Chapter 6

QUANTIFYING THE BENEFITS FROM STRUCTURAL REFORMS IN ELECTRICITY AND GAS MARKETS IN APEC ECONOMIES

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- Structural reforms in electricity sectors in APEC economies since 2004 have generally been incremental; and those in gas have been less extensive than in electricity.
- Partial reforms have had significant effects on productivity.
- Reform to introduce competition, in particular, is expected to lead to further efficiency gains and lower prices.

6.1 INTRODUCTION

The production and distribution of electricity and gas involves networks – networks of electricity transmission and distribution lines, and networks of gas transmission and distribution pipelines. At least some components of these networks have the characteristics of a 'natural monopoly', meaning that it is less costly for their operation to be carried out by a single producer using a single set of facilities, rather than having two or more operators with duplicate facilities. In addition, there are strict technical requirements for operating electricity and gas networks, so as to preserve the physical integrity of the distribution systems. For these reasons, electricity and gas have traditionally been supplied by single, vertically integrated monopolies often in government ownership.

The absence of competition meant that there were few (if any) incentives for electricity and gas providers to keep costs to a minimum and to operate efficiently. Unless prices were regulated, there was also scope for operators to abuse their monopoly power and price above cost.[2]

Structural reforms in electricity and gas have aimed to overcome these two key problems. The reforms have typically aimed to introduce competition to allow competitive suppliers having access to those parts of the network that are natural monopolies. Successful reform also requires that the restructuring be done in such a way that the benefits of competition in the competitive sectors outweigh the loss of any economies of scope that may have prevailed when the monopoly and competitive activities were operated together under single ownership.

Beyond these common features, there are some differences in the physical characteristics of electricity and gas markets, which have led to differences in the extent of reforms carried out.

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[2] Notwithstanding higher prices, government owners often received returns on equity and capital that were below average.

6.2 KEY FEATURES OF ELECTRICITY AND GAS MARKETS

6.2.1 Electricity markets

The production of electricity involves: generation, transport over high-voltage lines (transmission), transport over low-voltage lines (distribution), marketing to consumers (supply) and buying and selling on wholesale markets (trading). What follows is drawn from European Commission (2007).

Transport operations are considered to be natural monopolies, and typically remain regulated even after structural reform. But generation is seen as a competitive activity, and is generally the first activity to be opened to competition, followed by wholesale trading and retail supply. However, retail prices may remain regulated in some economies, even after structural reform.

Unlike gas, electricity cannot be stored economically once it is produced, so supply has to be matched to demand on a second-by-second basis, even though demand may vary significantly over different times of the day and over different seasons. The introduction of new competitive generators needs to be managed in a way that does not jeopardise this supply–demand matching or bring down the grid network.[3] After structural reform, this balancing is typically achieved by having balancing markets run by an independent system operator.

Electricity can be generated using a variety of technologies, each of which has different cost characteristics. Nuclear plants tend to have low operating (variable) costs, so are typically used for base-load supply (i.e., operated all the time). Hydro plants also have low operating costs and are used for base-load supply when water availability allows. However, nuclear plants (and some hydro plants) also have very high capital costs, so the prices to consumers from this source may have to be high if operators are to receive an adequate return on capital. The operating (variable) costs of thermal plants depend largely on the prices of their input fuels. At current prices, coal-fired plants tend to have the next lowest operating costs after hydro and nuclear, and thus are next on the 'merit order'. Combined cycle and gas turbine plants tend to have the highest operating costs, and tend to be used as 'peaking plant' (i.e., used to meet peak demand). However, combined cycle and gas plants have low capital costs, so consumer prices from this source can be relatively low. In general terms, therefore, electricity prices to consumers depend not just on the extent of structural reform but also on the mix of production technologies available.

Finally, like most network industries, electricity transmission and distribution are subject to economies of density – costs are lower, the shorter the distances over which electricity has to be transported. Thus geography also has an impact on electricity prices to users.

England and Wales took the lead in structural reform of electricity markets in 1990, but many OECD economies (and some non-OECD ones) have gone at least some of the way down similar paths. In the European Union (EU) structural reform has received an additional impetus with the Second Electricity Directive of 2003 (discussed below). Doove et al. (2001) describe the broad outlines of the structural reform agenda as follows:

- structurally separating ('unbundling') the competitive activities (particularly generation, but sometimes also retailing) from the natural monopoly elements (particularly transmission but sometimes also distribution) – this is called 'vertical separation';

[3] This applies particularly to wind and solar sources which may be generating at a time supply is not required.

- dividing existing generation capacity among a number of different generation companies, who then compete with each other – this is called 'horizontal separation';
- allowing new generators to enter the market – these are sometimes called independent power producers (IPPs);
- guaranteeing open and non-discriminatory access for all generators to the transmission grid (subject to available capacity), so that they can sell directly to downstream suppliers or users, rather than selling to the incumbent – this is called 'third party access (TPA)';
- establishing a wholesale price pool or spot wholesale market for electricity (either mandatory or optional, and broader than, but interconnected with, the balancing market), so that new entrants are not obliged to enter both the generation and retailing sector at the same time, thus lowering entry costs;
- regulating the natural monopoly activities to prevent any abuse of market power;
- introducing an economic regulator independent of industry players and day-to-day influence, and typically separate from the (technical) system operator;
- enabling large customers (retailers and sometimes large industrial users) to buy electricity directly from the generator of their choice;
- introducing competition into metering and billing activities and contract terms, thus allowing retail customers freedom to choose among different electricity suppliers;
- providing a full range of tradable financial instruments (e.g., futures contracts and options);
- undertaking partial or complete privatisation or corporatisation of publicly-owned assets;
- introducing cross-ownership restrictions, especially between competitive and natural monopoly activities;
- liberalising restrictions on foreign investment and ownership;
- mandating service quality standards; and
- allowing retailers to introduce innovative services (e.g., the ability to switch retailers over the internet or providing electricity jointly with other services such as telephony and gas).

