 Few reform programs have yet been fully implemented, so attention has been focused on one or two that have been carried through. The high profile given to the United Kingdom's privatization program has meant that it has served as a reference case for virtually every consultant study on potential reform in countries around the world. Chile and Argentina, which have also largely completed reform programs, have attracted much less attention outside of Latin America.

1.3 The focus in the United Kingdom has been coupled with reform paradigm in which the power sector is "unbundled." The idealized case being put forward is one in which generation is to be separated from transmission; transmission is to be separated from distribution; and all the new entities thus created are to be corporatized and commercialized. The generation sector is to be split into several firms if at all possible, and these generators are then to be privatized, or at least new generators are to be permitted to be privately owned by independent power producers (IPPs). The distribution sector is also to be split into separate entities, geographically based, which may be destined for private sector ownership. The transmission sector is usually to be retained under some form of public or collective ownership.

1.4 This program of reform envisages gains to the economy coming from three distinct actions: (a) the removal the of the government's use of tariff setting, employment strategies, and other aspects of routine management as instruments to achieve noneconomic ends; (b) the introduction of private capital and the associated profit motive; and (c) the introduction of competition where possible.

1.5 The reform of the U.K. system appeared to introduce all three stages of this reform process (in the England and Wales system), and the largely completed reform programs in Argentina and Chile have also involved substantial elements of this

approach. Accordingly, it is not surprising that this model has been taken as a reference for ongoing and future reforms in other countries.

1.6 It should be noted, however, that although reforms have been implemented in these countries, their final success has not yet been definitively evaluated. In the United Kingdom, for example, it has been necessary to make several alterations to the initial reform package, and further changes are still being sought by critics of the system.

1.7 Moreover, in small or very poor economies, where the existing power system is small scale, it is becoming apparent that the balances of advantages and disadvantages of a particular pattern of reform and restructuring may be quite different from those in a larger system. Thus, although all reforms may have a country-specific element to them, an important size-specific element needs to be taken into account in designing a reform program.

2

Small Power Systems and Reform

2.1 A large number of countries have small-scale power systems. Although, as will be shown below, no firm line determines whether a system is "small" or not, for the purposes of restructuring it is important to have a reference point on the size distribution of systems throughout the world. Annex Tables 2 and 3 present data on all countries whose total installed capacity was less than 1,000 megawatts (MW) in 1990, that being the last year for which extensive data are available. Not surprisingly, the size distribution of installed capacity is extremely unequal. The data indicate that 60 countries (including many island groups) had capacities below 150 MW; another 30 countries had a total net public capacity of between 150 and 500 MW, and 17 countries had between 500 and 1,000 MW. Even countries with systems of considerably more than 1,000 MW may find that in their particular circumstances the gains from restructuring are rather small.

2.2 It should be noted that the nature of the countries is such that some power sectors cannot be restructured to introduce competition at all. Island groups, for example, may have one generation plant per island; other countries may be completely unsuitable for either restructuring and or privatization for other reasons. However, many of the remaining countries, especially in the 500 to 1,000 MW group, are already being considered as candidates for reform.

2.3 An extreme example of the restructuring proposals following the paradigm is one suggestion that has been made for the Madagascar power system. This sector (presently owned and run by a single state enterprise) has an total installed capacity of just over 200 MW. It comprises 63 separate (isolated) integrated systems, of which 7 account for 94 percent of generation. A proposed electricity law envisages separation of ownership of generation from transmission, and that of transmission from distribution in every system, unless an exception is made by the ministry. Such a restructuring plan would fragment the industry into a series of very small individual units and would risk losing economies of scale and increasing the overhead costs associated with establishing separate companies. At the other end of the scale, Malaysia decided to keep its 6,000 MW system, serving the peninsula, as a single vertically integrated company for the purposes of privatization.

2.4 The most striking features of experience with power sector reform are that very few countries have yet actually fully implemented a reform program, although several are advanced in their planning, and that those countries that have actually carried out substantial reforms are quite large-scale producers, as Table 2.1 makes clear.

Table 2.1 Power System Reform and System Size (in MW)

Country	*Date of reform*	*System size (1992)*
Chile	1978–1990	5,500
Argentina	1989–1993	17,000
Norway	1991	27,000
England and Wales	1990	66,000
Scotland	1990	12,000
Northern Ireland	1992	2,400
New Zealand	1987 – present	7,000
Portugal	1994	13,500
Malaysia	1992	6,000

It can be seen from Table 2.1 that no small-scale producers have yet completed a reform program and that the most prominent case (England and Wales) is operated on a scale completely different from that in many countries for which it is being referred to as a model.

2.5 Countries that are advanced on their way to power sector reform include Jamaica (500 MW), Costa Rica (900 MW), Peru (4,000 MW), Bolivia (500 MW) and Colombia (10,000 MW). Some small countries in West Africa have adopted the distinctive French approach through a system of management contracts (Côte d'Ivoire and Guinea Bissau). Detailed descriptions of the major reforms in all the Latin American and Caribbean countries, together with material on the United States, United Kingdom, and Norway, are given by Covarrubias and Maia (1994).

2.6 The enormous differences in system size and complexity can give very different weights to the costs and benefits of the various aspects of reform. This paper looks at the sources of economic gains and costs of the various steps in reforming a power system and attempts to highlight those that are likely to be size-specific.

3

Costs and Benefits of Removing Direct State Involvement

3.1 The direct involvement of the state in the running of the power sector is usually exercised through the power of the relevant ministry to set prices; to determine the expansion program; to affect employment in the sector (e.g., by opposing redundancies or even by using the sector as a source of employment for surplus labor); and to finance the deficit of a loss-making utility.

3.2 The use of subsidies to hold prices below costs for power consumers not only distorts the economy in general but also tends to lead to suboptimal performance by the power sector, since the incentives to be technically efficient (produce a given output at lowest cost) are greatly weakened when managers know that losses will be paid out of the central government budget. Symptomatic of these inefficiencies are high power losses (often reflecting theft or unbilled consumers), poor debt collection, high staff-to-output measures, and poor system reliability in the presence of apparently adequate nameplate capacity.

3.3 Removal of direct state involvement in a public utility usually involves two distinct processes. The first is the corporatization and commercialization of the utility, while maintaining it in public ownership. The second is the privatization of all or part of the sector. The first can take place without the second, or the two can be undertaken in sequence or simultaneously.

Corporatization and Commercialization

3.4 The aim of corporatization and commercialization is to set the managers' targets to be met and to give them the freedom of action to meet these targets—in particular, the freedom to set prices on an economic cost-related basis. Such independence for managers would also imply that they had the freedom to cut employment where there was overstaffing; to set wages to provide incentives for good performance (rather than being bound by government policy on wage setting in the state sector, which is often designed to be simply anti-inflationary); and to determine a least-cost expansion plan financially viable at the prices determined by the corporation. This

model of reform relies heavily on the government binding itself not to interfere on a day-to-day basis with the management of the sector. Even though changes can be made to electricity laws that remove the requirement that the minister approves all decisions, the power to appoint management to the state corporation nevertheless gives the government very considerable influence if it wishes to use it. The reform in New Zealand began with a move to corporatization and commercialization, but, even in that country, which has a lengthy democratic tradition and a well-established and independent civil service, critics have pointed out how difficult it has proved for the government to keep to an arm's-length relation with the power sector. Indeed, New Zealanders are now discussing the need to move all the way to a privatized system to obtain the full benefits of independent management in the sector (see Spicer and others 1991). Malaysia corporatized and commercialized its vertically integrated industry prior to the beginning of privatization in 1992.

3.5 The step of commercializing and corporatizing is certainly less radical than privatization and is an important option where it would be difficult to privatize. One particular difficulty in privatization is finding the sources of private capital, and here small economies may have difficulty when their capital market is not well developed. In this case, the possibility of using local finance is very limited, and international finance is not attracted to such small and relatively unknown markets. Because of political risk and exchange risk, international finance tends to be more readily available for markets that have already proved themselves in the domestic sphere. Small countries, rather like small firms, may find that there is a "financing gap" that can be overcome only at very high cost (e.g., by the government's giving of such extensive guarantees to foreign investors that the latter carry little risk while making a return that reflects greater exposure to risks). This would reduce the attractiveness of privatization to the country.