The possible benefits of these reforms are discussed below.

6.2.2 Gas markets

Natural gas is found in underground reserves, often in combination with oil and condensate products. Exploration and production is generally done by oil companies, and there are few synergies between these and other activities in gas markets. In economies without indigenous production, however, the primary supply activity is undertaken by importers, who may also be involved in downstream activities. What follows is also drawn from European Commission (2007).

Natural gas is mostly transported from production to market by high-volume, high-pressure transmission pipelines. Natural gas can also be cooled and condensed, and then shipped overseas in liquid form (liquefied natural gas [LNG]). Both forms of transport are expensive relative to the value of the gas transported, but pipeline is cheaper for shorter distances while shipment is more viable for longer distances. Both transmission pipelines and LNG terminal facilities involve substantial sunk costs, giving both activities natural monopoly characteristics.

Once natural gas reaches the market, it is distributed to customers over low-volume, low-pressure distribution pipelines. These distribution networks also have the characteristics of a natural monopoly.

Unlike electricity, there is essentially only one technology for producing natural gas. Also unlike electricity, natural gas can be stored, so there is no necessity to instantaneously match supply to demand. Nevertheless, flexibility is somewhat limited because the physical characteristics of storage facilities may limit the speed with which gas can be injected or withdrawn. Flexibility is also limited because gas extraction rates from underground reserves may depend on geology rather than demand, and the ability to alter pipeline pressures is also somewhat limited.

In many economies, gas importation, transmission and storage was traditionally undertaken by a single monopolist (or several companies with regional monopolies). Sometimes the monopoly importer also sold to consumers, or else these sales were handled by downstream monopolies.

Like electricity, structural reform of gas markets involves allowing new entrants into the potentially competitive segments of the market, without requiring them to be vertically integrated. Possible new business models include the following:

- new companies that produce gas or import it from external sources, in competition with the incumbent(s);
- new shipper/suppliers who buy gas on wholesale markets, arrange for its transportation with the network company and sign retail contracts with consumers;
- pure traders who buy and sell on wholesale markets to take advantage of arbitrage opportunities.

These new business models rely on the development of functioning wholesale markets and on third party access to transmission and distribution networks. To reduce the possibility of incumbents using their control over pipeline or terminal facilities to thwart competition, both transmission and distribution should be unbundled into separate transmission system operators (TSOs) and distribution system operators (DSOs). If such operators are sufficiently independent from incumbents, they should have an incentive to maximise, rather than restrict, the amount of gas sold through their networks, thus facilitating competition.

Thus the broad features of structural reform in gas markets are similar to those in electricity markets, though the scope for competition in primary production/importing is somewhat more limited than in electricity generation.

6.3 THE STATE OF PLAY IN APEC ECONOMIES

The state of play in APEC electricity and gas markets is summarised in Table 6.1, for those APEC economies for which adequate information has been collected via desk research (the exceptions are Brunei and Papua New Guinea). More details are in Tables 6.2 and 6.3 (Annex 6), which also note the extent of reforms since 2004. There are variations in regimes between regional jurisdictions in many economies. These are acknowledged in Tables 6.2 and 6.3. The status reported by Dee (2010; Tables 2.4 and 2.5) is based on reform in at least some significant regional jurisdictions or, in the case of the United States of America, on the situation in California, an area most relevant to the APEC region.

According to Table 6.1, very few APEC economies have achieved substantial reform of both electricity and gas markets, and those that have are essentially developed economies –

Table 6.1: Summary of current regulation in APEC electricity and gas markets, 2009

APEC member	Electricity				Gas		
	Unbundling generation	Third party access	Wholesale pool		Unbundling transmission	Third party access	Retail competition
Australia	Yes	Yes	Yes		Yes	Yes	Yes
Canada		Yes	Yes		Yes	Yes	Yes
Chile	Yes	Yes	Yes		Yes		
China	Yes		Yes				Yes
Hong Kong, China							
Indonesia					Yes	Yes	
Japan		Yes	Yes			Yes	Yes
Republic of Korea	Yes	Yes	Yes				
Malaysia							
Mexico						Yes	Yes
New Zealand	Yes	Yes	Yes		Yes	Yes	Yes
Peru	Yes	Yes			Yes	Yes	
Philippines	Yes						
Russia	Yes	Yes	Yes				
Singapore	Yes	Yes	Yes		Yes	Yes	Yes
Chinese Taipei							
Thailand					Yes	Yes	
United States	Yes	Yes			Yes	Yes	Yes
Viet Nam							

Sources: See Tables 6.2 and 6.3 in Annex 6.

Australia; Canada; New Zealand; Singapore; and the United States of America. Japan and Peru have achieved some reform in both markets, though in Japan's case this has been without vertically unbundling its incumbent operators. China has also started to reform both markets, though its electricity reform is only on an experimental basis in a few geographic areas. A few APEC economies have achieved substantial reform in electricity but not in gas – Chile; the Republic of Korea; and Russia – though Table 6.2 indicates only partial electricity reform in the Republic of Korea. A few more APEC economies have achieved substantial reform in gas but not electricity – Indonesia; Mexico; and Thailand.

Tables 6.2 and 6.3 (Annex 6) indicate that, to the extent that structural reforms have taken place in electricity and gas markets since 2004, they have tended to be incremental – there have been few 'big bang' initiatives.

6.3.1 APEC electricity markets

Reform in electricity is incremental partly because introducing competition into generation and retail is a highly complex regulatory process. The regulatory requirements for competitive new producers and/or wholesalers to get access to existing transmission and distribution networks need to be compatible with the technical requirements for the safety and physical integrity of the system. The Californian electricity crisis of 2000 and 2001 had a chilling effect on reforms in Malaysia. Reforms have also been stymied by domestic legal or political considerations. For example, in 2004 Indonesia's electricity reform legislation was annulled by the Constitutional Court; only in late 2009 was amended legislation passed. Similarly, in the Philippines reform has been handicapped by a legislative requirement that liberalisation can proceed only after key players have been privatised. In Mexico, under Article 27 of the Constitution, the state has exclusive responsibility for generating, transporting, transforming, distributing and supplying electricity as a public service. In Chinese Taipei, the incumbent had a legislated monopoly until 2008, though it now only produces 75% of the island's electricity. In Thailand, after a change of government in 2001, reform plans were converted into a plan to create a 'National Champion'.

However, by 2004 some economies in the APEC region had already achieved major structural reforms in electricity generation. These included Australia; Chile; New Zealand;

Peru; and parts of the USA. In Hong Kong, China the electricity market is a duopoly, but this appears to be 'natural' as neither party has exclusivity.

Thus the post-2004 reform experience in the region has been concentrated in a few economies – Canada and Japan have undergone minor reforms, while the Republic of Korea; Russia; and Singapore have undergone more significant ones. In several Canadian provinces and Japan, wholesale price pools have been introduced. The Republic of Korea has gone through a more extensive process of separating transmission from generating capacity and introducing one-way bidding in a wholesale pool but it has yet to introduce competition in the retail sector, and the six separate generating companies are still wholly owned subsidiaries of the majority state-owned incumbent. Singapore had already separated generation from transmission prior to 2004, and has been gradually introducing both wholesale and retail competition since then. Russia has undertaken the most comprehensive reform since 2004, by separating generation capacity into separate companies (though still under partial ownership of the incumbent) and, from 2008, introducing both wholesale and retail competition.

6.3.2 APEC gas markets

Reforms in natural gas since 2004 have been less extensive than in electricity. In part this is because the scope for competition in natural gas production depends on the range of sources of supply. Indeed, many of those economies with extensive indigenous reserves had already undertaken significant reform prior to 2004. These included Australia; Canada; Mexico; New Zealand; Peru; and the USA. At the other extreme, the Philippines has little domestic production and no imports, meaning the market is essentially still nascent. In Chile the scope for competition is limited, given that there is deemed little scope for sources of gas other than Argentina. Import-dependent economies such as the Republic of Korea and Chinese Taipei have extended their sources of supply by building terminals to handle LNG, but so far their natural gas industries are still dominated by incumbents.

There have been four main instances of reform since 2004. China reformed its retail price controls so that they can more closely match production costs. New Zealand introduced a regulated third party access regime for one of its pipelines. Following earlier reforms in 2002, Singapore introduced a Gas Code in 2005 that details the terms and conditions for gas transportation on an equitable and non-discriminatory basis. Similarly, Thailand introduced third party access to pipelines to facilitate wholesale competition among its four major producers.

6.4 THE GAINS FROM REFORM – EVIDENCE TO DATE

The evidence of gains from the reforms to date has been qualitative and quantitative. Most of it has been based on the ongoing reform experiences in the developed economies, particularly in Europe and the USA. Reviews of the reform experience have also had to evaluate instances of possible reform failure – the first being the Californian electricity crisis of 2000–01 and the second the United Kingdom's retreat from a wholesale price pool back to bilateral contracts in 2001. Empirical evidence on these two issues is presented later.

6.4.1 Qualitative evidence

In several recent papers Pollitt (2007, 2008) summarises the gains from reform in electricity markets (and by extension, he claims, in gas markets), based primarily on the UK experience, which in many respects is a best-case scenario. While the UK is not a member of APEC, the research provides some guidance to impacts from reform.

Competition reduces costs (and prices) significantly, relative to what they might have been without reform, even if it does not reduce them in absolute terms over time. It does this by encouraging efficient operation and least-cost and timely investment. It also exposes pre-existing market power.

Retail competition has been revealed to be an important complement to competition in generation. Retail competition involves more than the choice of buying wholesale power from a non-incumbent generator. It also involves competition in billing, contract terms and the bundling of other services (i.e., competition at the supplier level).

Consumers do respond to price signals, both by switching suppliers and by demand reduction. This contradicts the previous conventional wisdom that demand was very unresponsive to price. Further, Pollitt (2008) claims that household consumers do not need institutionalised protection from fluctuations in wholesale prices – where they prefer fixed tariffs, suppliers have generally offered these voluntarily, providing a form of insurance as part of their bundled package of services. Pollitt (2007) also claims that with sufficient competition in generation, regulation of the level of retail prices should also become unnecessary (though incentive regulation of transmission prices, through CPI-X price caps, remains a critical part of the regulatory landscape).

Vertical separation is costly, but the vertical economies of joint operation between networks and competitive segments of the industry are not sufficient to outweigh the increased competitive pressure that comes from clear separation of the monopoly networks from the rest of the supply chain. Pollitt (2008) claims that this has been proved for electricity transmission, gas transmission and may be in the process of being proved for gas distribution in the UK. For APEC members this finding suggests that vertical separation should not be pursued for its own sake, but only where it can facilitate greater competition.

However, Pollitt (2007) notes that vertical economies between generation and transmission are not sufficient to offset the benefits of competition in wholesale power markets but they do appear to be significant between generation and retail. This is because the integration of generation and retail offers advantages in terms of matching supply and demand, and it means that retail-only companies are likely to struggle, as they have in the UK, the Netherlands and New Zealand. One side effect of generation and retail integration, however, is that it makes wholesale markets much thinner, which can have its own effect on the ease of new entry.

Finally, markets have been good at choosing between technologies on the basis of price, as demonstrated by the move to combined cycle gas turbines in the 1990s and by the resurgence of interest in nuclear power more recently. It is sometimes claimed that regulated markets are good at ensuring the efficient use of existing capacity but are not as good at ensuring appropriate investments in new capacity. However, Pollitt (2008) notes that as network capacity limits are reached the X factor in CPI-X price caps should become less driven by squeezing monopoly profits and more driven by the need to finance new investments. Nevertheless, new regulatory mechanisms may be necessary to ensure that the new investments are least cost, rather than simply undertaken to the incumbents' specifications.