3.6 The use of management contracts is very closely related to the option of commercialization and corporatization. In this case, the government issues a contract, usually incorporating a substantial performance-related element, for the management of the entire sector. This contract can be subject to international competitive bidding so that the "winner" has an incentive to run the sector efficiently in order to make a profit at the contract price bid. The problem with this arrangement is again the willingness of the government (which still owns the sector) to allow the crucial steps to be taken that will improve performance when these would be politically unpopular, at least with certain segments of the population. Unless the government has made a commitment to allow prices to be raised toward costs and to allow labor shedding to take place where necessary, the improvements made by a management team may be limited to better technical practices (such as maintenance) and better financial practices (such as a tighter control on the collection of bills). These will certainly be useful gains, but in some situations they will not address the principal inefficiencies of the power sector. Management contracts are typically subject to the law, and failure of either party to comply with the terms of the contract can bring redress. A more indirect relation is the "plan du contrat," as used in France, which involves an agreement or understanding

between the state and the utility as to the goals to be achieved but does not provide for explicit penalties for failing to do so.

3.7 A solution that has been proposed in certain cases is one in which the existing industry remains as a vertically integrated public corporation but is run in such a way as to encourage the entry of private capital into new generation projects. The introduction of independent power producers (IPPs) can bring the benefits of competition through lower capital and operating costs for the incremental power and energy. For this to occur, competitive bidding for the market is important to ensure that the new capacity and energy supplied are at the lowest possible cost. Where IPPs enter as a result of a one-on-one negotiation between the state utility (or the government) and a single private producer, a distinct risk arises that the prices paid for power and energy will be higher than would have been attainable through open competition. Although IPPs are an important step in introducing the private sector and competition into the power sector, they do not bring competition within the market (i.e., competition between generators to supply electricity) unless some form of continuous bidding is conducted to supply the market (as in the England and Wales system). Since "open pools" of this type are expensive to operate and require great sophistication, this is not seen as a viable option for small systems wishing to take the first steps toward reform.

Privatization

3.8 Comparing a completely vertically integrated monopoly in public ownership to one in private ownership exposes the gains and losses due purely to privatization. This is an important step and one whose impacts are often confused with those of restructuring and of introducing competition. The impact of private sector ownership also depends on the extent to which a regulatory regime is imposed. The key to any changes is the introduction of the profit motive in the private monopoly situation. The costs and benefits of the change of ownership status come under five major headings:

a. Allocative efficiency gains and losses created by the change in prices charged

b. Distributive gains and losses to various sectors of society as a result of the change in prices

c. Productive efficiency gains and losses as the profit motive is introduced and the control of the state is removed

d. The impacts on public finance

e. The impacts of privatization on the capital market and other externalities.

Allocative Efficiency and Prices Charged

3.9 The amount of the allocative loss or gain from moving from a public monopoly price to a private monopoly price depends crucially on the extent to which the state was holding prices below costs in order to subsidize electricity consumers. An

unregulated private monopoly will charge at a price above marginal cost, whereas a regulated private monopoly will generally price nearer to marginal cost. Thus, where there is no subsidy, as in cases where the public sector monopoly prices at long-run marginal cost, there would be a "deadweight" allocative loss of consumer surplus from the price rise, coupled with redistribution from electricity consumers to the private monopolist, brought about by an unregulated price charged by a private sector monopoly. The size of both depends on the price elasticity of demand for electricity—the larger the price elasticity, the smaller these effects. The unambiguous nature of this allocative loss (plus the generally undesirable distribution effect) constitutes one of the main arguments against permitting an unregulated private monopoly to exist.

3.10 Where, as is often the case, the public sector was pricing below long-run marginal cost then, in addition to the two effects above, the comparison between public and private ownership adds two further effects. When prices are raised from the subsidized level to the cost-recovery level, there is a deadweight gain (the revenue loss that was occurring with the subsidy was greater than the gain in consumer surplus due to the lower prices) as well as a redistribution effect from the electricity consumers to the general taxpayers, who would have been financing the subsidy. That is, *pricing below marginal cost is allocatively suboptimal in the same way as is monopoly pricing above costs.* If the extent of the subsidy to the public monopoly had lowered prices below costs by a larger amount than an unregulated private monopoly would increase price above costs, then the decision to change from public to unregulated private ownership would result in an increase in allocative efficiency. These gains and losses can be calculated if the shape of the demand curve and the cost curve of the public sector monopoly are known. The allocative gains from the removal of subsidies can also be achieved by a commercialized state corporation, with a hard budget constraint, providing that the state really remains independent of the pricing process.

3.11 In calculating the allocative gains from pricing at marginal costs it is implicit that resources released from one sector will be reemployed elsewhere—the shift in resources being from a lower-value to a higher-value sector. Where resources become unemployed, this simple calculation cannot be utilized, and a longer-term perspective is needed.

Distributive Gains and Losses

3.12 The price changes following a move from unsubsidized public sector ownership to unregulated private sector ownership of the monopoly would have the effect of transferring resources from electricity consumers to the monopolist, which can be a sensitive issue if the company has some foreign ownership and profits are remitted abroad. If electricity had been subsidized before privatization, there would then also be the removal of the subsidy to consumers (matched by a reduction in general taxation used to finance the subsidy). Since studies on electricity demand in lower-income countries suggest that often most of the subsidies go not to the poorest households but instead to the heavier users of electricity, who are better-off households, it may well be that the

government could achieve its distributive goals by some other means and in a more effective fashion. However, the move to private sector ownership may find this factor one of the most difficult to overcome because of the interests and political strength of those receiving the major part of the subsidies.

Productive Efficiency and Ownership

3.13 The effects on productive efficiency of replacing a public monopoly by a private monopoly are controversial. It is widely observed that state monopolies have little incentive to cut costs because their explicit goal is not profit maximization and because managers lack incentives and do not have decisionmaking authority commensurate with their responsibilities. A major source of public sector inefficiency in certain countries has been the use of public sector industries for creating secure jobs, irrespective of the requirements of the industry. This creates a subsidy from taxpayers to this class of worker and presents serious difficulties for its removal at the time of privatization. Another example of this effect is the low incentive to collect revenues or prevent theft of power, thus leading to a further financial loss. These effects compound losses caused by subsidized prices.

3.14 Table 3.1 illustrates the variations that can be observed between public and private sector ownership (although the latter are not monopolies) with respect to selected performance indicators.

Table 3.1 Performance Indicators for Selected Countries (1991)

Country	*T&D losses as % of net generation*	*Sales per employee (MWh)*
Public sector ownership		
India	23.5	204
Indonesia	16.9	523
Pakistan	22.2	219
Philippines	15.6	481
Thailand	10.0	492
Turkey	12.3	762
Private sector or commercialized		
United States	7.1	4,057
United Kingdom	8.4	1,965
Argentina	11.7	1,514
Chile	10.8	4,971
New Zealand	5.3	2,210
Norway	5.7	5,520

Note: T&D = transmission and distribution.

Source: Gutiérrez (1993).

In general, public sector ownership is strongly associated with low labor productivity and poor technical performance, whereas the recently reformed and privatized industries show much better performance. In addition, the willingness of the government to run a state-owned enterprise on commercial lines, as in New Zealand and in the restructured New South Wales system (the ELEX pool) in Australia, can produce an improvement in efficiency.

3.15 However, it has been argued that private monopoly also may not be concerned with cost cutting, being more concerned with a "quiet life" than with profits. The lack of competition is what allows this situation to persist. In effect, this suggests that profit maximization is a passive goal of companies, only undertaken under pressure from other companies (who presumably are concerned with profits). It is important to recognize that these arguments are often conflated with the previous case: the obvious cost inefficiency of some public sector power firms has been used to suggest that monopoly in general will be inefficient. The evidence for this in the power sector is limited, since the private sector power monopolies, of which there are many in the United States, as well as examples in Barbados and Bermuda, are not obviously inefficient.

3.16 In one of the few detailed studies of the effects of privatization, Burns and Weyman-Jones (1994) concluded that for the case of the nearly monopolistic distribution companies in the England and Wales, no increase occurred in the rate of productivity in the period after privatization relative to that before privatization. Evidence from partial productivity measures suggests that output per individual rose much more sharply in the generators, although it is unclear (given the regulator's 1994 decision to cap pool prices) whether these benefits were passed on to consumers in terms of lower prices, as would happen in a truly competitive market. In Chile, Galal (1994) found a similar picture, with the larger gains in productivity coming in the generating company studied, and rather small gains in the distribution company.