Despite these potential gains from structural reforms, they have been implemented the farthest only in jurisdictions where supranational bodies (the European Commission), central governments (the USA) or inspired individuals (in Russia) have pushed hard and consistently. But even parts of the USA do not yet have full retail competition. In many other jurisdictions, reforms have stalled at some early or intermediate stage.

Clearly, local physical, institutional and other factors have a role to play in the ability of reforms to deliver real gains. According to Pollitt (2007), key institutional factors that seem to have been important are significant initial public ownership and prices that more than cover efficient economic cost (as in Australia; Chile; New Zealand; and the UK). Initial private ownership (e.g., in Japan and the USA) and prices below economic cost (e.g., in India) have made reform much more difficult. This is a significant qualification, since subsidisation of energy prices is relatively widespread in the APEC region. Also critical has been the capacity and flexibility of regulators to tailor reforms to local conditions and to adapt as network conditions change.

Beyond local conditions, Correlje and De Vries (2008) identify four key lessons from reforms that have taken place in:

- ownership separation (not just accounting or legal separation) of electricity transmission from the rest of the network has been critical to improving access for competitive generation and removing incentives to under-invest in transmission;
- getting the market structure right in electricity generation is crucial for the success of reforms, and allowing new entry alone may not be sufficient – horizontal separation may also be required;
- incentive regulation based on CPI-X price control of monopoly transmission networks can deliver significant incentives to reduce costs and facilitate efficient operation, while proving a stable cash flow for new investment, and economies with tougher incentive regulation of networks have significantly lower network costs as a result;
- regulation can address market failures such as those associated with the quality of supply, but it requires a degree of regulatory sophistication to balance efficiency and quality objectives.

Reviewing the experience of electricity reform in developing economies, Jamasb (2006) notes that the cost savings from wholesale markets or independent power producers will not be passed on to consumers if there is not enough competition in generation. While retail competition may be feasible only in the long term, competition among independent generators is possible even in a single-buyer market, and economies with small markets can also introduce competition *for* the market.

Reform in developing economies can take place even without privatisation. Reform requires a well-functioning transmission system, which should probably remain in public ownership in the early stages of reform. Incentive regulation can also drive efficiency improvements in distribution activities and ensure that they are passed on to consumers, even when distribution companies remain in public or local ownership.

Jamasb (2006) also confirms that cost-reflective tariffs and proper subsidy schemes (i.e., funded transparently and not relying on cross-subsidies) are crucial for the sustainability of reforms. He notes that stable macroeconomic conditions are crucial for attracting the necessary investments from domestic and foreign sources. Finally, he notes that progress in developing economies is likely to be evolutionary, particularly since regulatory capabilities and experience and the necessary institutional structures take time to develop.

6.4.2 Empirical evidence

The empirical evidence on the gains from reform is mixed. To some extent, the mixed results are themselves a sign that reforms may not have been taken far enough in some economies or are still in progress. Either reforms have not been taken far enough to have any real effect or

there are not enough reforms in the chosen samples for econometric techniques to discern any significant effects.

The mixed results may also reflect the difficulty of the empirical task. Establishing the effects of reform requires a data sample in which there has been a variety of reform experiences. This typically requires a data sample involving a number of different economies, and it can be difficult to correct for all the other economy-specific factors (other than reform) that may also account for the performance of the electricity sector. Even if it is possible to establish the effects of reform (correcting for other factors), it is typically very difficult to get robust evidence on which dimensions of the reform experience are responsible for those effects. As noted earlier, reform involves a number of inter-related steps, many of which are often taken together. This makes it very difficult to isolate which particular steps are responsible for the effects.

One of the first empirical assessments of the effects of electricity reform was Steiner's (2000) study of OECD members over the 1986–96 period. She found that unbundling of generation, third party access and the introduction of wholesale electricity markets were all associated with lower electricity prices. However, she also confirmed that private ownership was not necessarily associated with increased competition. Nevertheless, both private ownership and unbundling of generation and transmission were found to be associated with a higher rate of utilisation of existing generation capacity, and with reserve plant margins that were closer to optimal.

Hattori and Tsutsui (2004) undertook a similar study of OECD members over a slightly later period of 1987–99. Their findings were less definitive than Steiner's, though this could in part be because of differences in their measurement of variables (including prices). They found that giving customers access to alternative suppliers (which they argue is highly correlated with third party access) was associated with lower prices. However, unlike Steiner, they did not find a significant effect of unbundling or the introduction of a wholesale spot market on prices.

Nagayama (2007) undertook a broadly similar study of 83 economies over the 1985–2002 period. He found that neither unbundling nor the introduction of a wholesale pool market on their own would necessarily reduce electricity prices. In fact, contrary to expectations, there was a tendency for the price to rise. However, coexistent with an independent regulatory authority, unbundling could work to reduce prices. He also found that privatisation, the introduction of foreign independent producers and retail competition could lower electricity prices in some regions, but not all.

There have also been in-depth before-and-after studies of reform experiences in individual economies. Two areas of interest are the Californian electricity crisis and the UK's apparent reversal of reforms in the early 2000s. Both of these demonstrate the dangers of incomplete or inconsistent reforms.

Joskow's (2001) detailed analysis of the Californian crisis shows that when demand spikes, individual generators may have considerable market power to increase prices and withhold generating capacity, even when there is not collusion among them. This was found to be a factor contributing to a ten-fold rise in wholesale electricity prices in California in 2000. But regulatory problems also contributed significantly. One problem was wholesale market-design rules that prevented a smoothing of wholesale prices. Another problem was the maintenance of retail price caps that prevented signals about market conditions being passed

on to consumers. The caps led to the bankruptcy of major suppliers when wholesale prices rose above the capped retail prices.

Evans and Green (2003) examined why electricity prices fell in the UK after the abandonment of the wholesale price pool and the return to bilateral contracts. One problem with the pool had been collusion or manipulation by dominant players (arguably because of insufficient horizontal separation). Evans and Green attempt to distinguish the impact of a subsequent decline in market concentration from the introduction of the new electricity trading arrangements in 2001. They found that it was declining concentration that explained the fall in wholesale prices. This shows that effective regulatory action to reduce incumbent market shares can be more important than market design per se.

There are fewer studies of the effects of reform in gas markets. Jamasb, Pollitt and Triebs (2008) studied the effects of US regulatory reform on productivity, and found that encouraging competition has been rather successful in raising productivity. Hawdon (2003) found evidence that the types of reforms introduced in the UK are associated with higher levels of efficiency, good utilisation of labour and levels of underutilisation of capital sufficient to support the development of competitive markets. Nevertheless, Brakman, van Marrewijk and van Witteloostuijn (2009) warn that lack of competition and capacity constraints in gas production/import can prevent these gains being passed on to consumers.

6.5 NEW EVIDENCE ON THE GAINS FROM REFORM IN ELECTRICITY AND GAS MARKETS

One of the limitations of empirical studies of the effects of regulatory reform is that the studies are somewhat 'captive' to the nature and extent of reforms that are present in the sample. As the recent APEC experience shows, regulatory reform in the developing world has tended to be slow and incremental, so that samples taken from developing economies will not necessarily encompass a wide variety of reform experiences. Samples drawn from the developed world may not match the local conditions of developing economies, so that any extrapolation needs to be done with care. But samples from developed economies may capture a wider set of reforms and, therefore, give a clearer picture of the *potential* benefits of reform.

A recent round of new EU directives has provided a fresh impetus to regulatory reform of electricity and gas markets in these economies. This provides a rich new source of reform experience with which to test the empirical findings of earlier studies.

The First Electricity Directive (Directive 96/92/EC) of 1996 removed legal monopolies by requiring EU member states to allow large electricity users to choose their suppliers.[4] It also obliged vertically integrated companies to grant third party access to transmission and distribution networks and a minimum level of unbundling of vertically integrated companies. Gradually, this regime was seen to have various limitations. It allowed the terms of third party access to be negotiated rather than regulated. The unbundling obligations were limited, allowing accounting separation as well as legal or ownership separation. And the directive did not require the establishment of a national energy regulator. As a result, there were significant differences across member states in the extent of market opening.

To overcome these limitations, the Second Electricity Directive (2003/54/EC) was introduced in 2003, seven years after the original Directive. This obliged EU members to introduce a

[4] This is competitive because it involves large and informed consumers dealing with large informed producers.

regulated third party access regime, and removed the possibility of negotiated third party access. It also mandated the appointment of a national regulator that is independent of the industry. It required legal separation, rather than just accounting or management separation, between network activities (transmission and distribution) and all other activities. Finally, it required non-household customers to have choice of supplier by mid 2004, and household customers to have choice by mid 2007. These regulations tightened up a range of market opening requirements, and led to significant additional regulatory changes in lagging member states during the 2000s. In particular, the new regulations also stimulated the development of wholesale electricity markets in those members, so they could meet their obligations regarding consumer choice.

A similar slow evolution of regulation occurred in EU gas markets. The legislative process began in the 1990s with a series of directives aimed at abolishing import monopolies, gradually opening markets, mandating accounting separation for vertically integrated network companies and the adoption of regulated third party access. The Second Gas Directive (2003/55/EC) of 2003 required full market opening, national sector regulators, regulated third party network access, regulated or negotiated access to storage facilities and further unbundling of integrated companies. Supporting regulation set obligatory minimum requirements for access to transmission systems, including network tariffs, third party access services, capacity allocation, transparency, balancing and trading of capacity rights.

In analysing the impact of these regulatory frameworks, European Commission (2007) stresses how incomplete unbundling can seriously undermine attempts to introduce competition into electricity and gas markets. If network operators are not sufficiently independent from incumbent service suppliers, they will find a myriad of ways to thwart the activities of new entrants, despite third party access legislation.

The remainder of this section describes econometric analysis of the effects of electricity and gas reforms on prices and non-price measures of efficiency, using data for OECD members (including a significant number of EU members) over the 1990–2008 period. Thus the sample captures regulatory changes induced by both the first and second waves of EU reforms. The choice of OECD members is dictated largely by the availability of price information. A key source of relatively consistent information on energy prices across economies is the 'Energy Prices and Taxes' publication of the International Energy Agency, the data from which is available for sale online. However, the price information is only available for OECD members. Ideally, the exercise would have included the effects of reform on quality measures such as the reliability of supply. Unfortunately, there is no comprehensive international data on these measures.

6.5.1 Analysis of electricity markets

The analysis closely follows the approach of Steiner (2000). Electricity prices are modelled as being determined by measures of regulatory policy, as well as a number of non-regulatory controls. The regulatory measures are the presence of a regulated or negotiated third party access regime, the existence of a liberalised wholesale market for electricity, the existence of vertical unbundling between transmission and generation, and the prevalence of private ownership. The non-regulatory controls are the level of GDP, the shares of electricity generation accounted for by nuclear sources and hydro sources, and the urban share of the population, as a measure of the density of the network. These explanatory variables are the same as in Steiner, except for the addition of the degree of urbanisation, a higher value of which could be associated with lower prices if there were significant economies of density.

Missing from the current analysis are Steiner's measures of the time to privatisation and the time to liberalisation, since these performed perversely in her regressions, suggesting that they were correlated with each other and with other variables, so their own effects would not be established with precision.

Ideally, the model of electricity prices should include the prices of thermal fuel inputs (i.e., oil, coal and gas) as controls. However, the coverage of input prices from International Energy Agency sources is very patchy, and restricting the estimation to those economies and time periods for which it was available would severely restrict the range and extent of electricity reform in the sample. To some extent, controlling for hydro and nuclear shares helps to control for variations in generating input costs. The estimation also corrects for unobservable differences across economies, as will be explained shortly.