3.17 Various solutions have been suggested to put more pressure on the private monopolist to be cost efficient. One approach, particularly important in the power sector, is to have "competition for the market" (i.e., to have a competitive bidding process to acquire the assets of the formerly public monopoly, or for the right to use the assets [franchise or *affermage*]). If a highly competitive auction is held, then the price will be bid up, so that to make a normal profit the successful firm will have to put into effect all the transparent cost efficient strategies available. If all bidders can see possibilities of cutting costs, they will allow for this in their valuation and in their bid. Once a bid has been accepted, the company will be forced to make these cost reductions in order to recover the price paid to acquire the firm or the contract price bid to run the firm. The same argument applies if competitors bid a price at which they would be willing to supply the market—in this case the supply price will be bid down, taking into account transparent inefficiencies that could be corrected.

3.18 The scope for cost cutting in a public power sector may be gauged in part by the use of various performance indicators taken from other countries, but this is a particularly difficult exercise for small systems, which may be unable to capture the

economies of scale that automatically accrue in larger systems. That is, cross-country comparisons between large and small countries may not be very reliable as a guide to potential efficiency. It would probably be necessary to undertake a study of similar countries both in size and other respects (e.g., customer density, fuel use) before taking a view on the degree of inefficiency present in any particular system. One such study has been undertaken for the Australian electricity supply industry (1993) covering each of the nine state supply industries, which range from 350 to 11,000 MW installed capacity.

Impact on Public Finance

3.19 One important gain from the public finance aspect is the removal of subsidies implicit in the move to privatization. The actual sale of the company is also expected to raise revenue for the state. The former is in effect a long-run gain if the subsidies would have been continued year by year, but the second is a one-time financial gain whose impact can be expressed as an annual equivalent. The amount raised depends both on the attractiveness of the company as sold and on the effort taken to ensure that the bidding process is competitive. One point of tension in the privatization decision is that the larger the prospect of monopoly profit the more attractive the power company would be to private buyers. Strictly regulated firms (whose profits will be contained as prices are forced down to costs) or highly competitive industries are obviously going to raise less revenue for the government. A conflict of interest again arises between the government as a privatizer and the government as a regulator, which is in effect a conflict between the electricity consumer and the general taxpayer.

Effects on the Capital Market

3.20 An important argument for privatization is that where it transpires through a stock market flotation it helps to increase the total capitalization of the market and to improve the general efficiency of financial markets. The size of the power sector relative to the market as a whole makes this an important consideration. There are limits to the amount of equity that can be safely issued without disrupting the operation of the stock exchange; for example, the initial public offering of 23 percent of the shares in the Malaysian integrated power company resulted in these shares accounting for 62 percent of total Kuala Lumpur stock market trading on the first day on which they could be traded. The use of local bond finance can help to create or strengthen the market for such instruments. Other forms of sale also can bring in foreign capital and valuable foreign expertise at the same time. Where foreign companies take a share of the local power company, perhaps in joint ownership with the local government, this can provide both the knowledge and the incentive to improve performance.

3.21 New investment, as opposed to the purchase of existing plant, is likely to limit the possibilities for the development of the local capital market unless there is freely traded currency (which is unusual in small and less developed countries), since the investment itself will typically have a very high foreign cost component.

3.22 One crucial lesson emerging from international experience is to "restructure first, privatize later," since, once privatization has taken place on a possibly restructured system, it is very difficult to engage in further restructuring, however desirable this may later appear. Shareholders will oppose any fundamental changes to the terms on which they purchased the assets; this would apply equally to joint ventures. In summary, where it is uncertain whether the structure is correct, it may be better to experiment with the restructuring before privatization. The U.K. experience is particularly important with regard to the number of generators created in the privatization exercise. In the privatized England and Wales system two private generators are in effect dominant (the IPPs are small although growing in importance), and they have exhibited apparently collusive behavior. The regulator, after a review in 1994, rather than force a further restructuring through the use of anti-monopoly legislation has placed a price cap on power sold through the pool by generators. The two dominant generators were also required to divest themselves of a limited amount of capacity, but, since the choice of which capacity to divest was left to the companies, this was unlikely to increase the competitive pressure on the dominant companies by a significant amount. This move, although popular with shareholders who did not want to see the value of their shares reduced by forced division of the companies into smaller units, illustrates that competition is not functioning to its full potential, which cannot now be attained using the original policy instrument. In the England and Wales case, the regulatory tension between allowing traders in the noncompetitive segment to keep rents from productivity gains, rather than passing them on to consumers, is becoming a major issue in the postreform industry.

Domestic versus Foreign Interest

3.23 The country with the longest experience of post-privatization is Chile, and here the study by Galal (1994) of a generating company and of a distribution company gives an analysis of who benefited and who lost as a result of divestiture. The gains for the generating company accrued in large part (nearly 70 percent) to foreign shareholders, whereas for the distribution company the gains accrued largely to domestic welfare (88 percent).

3.24 In summary, most of the costs and benefits associated with the change in the role of the state are not size specific but rather relate to the traditions of the country both with respect to the desirability of political independence of state enterprises and of the strength of the profit motive in the private sector. These are not issues that need special attention in the small countries; rather, they need to be considered wherever reform is being undertaken.

4

Costs and Benefits of Restructuring

4.1 As noted above, the dominant model for power sector restructuring has largely focused on the benefits of having a separate generation sector, since this is the part of the industry that offers the best possibilities for competition. Transmission is seen as a natural monopoly that can either stay under state ownership or operate as a regulated private sector monopoly, whereas distribution is seen to be largely a series of local monopolies with limited possibilities for retail competition through sales to large users. The gains in efficiency are expected to come both from the involvement of private ownership and from competition where intergenerator competition is possible.

4.2 The need to separate transmission from generation is strongly linked to the desire to obtain competition between generators. Were an existing generator to remain linked to transmission, the combined company could act to place other generators, who are required to use the transmission network, at a disadvantage. The simplest way to provide a "level playing field" is to make all generators separate from transmission. This argument is particularly important where a system is relying on the entry of IPPs to provide the competition to existing generators, and where the IPPs are allowed to sell directly to distribution companies or to consumers. If the IPPs supply bulk power to the incumbent utility under long-term sales agreements—which do not place competitive pressure on other generators—then separation of transmission from generation is less necessary because there is no competitive market in generation to be encouraged.

4.3 However, the gains from competition between generators can be small or will occur after many years so that the need to achieve vertical separation from transmission is much reduced. Since vertical separation as well as horizontal separation have both costs and benefits, it is crucial to look at the specific situation of the country at the time of the proposed reform. The potential costs of separation can be particularly high in relation to benefits in small power systems, so these are areas that need detailed analysis.

Costs and Benefits of Vertical Separation

4.4 The first benefit of vertical separation, as highlighted above, is that it facilitates competition between generators when all other conditions are appropriate. When there is the potential for several generators to exist, either through horizontal separation of existing plants or through the entry of IPPs, then the maintenance of the link between transmission and one or a subset of generators will give this group such an advantage that it could discourage the entry that would otherwise have taken place. This, in turn, would permit the existing firms to operate below the optimal level of efficiency because they were not threatened by entry. Hence, the extent of the benefits of vertical separation are strongly linked to the possibilities of effective competition in generation. However, other costs and benefits must be taken into account, particularly when the scope for competition in generation is small, since this removes one of the major benefits of vertical separation.

4.5 If distribution, transmission, and generation are each separated as private monopolies, this creates opposing forces on the attractiveness of this structure to private capital. Vertical separation can increase the effect of monopoly power and can lead to the loss of economies of coordination.

4.6 Where each stage is monopolistic, and the technology is relatively fixed, the classic result is that an unregulated chain of vertical monopolies will tend to sell at a higher price than an unregulated integrated monopoly (the "double wedge" problem as explained in Waterson [1984]), thus increasing the loss of consumer welfare. Regulation becomes more important in a such a case. Again, the tighter the regulation, the lower will be the bids for the firms. Provided that regulation of an integrated company or of separated companies can be equally effective and performed at equal cost, this aspect of separation should not be important in determining industry structure. If the generation stage is competitive, then only the transmission stage would require regulation. In summary, it appears that the "double wedge" argument is of little importance where some competition exists in the separated generation sector but that it will become more important in small systems where more than one generator may not be viable, or even where two or three are operating, if there is tacit collusion between them. In such cases, the effectiveness of the regulator to monitor and control both generating prices and transmission charges will become more important.