The current analysis also examines the effects of regulatory policy on capacity utilisation, and on the extent of deviation of reserve plant margins from optimal. Efficient generators typically plan to meet demands with a capacity buffer that is prudent but not excessive. This analysis follows Steiner in using a 15% margin as a rough indicator of the optimal reserve plant margin. Both measures of efficiency are modelled as being determined in part by the extent of third party access, the extent of unbundling, and the degree of private ownership. The existence of a wholesale price pool is not expected to influence efficiency, though it is expected to influence prices. These measures of efficiency are also affected by non-regulatory controls, including the degree of urbanisation. Instead of Steiner's measures of state preferences in favour of coal technology or against nuclear technology (both of which would be expected to reduce measured efficiency), the current formulation uses the actual shares of hydro, nuclear and coal technologies on total generating capacity.

The data sources are similar to those used by Steiner though including more APEC members. Electricity prices are taken from 'Energy Prices and Taxes' (third quarter 2009 edition) published online by the International Energy Agency. The necessary data on electricity capacity and generation to compute the efficiency and control measures were taken from 'Electricity Information' (2009 edition), also by the International Energy Agency. GDP and the rate of urbanisation are both taken from the World Bank's 'World Development Indicators'. Both electricity prices and GDP are expressed in US dollars converted using purchasing power parities. Electricity prices are the net-of-tax prices to industrial users, since the share of generation costs in consumer prices is likely to be highest for industrial users, and reforms are expected to impact most on generation costs. A summary of the data on electricity prices, efficiency measures, and non-regulatory controls is shown in Table 6.4 (Annex 6).

The policy variables used in the analysis are defined as follows:

etpa Existence of regime for regulated or negotiated third party access to electricity transmission grid
0 = no third party access, 1= third party access

ewpp Existence of liberalised wholesale market for electricity (wholesale price pool)
0 = no wholesale price pool, 1= wholesale price pool

eunb Existence of vertical separation between the transmission and generation segments of the electricity market (whether accounting separation or separate companies)
0 = no vertical separation, 1= vertical separation

eown Ownership structure of the largest companies in the generation, transmission, distribution and supply segments of the electricity market
0 = public, 1 = mostly public, 2 = mixed, 3 = mostly private, 4 = private

Measures of these policy variables for all of the OECD economies in the sample except for the Republic of Korea and Mexico are available up until 2003 from OECD (2005). Measures for the remaining economies and time periods were constructed from information obtained online from the International Energy Regulation Network, the 'EIA Country Analysis Briefs' of the US Energy Information Administration, and the 'Trade Policy Reviews' of the WTO. Web addresses for these sources are shown at the bottom of Tables 6.2 and 6.3 (see Annex 6). A full listing of the values of these policy variables for all OECD economies and time periods in the sample is given in Table 6.6 (Annex 6).

As noted earlier, one difficulty in exercises like this is distinguishing the separate contributions of different steps in the reform process when the different steps are often taken together. This creates a technical problem of multicollinearity, which manifests itself in econometric estimation on panel data sets as instability or 'flip-flop' in the signs of the coefficients on the policy variables, while the magnitudes of the coefficients are often implausibly large, but apparently highly significant. As an initial reality check, it is therefore useful to look at the *simple* correlations between the policy variables and the resulting measures of performance, prior to correcting for the influence of other variables.

These simple correlations are shown in Table 6.7 (Annex 6; unfortunately, graphical presentation does not show the correlations clearly, because of the zero-one nature of the policy variables). The table shows the same pattern of policy changes on price as in Steiner – third party access, a wholesale market and unbundling all tend to reduce electricity prices, while private ownership can increase them. Third party access, unbundling and private ownership also tend to increase capacity utilisation, while a wholesale market can apparently reduce it, though the effect is small, as expected. Third party access, a wholesale market, unbundling and private ownership are all associated with reserve plant margins being closer to optimal (the distance from the optimal margin is reduced), though the effect of the wholesale market is again small, as expected.

The simple correlations do not show whether the strength of these effects is significantly different from zero. They also do not correct for the influence of other, non-regulatory factors. The results of econometric estimation shown in Tables 6.9 and 6.10 (Annex 6) overcome these limitations.

The econometric estimation also attempts to control for *unobservable* influences on electricity prices and efficiency that might vary over time or across economies. Unobservable differences over time are controlled using a deterministic time trend. In principle, unobservable differences across economies could also have been controlled using deterministic dummy variables. However, such dummies are relatively highly correlated with both the policy variables and with the degree of urbanisation (which does not vary much over time in many economies). Including such deterministic dummies, therefore, causes the 'flip-flop' problem noted earlier. Consequently, unobservable economy effects are controlled by assuming them to be random and using random effects estimation, even when Hausman tests show that these estimates differ significantly from fixed effects estimates (the fixed effects estimates are not regarded as robust, for the reasons just described).

The effects of the policy variables on electricity prices are qualitatively the same as indicated by simple correlations. Furthermore, the effects are shown to be significantly different from zero. So Steiner's results are again confirmed – third party access, a wholesale market and unbundling all tend to reduce electricity prices, while private ownership can increase them. The apparent insignificance of some of these factors found by other researchers, particularly

the presence of a wholesale market, has been overcome by using a dataset in which there is more reform 'action'.

The non-regulatory influences on electricity prices are generally also as expected. Prices tend to be higher when GDP is higher, while a higher hydro share in generation tends to reduce prices. A high nuclear share also appears to reduce prices, against expectations, but this effect is not significant. A higher rate of urbanisation tends to reduce prices, confirming that there are economies of density in the production and sale of electricity.

The policy variables have less significant effects on efficiency than on prices. The only result that comes close to being significant is that unbundling tends to increase capacity utilisation. Note that European Commission (2007) also identifies adequate unbundling as the key linchpin to promoting effective competition. Utilisation also increases significantly when there is a high nuclear share in generating capacity. No policy variable has a significant effect on the deviation of reserve plant margin from optimal. However, this estimation performs poorly on all fronts.