4.7 The fact that many industries, even in competitive markets, show evidence of vertical integration is an indicator that companies can gain from unified ownership. In many countries, the early history of the power sector has been to start with separate generation, transmission, and distribution; this arrangement has then evolved toward an integrated system. The United States is the dominant case of private sector integrated companies, but it should be noted that IPPs have recently entered increasingly into this market, and that is producing an element of competition.

4.8 Probably the most important argument concerning vertical de-integration relates to the decision making process itself and *economies of coordination.* In an

integrated company, coordination takes place by internal commands and should take place under complete information about all parts of the system. Coordination problems arise both in the short run with despatch and in the long run with investment. In a deintegrated structure, the coordinating mechanisms are the prices and contracts agreed between the two parties. Since each firm is trying to gain more of the profit for itself, they each have a strong interest not to divulge information to the other in any bargaining that takes place, and this can lead to inefficient decisions.

4.9 In the power sector, the issue of day-to-day and minute-by-minute coordination is central. Other industries typically store partly assembled components to avoid costs of shortage created by foreseen demand surges (production smoothing) and unforeseen demand and supply shocks. But electricity cannot be stored, so supply at the generation stage must respond to demand shifts. The short-run techniques used in other industries to make demand conform to available supply, such as lengthening order books and deferring fulfillment of demand, are generally regarded as undesirable in power, where load shedding is seen as a serious and costly industry failure.

4.10 Furthermore, the system nature of electricity supply requires an overall controller and that all parts of the industry respond to central directives. The need for despatching requires coordination and agreement of all parties involved. In a deintegrated industry, this is achieved through the contracts agreed between transmission and generation, whereas in an integrated company a unified physical control imposes the coordination. Two related problems arise with the disaggregated system. First, it is difficult to design a contract structure that will operate as efficiently in despatching as would an integrated company; second, the costs of running a separate despatch center are likely to be greater than these costs in an integrated system. Not only will the company incur the costs of drawing up contracts, but it will face the costs of establishing a separate center and of the additional accounting procedures.

4.11 The variety of "pooling" arrangements for independent generators to sell power to the transmission system, or to a power purchaser, that have been devised in the various reformed systems, points to the difficulties of actually establishing this part of the market in an efficient form. The criticisms of such systems revolve around the determination of the true merit order (based on actual costs) at a point in time. The use of long-term contracts is difficult to reconcile with least-cost despatch because of the uncertainty over future fuel prices, plant efficiency, capacity additions, and maintenance requirements. These difficulties are addressed by systems in which energy trading takes place between generators, so that one firm can find it more profitable to buy energy from another generator to meet its own contractual obligations to despatch. Generator trading is used in the United States, Norway, and Chile, but it might prove difficult to adapt to small countries, where the relative costs of implementing such a system might be large.

4.12 Just as a problem may arise in determining which generator is really the lowest cost, because of the inevitable lack of information independent companies have about each other, the companies may lack perfect information about the investment plans

of other parties. If the system is truly to achieve a least-cost expansion plan through the market mechanism, it is important to avoid the possibilities of substantial underinvestment or overinvestment. Underinvestment by generators or by the transmission company can occur because the party that should invest is not aware that the other is increasing its investment to meet demand. For example, in the face of rising power demand, a transmission company may not be in a hurry to invest in extra transmission until it is sure that the generators are going to build new plants. This can lead to a situation in which each party is waiting on the other to move in order to minimize the risk to itself from investing too early. Overinvestment is most likely to occur where several generators are each rushing to take advantage of a shortfall in supply without being fully aware that others are doing exactly the same thing. Since the latter is likely to lower costs to consumers as companies cut margins in order to sell from excess capacity, whereas the former situation of underinvestment places the burden on consumers in the form of power shortages, the most serious coordination problem is seen to be that of ensuring synchronization of investment between the different stages that avoids some form of rationing. Such problems can be reduced in vertically deintegrated structures that use a "central procurement agency," as in Northern Ireland, Mexico, and Portugal, both for despatch and for the determination of investment requirements.

4.13 The solutions to the despatch problem, by different countries that have restructured, are worth noting :

a. *England and Wales.* The generating companies are required to sell all their output into the wholesale spot market (pool), which is administered by the National Grid Company, while all suppliers of electricity (both distribution companies and traders) have access to the pool for wholesale purchases. The pool price is set every half hour and, because of its volatility, a separate market for contracts between generators and suppliers has emerged. The operating company calculates the market-clearing price from bids to supply (declared the day before), determines despatch, collects data on power flows, and operates the financial settlement system. It neither buys nor sells electricity and is financed by a levy on pool members. A number of problems have arisen with the operation of the system, partly because only two large generators presently dominate the market; other sources supply too little power into the pool to be effective in constraining the large suppliers' behavior. In this system, generators bid both a price and the availability to supply at that price so that information on costs of generation is contained in the bid. With a fully competitive version of this system, the bid price would be forced down to marginal costs, and efficient despatch would automatically ensue. The price contains a system marginal energy price component and a capacity payment in order to ensure that incentives to maintain and build capacity to meet peaks in system demand.

b. *Scotland.* The reform of 1991 left two private vertically integrated companies, in which generation, transmission, and distribution each operate as separate profit centers and prepare separate accounts. This arrangement was determined by the

fact that Scotland could not at that time be integrated into the England and Wales grid and that it was judged that little prospect existed for introducing strong competition in generation. No pool exists, and supply businesses are obliged to purchase electricity from the most economical source, including their associated generation business. Allowed purchase costs for generation are regulated by a price cap and by reference to the England and Wales pool price.

c. *Northern Ireland.* The three private generators sell power on a contract basis to a power purchaser that then on-sells to suppliers. These long-term contracts (terminating from dates between 1996 to 2010) are tied to fuel-price indexes for the energy components; an availability component is also involved. Centralized despatch on a merit order is determined by the energy payments specified in the contracts. The contracts are effectively "take or pay," in which a minimum take is guaranteed.

d. *Norway.* The country has a mixture of public and private generation (with a dominant public company, Statkraft), and these companies sell the majority of energy (90 percent) on a firm contract basis (from 5 to 30 years' duration), despatch being determined by contractual obligations. Marginal sales of energy are made through a pool where bids and offers made beforehand are equated by the setting of a constantly varying pool price. The pool is operated by the transmission company.

e. *Argentina.* The private sector generators sell into a spot market, run by an independent pool operator (paid for by a levy on sales), where the hourly cleared price is based on the marginal costs of thermal generators plus a capacity element. The marginal costs are calculated from the thermal efficiencies of the plants, which are registered with the pool company, and from daily fuel prices. Capacity prices are determined by a complicated system that first determines whether the risk of failure in the system is above some threshold. Below the risk threshold, generators bid capacity prices, and the value used in the pool price is the most expensive one required to meet the reserve requirements. Above the threshold, generators are paid a value equal to the failure risk multiplied by the value of lost load (determined at present by law). Wholesale prices are a smoothed seasonal average of the pool prices, such that the pool operator makes no gain or loss over the long run on the sale of electricity.

f. *Chile.* The generators (some 85 percent of which are privately owned) form a club for the operation of the electricity trading pool, which largely focuses on despatch (since prices can be relatively constant because of the large regulating capacity of the reservoirs). Marginal costs for the various plants form the basis of despatch.

The most striking feature of these arrangements is the wide variation in techniques for determining despatch. Since merit-order despatch is essential to obtain efficient operation of the system, it is important to realize that there is no agreed method of

achieving this with the limited amounts of competition that have been so far established in these countries.

4.14 One general reason for the success of vertical integration in industry is the existence of *economies of scope.* Certain activities need to be undertaken by both parts of the industry, but some inputs could be shared. A typical example would be the need to have an accounting department in each company, some of whose activities would be in handling the transactions between the two companies. Integration would not do away with such transactions, although they become internalized, but they would be accounted for just once instead of twice. Related to this would be an *economy of scale;* an accounting department would not need to be twice as large to deal with a company double the size, there being some basic set-up costs (e.g., computers) that could be shared. A very important version of this argument is the existence of economies of scale to top management; if good managers are scarce (especially in small economies), integration may save on this resource. A consultant report on proposed restructuring in Kenya (700 MW) argued that the establishment of horizontal monopolies (one for generation, one for transmission, and one for distribution) had few advantages over the integrated monopoly alternative and had several important disadvantages. Foremost among those would be the reorganization that would be required and the shortage of scarce managerial skills, as well as a decline in efficiency of the planning process. Since the main weakness in the Kenyan system was the inefficiency of the generation sector, the recommendation was not to split the system into the three stages of production but to establish the possibility of entry of IPPs for new generation projects. The existing system precluded any effective division of generation to produce a competitive market, but the anticipated growth of demand suggested that several new plants would be needed in the near future; that was seen as a vehicle for private sector participation and the introduction of competition between generators.

4.15 An extension of these cost comparisons comes from certain factors needed for the successful operation of a business but that might not be fully utilized by a single entity. Spare capacity could then be eliminated by integration. This phenomenon is especially important with very small firms, where the discreteness of inputs is substantial in relation to the size of the firm. For example, it may be necessary to have in-house legal expertise on contracts. Separated firms could well each need to have a legal expert, not fully utilized, so that integration would allow sharing of a single specialist. Some physical assets can also be employed to create spare capacity, which in effect could be used by the other firm much of the time. This combines both aspects of discreteness and aspects of risk pooling. Suppose, for example, that a vehicle fleet is required for emergency repair work; by its nature, that fleet would often be idle (more often in smaller systems). With both stages of production needing such a resource, each could realize an obvious gain from sharing, particularly since the risks to the two stages of the system are not perfectly correlated.

4.16 The presence of economies of scale and scope can be exposed by considering an integrated industry that is to be separated. An inventory of the additional

costs, such as buildings, personnel, and material, can be drawn up. Some of these costs will be on a once-for-all basis, equivalent to a certain annuitized value, whereas other incremental costs will be ongoing.

4.17 An aspect that may have some importance for the decision on whether to separate is that the costs of borrowing money may be higher because of the splitting of the cash flow for the separated companies. That is, pooling cash can reduce the costs of financing a given expansion, when the expansions of the two parts of the firm are not perfectly correlated. In addition, financial implications may stem from the ways losses are treated for taxation purposes in separated companies; losses in one company cannot be offset against profits in the other, as they would be in an integrated company.

4.18 For very small systems, splitting the companies will reduce the flexibility for staff advancement and lead to losses of skilled personnel who see their career path blocked by a particular individual.

4.19 An important reason for considering separation of a company relates to the internal organization of multifunctional production. The internal divisions of a company may treat each other as rivals and may not coordinate perfectly, so that the arguments put forward for inefficiency in the presence of loss of coordination in separated companies can also occur in integrated companies. This phenomenon is most likely to occur in large systems where each division is so large that staff become remote from other divisions and do not have a feeling of joint purpose. Moreover, in very large systems the passage of information between divisions becomes very complex: many large companies use transfer pricing to simulate the information flows which the market would provide. Analysis of the performance and behavior of an integrated industry may reveal whether coordination has become so complex that separation will impose no extra burden.

4.20 A key argument in favor of separation is that it increases the transparency of transactions between the two parts of the company, so that the source of inefficiencies in one or other part become more apparent, thus putting pressure on the managers to become more focused. This is more likely to be an important consideration in a large and complex system than in a small system, where one senior manager may have a good knowledge of the working of the whole company.

4.21 Where it is decided to separate generation from transmission, the issue remains of whether transmission should be privatized. Where the transmission system is separated from generation (and the latter has been privatized), it is important to ensure the neutrality of the transmission system to guarantee open access and to ensure reliability. In small countries, it is more likely that the regulatory institutions, required to prevent capture of a private transmission company by one generator, would be weak or would not exist. Hence, this crucial sector is likely to be left in state ownership.

4.22 Where the industry is to be vertically separated and also privatized, then regulation will be more problematic, especially in small countries. Each stage of the process will require separate regulatory reviews (as in England and Wales). The total

amount of time and resources devoted to the regulation process will increase with the degree of disaggregation. Indeed, for the smallest and least developed economies, shortages of the necessary skilled personnel to staff a regulatory agency may be an important constraint on the feasibility of privatization of the whole ESI.

4.23 Most consultant studies of reform and restructuring merely list the advantages and disadvantages of various solutions, possibly ranking them on a scale from strong advantage to strong disadvantage. However, a study on the proposed restructuring in Jamaica did attempt to cost out the effects of vertical separation. In Jamaica, the system is so small (about 500 MW) that a single private generating company was recommended, together with the possibility that new entrants would be IPPs. Table 4.1 repeats the findings of this 1992 study.

Table 4.1 Consultant Analysis of Possible Costs of Disaggregation of Generation and Transmission in Jamaica (US$1 = J$22)

a.	**Generation/transmission coordination.** The extent of any diseconomies of coordination depends on the quality and details of the commercial arrangements. The main diseconomy would result from any deterioration in merit order operation. If, in the extreme, an additional 5 percent of the units were to be generated on the gas turbines rather than steam plant, the total cost would be J$118M per annum or about J$0.070/kWh over all units generated.
b.	**Metering and administration.** Improved metering would almost certainly be needed in the power stations and administration of the Power Purchase Agreements would require development and operation of contract management systems. These are mainly one-off costs which we estimate might be around J$100M or, after annuitization, about J$0.007/kWh.
c.	**Overhead costs (duplication of services).** Ignoring any scope for efficiency savings, assuming around one quarter of overhead costs would not be necessary in the new T&D entity and that a further one half would be incurred in the new generation entity(ies), additional overhead costs amount to J$36M per annum or about J$0.021/kWh.
d.	**Borrowing costs.** We think that there would be little change to overall borrowing costs as most of JPSCo's loans are on concessionary terms, from lenders which we believe would look sympathetically at a restructuring which leads to increased private sector participation. Were the existing borrowings on more commercial terms there might have been a more material effect. Increased financial costs could arise from two different effects: new borrowings could be more expensive (for the industry, if not for the economy in aggregate) because of increased risk through splitting cashflow and through competition; and splitting total cashflows could mean total borrowings will increase as surplus cash in one entity could not be used to reduce borrowings in another entity. If all borrowings were to cost 2 percent more, the increase would be about J$25M per annum, or about J$0.015/kWh.

These additional costs had to be balanced against the additional benefits, the principal of which was thought to be the effect of more focused management in the separated generating company in improving operating efficiency. Here, the consultants suggested a gain of up to J$0.06/kWh. Further benefits from the impact of IPP competition on capital costs might also be expected, bringing an annuitized gain of J$0.03/kWh. The range of net benefits that these preliminary calculations suggested lay between +6 percent and -4 percent of total operating revenue, and the consultants took the view that on balance a net gain would accrue, and the sectors should therefore be separated.

4.24 The above analysis for Jamaica, which was not based on any systematic study or detailed calculations, was all the material given to any quantitative evaluation of whether or not generation should be separated from transmission. It certainly cannot be accepted as a definitive answer to the question, but it does indicate that money values can be given to the costs and benefits involved and illustrates the line of approach that should be followed in attempting to decide whether or not separation is worthwhile. It is clearly much more informative to identify potential cost and benefits, and to put numbers to them, rather than merely to list important and unimportant factors with no way to consider their relative weights.

Costs and Benefits of Horizontal Separation in Generation

4.25 The possibility of introducing competition into generation is one of the crucial steps for the whole of the power restructuring strategy. If it is not possible to introduce effective competition, then in turn the argument for vertical separation, that it is a necessary condition to permit such competition to take place, is weakened, and on balance it may be better to leave the industry integrated even though it has been privatized. A crucial step in assessing the extent to which competition is being effective is to see whether sales prices have been reduced. Increasing productivity and profits, without price reduction, indicates the strength of the profit motive but confers no benefits on consumers.

4.26 The key to the issue is the mechanism by which competition takes place. A very important aspect of the power market is that the existence of several generating companies does not by itself necessarily introduce competition, so that breaking up the state company into several private generators could lose some benefits of scale or scope and yet not gain any benefits from competitive downward pressure on prices. The worst failure would be to split up the generation sector, believing that this would introduce competition, and to find that de facto private and unregulated oligopolies had emerged. For competition to be effective in reducing costs and constraining existing companies to perform efficiently, the incumbents must perceive a distinct possibility of losing sales to a rival who undercuts them; such a rival may be an established firm or a potential new entrant.