These results should not be taken to mean that structural reform of electricity markets has minimal effect on efficiency. It just means that it has little discernable effect on the particular efficiency measures chosen in this exercise. Reform could still have a large beneficial effect on other measures, such as labour productivity. Indeed, the reforms that are shown to reduce electricity prices could do so in one of two ways – perhaps by squeezing the excess profits of incumbent operators, or more likely by encouraging them to reduce inflated production costs. Anecdotal evidence from the reform experience in economies such as Australia suggests that reforms can dramatically boost labour productivity and, therefore, reduce production costs.

6.5.2 Analysis of gas markets

While there are many models of gas efficiency (e.g., Lee, Park & Kim 1999, Granderson 2000, Hawdon 2003, Jamasb, Pollitt & Triebs 2008, Farsi & Filippini 2009) there are fewer models of gas prices. Furthermore, many of the price models explain the extent of convergence of gas prices across different geographic markets (e.g., Walls 1994, Cuddington & Wang 2006) rather than the level of gas prices *per se*.

This may in part reflect the limitations imposed by the way that gas prices are set, especially in Europe. As explained in European Commission (2007), a large majority of gas consumed in the EU is bought by the incumbent wholesale players under long-term contracts from producers outside and inside the EU. The prices in European long-term gas contracts are mainly linked to the prices of oil and oil derivatives. Thus the contract prices paid by different producers to different suppliers move in an almost identical manner through time, and do not react smoothly (or at all) to changes in the supply and demand of gas markets. The UK gas market is a little different, with long-term gas prices from UK fields being determined partly by hub gas prices (i.e., the prices on more or less organised wholesale exchanges) and partly by general inflation indexes. But hub trading has been slow to develop. At the retail end a majority of EU members regulate prices to households and small businesses, while at least six members set a regulated price that is available to all customers (though the proportion of consumers that have stayed with the regulated tariff varies between member states).

Thus if EU structural reform is to be reflected in gas prices at all, it is likely to be reflected in the wholesale–retail margins on gas sold to industrial users. The approach here is, therefore,

to look for any discernable effect of regulatory reform on the net-of-tax price to industrial users. These prices are modelled as being determined by measures of regulatory policy, as well as a number of non-regulatory controls. The regulatory measures are the presence of a regulated or negotiated third party access regime, the percentage of the retail market for gas that is open to competition, the absence of national, state or provincial regulations that restrict the number of competitors, the existence of vertical unbundling between production/import and other segments, the existence of vertical unbundling between gas supply and other segments and the prevalence of private ownership. The non-regulatory controls are the level of GDP, the total gas pipeline length (to account for economies of scale) and the urban share of the population (to account for economies of density).

Ideally, the model of gas prices to industrial users should include the wholesale price of gas as a control. However, as was the case for electricity, the coverage of input prices from International Energy Agency sources is very patchy, and restricting the estimation to those economies and time periods for which it was available would severely restrict the range and extent of gas reform in the sample. But given the relative unresponsiveness of wholesale gas prices to supply and demand conditions, it was judged adequate to proxy wholesale gas prices by a non-linear time trend.

The current analysis also examines the effect of regulatory policy on gas capacity utilisation, as measured by annual gas consumption relative to total pipeline length. This is modelled as being determined in part by the same regulatory variables as for gas prices. It is also affected by non-regulatory controls, including the share of gas in electricity generation (which would be expected to increase the utilisation rate) and the degree of urbanisation. Urbanisation could have an ambiguous effect on the utilisation rate. Greater urbanisation could increase the utilisation rate by allowing economies of density. However, if there were industrial or other users with heavy and reliable gas demands (such as mining operators or electricity generators) located outside urban areas, this too could increase utilisation despite the degree of urbanisation.

The coverage of economies and time periods is the same as for the electricity analysis. Net-of-tax gas prices to industrial users are taken from ‘Energy Prices and Taxes’ (third quarter 2009 edition) published online by the International Energy Agency. The necessary data on gas consumption and the gas share of electricity capacity is taken from ‘Electricity Information’ (2009 edition) and ‘Natural Gas Information’ (2009 edition) by the International Energy Agency. Pipeline lengths are taken from various editions of the ‘CIA World Factbook’, available online. GDP and the rate of urbanisation are both taken from the World Bank’s ‘World Development Indicators’. Both gas prices and GDP are expressed in US dollars converted using purchasing power parities. A summary of the data on gas prices, the efficiency measure and non-regulatory controls is shown in Table 6.5 (Annex 6).

The policy variables used in the analysis are defined as follows:

gtpa Existence of regime for regulated or negotiated third party access to gas transmission grid
0 = no third party access, 1= third party access

gretc Percentage of the retail market for gas that is open to competition
0 = less than 10%, 1= 10% or more

gent Existence of national, state or provincial laws or other regulations that restrict the number of competitors allowed to operate a business in at least some markets in gas production/import
0 = restrictions in all markets, 1= free entry in all markets

gunb_p Existence of vertical separation between gas production/import and other segments of the gas market (whether accounting, legal or ownership separation)
0 = no vertical separation, 1= vertical separation

gunb_t Existence of vertical separation between gas supply and other segments of the gas market (whether accounting, legal or ownership separation)
0 = no vertical separation, 1= vertical separation

gown Percentage of shares in the largest firm in the gas production/import sector owned by government
0 = 100%, 1 = more than 50%, 2 = 50%, 3 = less than 50%, 4 = 0%

Measures of these policy variables for all of the OECD economies in the sample are available up until 2003 from OECD (2005). Measures for the remaining time periods were constructed from information obtained online from the International Energy Regulation Network, the 'EIA Country Analysis Briefs' of the US Energy Information Administration and the 'Trade Policy Reviews' of the WTO. Web addresses for these sources are shown at the bottom of Tables 6.2 and 6.3 (see Annex 6). A full listing of the values of these policy variables for all OECD economies and time periods in the sample is given in Table 6.6 (Annex 6).