4.27 In some large power systems where reforms have taken place (e.g., England and Wales, Chile, Norway), the generators constantly bid to supply power (on a

daily or even half-hourly basis). This constant bidding (real-time pricing) is the first dimension that allows competition to be effective; if costs can be cut, then the possibility exists of immediately forcing a rival out of the way and supplying instead. The use of prices to gain market share is the hallmark of competition and has the crucial aspect that the benefits are passed on to consumers through the lower prices.

4.28 Such a system is too complex for most smaller systems and for economies at lower levels of development, so a contract system is often used for selling power from the generators. With a long-run contract system, the opportunities for using cost reductions to gain market share are very much more infrequent. Thus, cost cutting on existing contracted volumes will depend largely on the desire to make profits in what is essentially a temporary monopoly; this motive exists as much for a single generator as for a series of nonrival generators. Importantly, the benefits of cost cutting are retained by the firm and are not passed on to consumers in this approach. Clearly, the longer the period of the typical contracts, the weaker the effective competition may be. Furthermore, the operation of a recontracting system (based on a series of bilaterally negotiated commercial contracts) may well be less efficient than despatch under merit-order operation, since any mistake in despatch is likely to be perpetuated until new contract negotiations occur and the despatcher has a new opportunity to assess the true costs of the various generators. In most countries where IPPs have been introduced, contracts are either "take or pay" or based on despatching according to an indexed cost formula. Such contracts do not lead to competition between the IPP and the existing generators and are not likely to lead the existing plants to improve their efficiency of operation.

4.29 The second dimension required for effective competition is the existence of a sufficient number of firms to avoid implicit collusion and gaming the system—a two-generator industry may be susceptible to a situation in which each firm tacitly allows its rival to behave in their mutual interest. The England and Wales arrangement, with two large private generators (plus the smaller and subsidized public nuclear company), has already demonstrated that a larger number of companies is required to induce real competition in behavior. For example, the generators have at times declared capacity unavailable—when in fact it is available—to force the use of more expensive plant, which then increases the returns to all plants already operating. Green and Newbery (1992) produced an analysis showing that a five-generator system would have been much more efficient and would have resulted in substantially lower prices. Fehr and Harbord (1993) suggest that bids into the pool were systematically above marginal costs. This analysis has been recently confirmed by the 1994 decision of the England and Wales regulator to place a price cap on generation prices, which had been expected to be able to be left unregulated because of the effects of competition. In Argentina, a guiding rule has been that no single firm should own more than about 15 percent of total generation; this has led to the emergence of several fairly equally sized firms.

4.30 It is believed that Norway, which has more than 40 generators, experienced problems with a dominant generator when Statkraft, which produces about

one-quarter of all electricity (more than three times the next largest and five times the third largest producer), decided in 1992 that it would not supply at prices below 11 NØre/kWh. It was able to achieve this, "disciplining" firms that deviated from this price by momentarily flooding the market and pushing the spot price toward zero. Although such extreme market power is likely to exist only where generators have large hydro reservoirs and where substantial excess capacity exists, as in Norway, it does illustrate the potential market power of a single large firm even when a large number of producers are present. In small systems, this introduces a problem, since the market can be too small to support enough separate firms of roughly equal size to curb anticompetitive behavior, without incurring greatly raised costs through loss of economies of scale at a plant level.

4.31 A third dimension necessary for effective competition in the market is similarity in the size and composition of the generating firms. If the cost structures are not similar, then cost saving could not be used to increase market share (by altering the "merit order" with respect to a rival), and hence any benefits that required competition to force their adoption would not be forthcoming. Also, if the plants that are potentially competitive were too "small" relative to the system as a whole, then the effect of competition would be very limited. These considerations raise very important issues on how the generation sector is to be unbundled, once that decision has been agreed. The grouping of existing plants into the separate firms can be a crucial element in introducing competition.

4.32 For new plants, the market will decide how big the plant should be, as firms make various bids to supply extra demand, but for the existing industry the plants may be of noneconomic size. A straight auction, plant by plant, will give buyers the opportunity to collect together plants that complement each other, but it may leave some poor plant to be sold well below the cost of its assets unless the government is willing to cancel part of the liabilities.

4.33 Related to the similarity in costs aspect is the "strength" of the transmission system. A system with very high transmission costs per unit distance will effectively allow some generators to be virtual monopolies, even if they are higher cost than some of their rivals, because the extra costs of supply across the transmission system to meet demand at a given node effectively prevents effective competition from more "remote" sites. Clearly, the longer the distances between rival stations and the higher the cost per unit distance for transmission, the less the chance of real competition between different generators. An important part of the reform process may be to strengthen the transmission system to lower the overall costs of despatched energy to the system as a whole, and to permit more competition between generators, and to encourage the entry of IPPs.

4.34 An existing industry must have excess capacity for competition to be successful in the short run. If every plant were needed on a regular basis, then no incentive would exist to cut costs to increase market share. Because of the nature of electricity demand, with its daily and seasonal peaks, it is very rare that the system is

always capacity constrained. It is nearly always true that for parts of the day and parts of the year excess capacity exists that then provides an incentive for undespatched plant to improve its efficiency to be used more often. Thus, the greater degree of excess capacity that is available for larger parts of the day and the year, the greater will be the opportunities for gain from increasing efficiency. When any substantial degree of excess demand exists, then, even in a contract system, prices will tend toward market-clearing levels and will be above costs.

4.35 Where relatively little overall excess capacity exists, and the system is suffering from load shedding at various times of the day and year, then the incentives for existing firms to compete are reduced. The main competitive threat then comes from new entry, which is attracted by the very existence of the opportunities for profit. If new entry is easy and can take place rapidly, then the threat of entry may be sufficient to induce existing firms to become cost-efficient. However, where entry is difficult, because of problems of obtaining licenses and of constructing the plants, or where entry is risky because the inherent cost advantages to incumbent firms may leave a new firm stranded, then the threat of entry may not be enough to affect behavior of established firms. In systems where demand for electricity is growing rapidly, entry will tend to occur more frequently and will be a more potent source of competitive pressure on incumbent firms. In systems where demand is very static, new entry will be a much less important force, so that in small, slowly growing economies the entry of IPPs cannot be counted on as a major force to introduce competition between generators.

4.36 Where excess demand exists, then entry of new firms may gradually place competitive pressure on existing firms. Even where an existing industry is not to have generation separated it is likely that the market will be structured so that IPPs can enter. A *competitive bidding program* for entry should help to ensure that these entrants do not make monopoly profits, but it is not automatic that this will place cost-cutting pressure on existing firms. To do so, the new plants must threaten the merit order of the existing plants. Where the existing firms have some cost advantage not available to new entrants, then an "intrinsic margin" is present that might not be competed away. The danger is that such a margin will not be fully reflected in low prices, because the existing firms become productively inefficient only to an extent that is not so great as to completely remove their advantage versus new entrants. Examples of such intrinsic advantages are privileged access to local fuel supplies (especially hydro) that cannot be bid away by higher contract prices for the fuel; superior location in terms of nearness to fuel source or to market; environmental suitability of existing sites; or even the nonavailability of new sites, as is the case in Jamaica. In fact, in Jamaica and Portugal, the energy purchaser acquires the generation sites and leases them to successful bidders to diminish any intrinsic advantages that may be present because of the limited number of suitable sites.

4.37 The size of the system and of potential incremental plants is important because of the issue of plant economies of scale. Where new plant of a very small size is added, a loss of potential economies of scale may occur (plant level). In system planning, the growth of demand is important in determining whether it is profitable to invest in

larger plant (temporary overcapacity), which has lower per unit cost once fully utilized. Adding a series of smaller high-cost plants may mean that losses from underutilization are avoided but that less long-term pressure on costs is available from using the most efficient plant. Rapid demand growth allows temporarily greater excess capacity and hence is more favorable to obtaining economies of scale as plant is added to a system. Again, a tension exists between adding many small plants, which has the virtue of creating many rivals, and having fewer but lower-cost plants, which will be more effective in putting pressure on existing plants to become cost-efficient.

4.38 The technical economy of scale also depends crucially on the fuel availability. For oil- and coal-fired steam plants, the economies of scale are all obtained with a 3- to 5-unit plant of about 250 to 300 MW each. For diesel and combined-cycle plants, the limit is certainly much smaller, but at present an exact figure cannot be suggested. Hence, the optimal scale of new entrants will be very situation-specific, but it is evident that for the smallest systems a tension exists between capturing economies of scale and creating a competitive environment. For an existing system, suboptimal decisions may have been made that will leave the economy with unavoidably high generation costs (until the plant is replaced). Hence, if the existing plant structure is such that it cannot engender true competition, it is important to examine the likely course of development of the sector to see if that is likely to transform the situation rapidly, or whether it is better to attempt to capture substantial economies of scale by encouraging investment in larger plants, even if this will not afford a way to increase the competitiveness of the industry substantially.

4.39 Where a public generator owns several plants, it may be that a move to separate ownership and independent operation could raise total costs (irrespective of inefficiency factors) as economies of scope are lost through the need to provide, separately, certain factors that were shared before (e.g., management, buildings) exactly as for the case of vertical separation.

4.40 A further reason for having more than one plant in a firm, even when economies of scale might suggest a single plant, is that of risk avoidance. Given the nature of generation, a failure of plant or a unit loses a substantial fraction of output. Separation thus increases the risk to the individual firm, which would require a higher price to compensate. Such costs can be avoided if the independent generators can make backup arrangements with each other at no extra cost to the system as a whole.

4.41 With existing systems, deintegration may bring about some losses of economies of scale. One such factor is the need to maintain a "reserve margin" against uncertainties. The experience of U.S. "power pools" has shown that pooling has enabled individual firms to reduce reserve margins, thus leading to significant overall cost savings. In most developing countries it is unlikely that such sophisticated devices can be made to work, so that the operation of a deintegrated system will incur this extra cost, for which an estimate could be made.

4.42 One feature of power systems is that they are not necessarily restricted to national borders when countries are interconnected and trade in electricity. The availability of imported power can provide a valuable element of competition to domestic generators, and this is likely to become more important as notions of trade become more accepted in a commercialized environment.

4.43 The case of Bolivia illustrates the typical problems that can be faced in any such restructuring. In 1994, Bolivia had two major generators serving the interconnected system. ENDE (publicly owned) had 73 percent of the total capacity of 596 MW; COBEE (privately owned) had 24 percent of the capacity. The ownership, type, and size of the principal generation plants are shown in Table 4.2.

Table 4.2 Generation Plant in Bolivia

Owner	*Plant*	*Type*	*Capacity (MW)*
ENDE	Guaracachi	Thermal	170
COBEE	Zongo	Hydro (R)	106
ENDE	Vallee Hermoso	Thermal	72
ENDE	Santa Isabel	Hydro (S)	72
ENDE	Corani	Hydro (S)	54
COBEE	Mugillas	Hydro (R)	19
ENDE	Aranjuez	Thermal	19
ENDE	Karachipampa	Thermal	15

R = run of river; S = reservoir.

4.44 The initial consultant report on the Bolivian system focused on an attempt to introduce competition into generation by breaking up the public company into "as many companies as possible," where the "companies should be of similar size, to avoid having excessive market power. They should also have a mix of generation technology to encourage competition at different points on the merit order." The first problem in breaking up ENDE was seen to be the size of the thermal plant at Guaracachi, which contained about 30 percent of existing total capacity. The second problem was that it seemed natural to group plant by region, and this would have given Vallee Hermoso, Santa Isabel, and Corani (all in Cochabamba) to one company, thereby creating a second company controlling nearly 35 percent of capacity. A solution to break ENDE into three companies involved grouping its two hydro plants (Santa Isabel and Corani) into one company, with the three thermal plants from three different regions into the third company. This solution satisfied the criteria of creating a reasonable number of producers and companies of roughly equal size, but it failed to produce a mix of plant types within companies or geographically concentrated companies. This illustrates well how difficult it may be to produce, from existing plant, a viable mix of companies that could be competitive.

4.45 In a subsequent report on the Bolivian case it was concluded that merit-order despatch through a pool-type system would not produce effective competition, with plants attempting to cut costs and hence prices in order to supplant a rival in the merit order, for several reasons:

a. The wide variation in the SRMC of different plant meant that it was unlikely that even with efficiency improvements plants would be able to improve their position in the merit order relative to others who did not improve their efficiency.

b. Nearly 25 percent of capacity is run-of-river hydro, which must run and cannot be freely despatched.

c. A further 25 percent is storage hydro, which has zero fuel costs and should be despatched on the basis of opportunity costs, calculated with reference to thermal plants, allowing for hydrological conditions.

d. Supply is dominated by the 170 MW thermal plant, which would have the power to "game" the system (see paragraph 4.29).

These considerations did not lead to the abandonment of the idea of separation of transmission from generation, which was strongly recommended in order to attract IPPs, nor to the abandonment of splitting ENDE into more than one company. However, the drive to achieve competition in the existing system was seen to be of limited practicality, and it was recognized that a different way of determining despatch would be required. In the case of Bolivia, it was recommended that a power purchaser should be used, as in the case of Portugal, Mexico, and Northern Ireland.

4.46 In the case of Jordan, which is a somewhat larger system at over 900 MW, two plants dominate the system, each supplying over 40 percent of the total energy required. In the light of this, a consultant report on restructuring options said: "Meaningful competition cannot exist when two of the generation companies that will be created have a minimum market share of over 40 percent. Competition is made even more impractical by the fact that the existing generation plants have dramatically different operating costs."

4.47 The recommendation of the consultant study on Jordan was not to split generation into separate companies and in fact to leave generation attached to transmission, although separating distribution. IPPs would be allowed to bid for future generation projects. However, it would appear that in a system of this size the balance of advantages of separation, in order to facilitate the entry of private generation, and maintaining the link between generation and transmission, is more finely balanced than in smaller countries. The system has no shortage of skilled personnel and management, and the existing utility is well run in a technical sense. In this case, a monetary analysis of costs and benefits of the alternative structures might highlight the central issues in making the right decision.

5

Assessing a Proposed Restructuring Plan

5.1 Two elements are crucial in assessing any restructuring plan; the various potential costs and benefits must be identified, and then they must be weighted against each other. This paper has drawn attention to some of the main factors to consider—these are summarized below—but it is also important to consider how the relative importance of these factors is to be determined.

5.2 A common technique used by consultant reports is to identify the principal factors involved (possibly assigning different weights to the factors). Each restructuring plan is then given a score on each factor (say, from 1 to 10), and the total score for the plan is derived by adding these scores. This technique appears to be useful in determining whether any schemes are vastly inferior or superior to the others, but the arbitrary nature of the weights means that it is difficult to be sure of the relative merits of two plans where the scores are fairly close together. In particular, it is difficult to construct an argument for or against the weighting adopted because the categorizations used themselves tend to be imprecise and because of the lack of any common standard to evaluate the relative importance of the different factors.

5.3 A recent example of a proposed restructuring scheme for the vertically integrated public utility in the state of Haryana in India illustrates the method. Ten factors were considered, and weights were assigned to their relative importance by asking a panel of five experts to divide a total of 100 points between the factors. The average weights of the panel were as follows:

1.	Commerciality	13.0
2.	Financial viability	18.0
3.	Efficient consumption	10.5
4.	Efficient production	12.5
5.	Optimized system	7.5
6.	Operational feasibility	6.5
7.	Legal feasibility	6.0

8.	Reduction in corruption	10.0
9.	Consumer protection	7.5
10.	Acceptability to stakeholders	8.5

Each factor then had various scores attached to the degree to which it was achieved, with the maximum total score per factor being 10 points. For example, the factor "efficient production" had the following components:

a.	Plant load factor	no increase in load	0
		moderate increase in load	1
		substantial increase in load	2
b.	Technical losses	unreasonable level	0
		reasonable level	1
		economic level	2
c.	Merit based personnel system (otherwise zero)		1
d.	Decentralized management (otherwise zero)		1

Other factors were treated in a similar fashion. The final aggregate scores (of a maximum possible of 1,000) ranged from 561 (no privatization but with multiple distribution companies) to 922 (privatization and wholesaling wheeling). The difference between the best and second-best options (privatization with multiple distributors and competition in generation to supply a central purchasing agency) was only 20 points (2 percent). It is not satisfactory to have to a make a decision between two such different options on such a small difference based on nonmonetary scores.

5.4 Such scoring clearly helps to rank individual components but loses much of the detail that is important in coming to a decision. Only by placing money values on any factor can the specifics of the situation be adequately taken into account. For example, it is not clear how to interpret a "substantial" increase in the load factor, and this in itself is then open to disagreement between those assessing the proposals. Only when a monetary value is placed on a component can an objective discussion ensue as to whether the figures are correct.

5.4 Accordingly, the use of such scales can form a valuable tool for obtaining an overall and broad-brush picture of the desirability of the various options, but they should be supplemented by a more detailed economic analysis of the costs and benefits of the principal alternatives. The study on restructuring in Jamaica showed how money values could be placed on the main costs and benefits of vertical separation. This then allows an informed debate on the values chosen and on the relative merits of various schemes.

6

Evaluating the Costs and Benefits for Vertical and Horizontal Separation in the Power Sector: A Checklist

6.1 In restructuring a vertically integrated industry, two issues stand out as giving rise to substantial design and implementation problems for the reformed system. First, the separation of generation from transmission requires an explicit arrangement to facilitate efficient despatch and to provide efficient expansion plans, and care should be taken to adapt the form of contracts or selling of energy and power to the circumstances of the country. Second, splitting existing generation into several parts is not a sufficient condition to ensure the introduction of efficient competition in generation. Where competition is not possible, regulation will have to be introduced to control pricing and profits in generation. Both issues are more likely to be more difficult to handle the smaller the system under consideration, and in some situations unbundling either horizontally or vertically may well be suboptimal.

6.2 The final solution chosen for restructuring and reforming a power system must take into account the specifics of the country involved. No "blueprints" are available for restructuring that can be automatically adopted without detailed analysis. In particular, no prima facie evidence exists that the high-profile model of the England and Wales reform, or indeed of any other country, is correct for any given case.

6.3 From the discussion it is also clear that no sharp dividing line can be drawn on what constitutes a "small system." A slow-growing economy, which has two or three large steam or hydro plants, could certainly have more than 1,000 MW capacity but might not currently be able to achieve competition through unbundling generation, nor would it have any substantial prospect of rapid change. If this were coupled with high costs of vertical separation, then the existing structure may be the most efficient. Gains in efficiency would then have to be sought through corporatization, commercialization, and privatization rather than through restructuring.

6.4 Before considering alternative restructuring proposals, it is important to clarify the gains and losses from other aspects of reform (that is, from corporatization, commercialization, and privatization). These changes can be made whatever the structure

of the industry, so that they should be used as a consistent baseline against which alternatives are measured. For example, if the status quo (no reform) is a viable option, then this should form the baseline, but if the government decides as a minimum to stop subsidizing power sales and to move to a corporatized and commercialized basis, then the baseline becomes a public sector commercialized monopoly, and the gain in performance from commercialization must not be attributed to a structural change.

6.5 A checklist of the most important costs and benefits associated with restructuring is given below as a guide to determining what questions should be answered by a study on potential restructuring options in a given country. Here, the analysis is taken in two stages. First, the separation of a vertically integrated monopoly into vertically separated monopolies is evaluated. This move is seen as necessary to allow the efficient entry of IPPs or to permit the second stage—the creation of a possibly competitive structure through horizontal separation of generators. The benefits of IPP entry (but not intergenerator competition) are accounted for in this first stage as well as any losses in efficiency through vertical deintegration. The second stage then evaluates the benefits and costs of separating the single generator into several companies.

Vertical Separation into Generating and Transmission Monopolies

a. What will be the gains, in terms of the price of entry of IPPs, from separating transmission from generation? Over what period will the IPPs enter, with what capacity, and what price advantage will be gained in comparing the bids into a separated system as opposed as into an integrated system?

b. What will be the scope for losses in despatch efficiency facing a single generator (plus IPPs) through using separated functions? Which units could possibly be run out of the true economic merit order, and how much extra would this cost? How does the transmission network give the generator increased power to exploit its monopoly position in terms of declaring which plant is available? If least-cost despatch does not occur, what will be the impact on signals for future investment?

c. What will be the extra costs of organizing a separation of despatch in terms of metering, accounting, settlement, and administration of power puchase agreements (PPAs), and of the extra overhead costs and running costs if a separate despatch unit is to be created?

d. What extra costs will be incurred by having separate transmission and generation in terms of buildings, personnel, vehicles, and so on? How will the costs of transacting business with the other party compare with the costs when the functions were vertically integrated?

e. What will be the effects on the costs of borrowing by making the borrowing unit smaller and less diversified?

f. What will be the effect on the prices of factors of production, especially management, through the creation of extra demand?

g. What will be the gains in operational efficiency through having a more focused management?

h. What will be the effect on employee efficiency through working in smaller but more focused companies, both in terms of chances for promotion and a closer identification with the company's performance?

i. What will be the extra costs of regulation required to deal with the disaggregated structure?

Horizontal Separation of Generation in Separate Companies

Grouping Plants into Companies

Since several alternative groupings of plant into separate enterprises will usually be possible, it will be necessary to decide on the most attractive groupings first, before undertaking a detailed cost–benefit analysis of the leading options. The approach to deciding groupings is to ensure that certain criteria are satisfied that would give a structure in which there is genuine potential for competition:

a. Ensure that there are at least three and preferably four or five separate enterprises.

b. Ensure that no one enterprise is dominant in terms of size.

c. Group plants so that separate companies have overlapping areas in the merit order, in order that there is potential for actual competition between companies.

d. Try to group plants on a regional basis in order to economize on management costs of control.

Costs and Benefits of Creating Several Generators

a. What gains in efficiency, beyond those already brought about by the introduction of the profit motive through commercialization or privatization, will be created by the force of competition? How much spare capacity is available to lead to competition, and how will the entry of IPPs affect existing generator efficiency?

b. What scope will there be for suboptimal despatch with several firms as opposed to a single generator?

c. What scope is there for "gaming" the system, taking into account the transmission structure, by generators not actually facing full competition?

d. What extra costs of buildings, personnel, accounting, and so on will be required by the separation of generation into several enterprises?

e. What will be the effect on the prices of factors of production, especially management, through the creation of extra demand?

f. What will be the impact of total reserve margins in the system by the separation of generation into separate firms?

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Annex

Table A1 Countries with Total Public Installed Power Capacity of Less than 150 MW (in 1990)

Benin	15	Burkina Faso	59
Burundi	59	Cape Verde	5
Central African Republic	43	Chad	31
Comoros	2	Congo	149
Djibouti	38	Equatorial Guinea	5
Gambia	11	Guinea	73
Guinea-Bissau	6	Mali	81
Mauritania	105	Niger	63
Rwanda	29	St. Helena	1
São Tomé	5	Seychelles	22
Sierra Leone	73	Somalia	60
Togo	17	W. Sahara	56
Antigua	25	Aruba	90
Barbados	140	Belize	23
British Virgin Islands	13	Cayman Islands	56
Dominica	8	Greenland	71
Grenada	8	Haiti	130
Martinique	110	Monserrat	4
Netherlands Antilles	100	St. Kitts–Nevis	11
St. Lucia	22	St. Pierre	24
St. Vincent	14	Turks and Caicos	4
Falklands	7	French Guiana	108
Guyana	52	Surinam	65
Cambodia	35	Maldives	5
Faeroes	91	Gibraltar	27
American Samoa	33	Cook Islands	6
French Polynesia	79	Kiribati	2
Nauru	10	Samoa	17
Solomon Islands	8	Tonga	7
Vanuatu	9		

Table A2 Countries with Total Public Installed Power Capacity of between 150 and 500 MW (in 1990)

Angola	460	Ethiopia	356
Gabon	279	Liberia	184
Madagascar	188	Malawi	170
Mauritius	239	Reunion	170
Senegal	226	Sudan	350
Uganda	155	Tanzania	419
Bahamas	346	Bermuda	170
Guadeloupe	314	Honduras	275
Jamaica	482	Nicaragua	340
Afghanistan	425	Bhutan	347
Brunei	334	Cyprus	462
Lao People's Democratic		Macao	183
Republic	225	Dem. Yemen	225
Nepal	264	Guam	302
Malta	250	Papua New Guinea	222
New Caledonia	230		

Table A3 Countries with Total Public Installed Power Capacity of between 500 and 1,000 MW (in 1990)

Cameroon	603	Kenya	706
Costa Rica	889	Dominican Republic	947
El Salvador	703	Guatemala	666
Panama	892	Trinidad and Tobago	935
Bolivia	531	Bahrain	950
Jordan	929	Lebanon	790
Mongolia	772	Myanmar	836
United Arab Emirates	860	Albania	755
Iceland	913		

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