As an initial reality check, it is useful to look at the *simple* correlations between the policy variables and the resulting measures of performance, prior to correcting for the influence of other variables. These simple correlations are shown in Table 6.8 (Annex 6; once again, graphical presentation does not show the correlations clearly, because of the zero-one nature of the policy variables). The table shows that removing regulatory restrictions on entry can have an apparently large downward effect on gas prices. Unbundling production/import and private ownership are also associated with lower gas prices. Third party access, retail competition and unbundling of gas supply appear to be associated with higher gas prices. But note that there is limited scope for customer prices to reflect the conditions of supply, demand and competition, especially in Europe.

In simple correlations the policy variables also appear to have mixed effects on the utilisation of gas pipelines. Retail competition and private ownership appear to be associated with higher utilisation rates. Third party access, removal of entry restrictions and any type of unbundling appear to be associated with lower utilisation rates. Note, however, that European Commission (2007) was particularly critical of the adequacy of unbundling and the effectiveness in practice of third party access regimes in European gas markets, even after the reforms, in part because of the prevalence of long-term contracts and the continued close vertical ownership links between incumbent operators. In addition, the methods by which the incumbents have been able to reserve storage capacity, whether or not they use it, have had serious deleterious effects on the ability of new entrants to provide adequate services.

The results of econometric estimations shown in Tables 6.11 and 6.12 (Annex 6) correct for the influence of other, non-regulatory factors and also show whether the strength of the policy effects are significantly different from zero.

As for electricity, the econometric estimation also attempts to control for *unobservable* influences on gas prices and efficiency that might vary over time or across economies. Unobservable differences over time are controlled using a deterministic, quadratic time trend. In particular, this trend is intended to capture the significant and accelerating upward trend in wholesale gas prices over the sample period. Unobservable differences across economies are controlled using random effects estimation, even when Hausman tests show that these estimates differ significantly from (perhaps flawed) fixed effects estimates.

When non-regulatory factors are controlled for, few of the policy variables have a significant effect on gas prices. The only variable that appears to be significantly associated with lower gas prices is the unbundling of production/import from other market segments. This result accords with the observations of European Commission (2007) that close ownership links (and long-term contracts) lock new entrants out of being able to secure their own primary gas supplies, creating a serious impediment to competition.

The non-regulatory factors have the expected impact on gas prices. Prices are higher when GDP is higher. Prices are lower when gas pipelines are longer, suggesting economies of scale in gas production. Higher rates of urbanisation tend to reduce gas prices, though this effect is not significant.

Few of the policy variables have a significant effect on the utilisation of gas pipelines. Third party access appears to reduce pipeline utilisation, but third party access in Europe has been effectively thwarted by a variety of other means. Retail competition increases pipeline utilisation. The presence of retail competition is the 'acid test' of whether unbundling and third party access regimes create effective competition, and the effect on pipeline utilisation is significant. Private ownership also has a significant positive effect on pipeline utilisation. Higher rates of urbanisation tend to reduce pipeline utilisation, though the effect is not quite significant at conventional testing levels and, in any event, the effect is ambiguous *a priori*.

6.6 IMPLICATIONS FOR APEC ECONOMIES

The econometric results of the previous section can be used to project the effects that further structural reforms in APEC electricity and gas markets may have on prices and efficiency.

As noted earlier, such out-of-sample projections need to be interpreted cautiously. The econometric results are conditioned by local factors and details of policy design and implementation that are peculiar to OECD members in general and European economies in particular. To the extent that these local factors are adequately captured by the policy and control variables used in the regressions, they can also be taken into account in out-of-sample projections. But many of them will not be adequately captured by these variables. For example, the above policy variables do not distinguish between regulated and negotiated third party access, and this distinction was seen as crucial to the effectiveness of European reform efforts. Nevertheless, while caution is needed in interpreting numerical out-of-sample projections, the general lessons from Section 6.3 also provide some guidance about the prerequisites for successful reform.

Tables 6.2 and 6.3 (Annex 6) provide a great deal of detail about the current state of play in APEC electricity and gas markets, and can be used as the basis for deriving values for the policy variables currently appropriate to each APEC economy. Combined with the coefficient estimates from Tables 6.9–6.12 (Annex 6), this information can then be used to project by how much prices or efficiency measures would change if further reforms were undertaken (and, hence, the values of each of the policy variables were to change). To simplify the process, however, projections can be made for each type of reform, assuming a starting point for prices or efficiency that was the same as the OECD average (as shown in Tables 6.4 and 6.5 [Annex 6]). Thus a rough guide to the effects of individual reforms can be obtained as follows.

In electricity markets, the introduction of a third party access regime would be associated with about 4.7% lower electricity prices than otherwise, on an indicative basis and holding all

other factors constant (where 0.0032/0.067587 = 4.7%). The introduction of a wholesale electricity market would be associated with about 7.2% lower electricity prices, while the unbundling of generation from transmission would be associated with 11.1% lower electricity prices. In reality, the allocation of separate effects to separate reform initiatives is unlikely to be as precise as the combined effect of all initiatives, since the separate initiatives tend to go together. The combined effect of all three initiatives would be electricity prices estimated to be 23% lower than otherwise. This is a similar order of magnitude to the effects implicit in Steiner's projections.

Note that the econometric results also suggest that wholly private ownership of electricity operators would be associated with prices that were 23.1% *higher* than if ownership were wholly public (where 4*0.0039/0.067587 = 23.1%). Pollitt (2007) also notes that private ownership can make it difficult to get reforms under way. However, this is an effect of initial conditions that is unlikely to persist over time. Doove et al. (2007) also note that ownership is unlikely to be independent of market structure, as the econometrics implies. Any positive relationship between price and private ownership is likely to be strongest when there is a monopoly provider – private sector monopolists might be more likely to pursue higher profits than government monopolists and, hence, to raise electricity prices by exploiting their market power. This effect is also unlikely to persist over time as reform efforts continue.

The econometric results also suggest that unbundling of generation from transmission would be associated with 2.1% higher utilisation of generating capacity on an indicative basis (where 0.0944/4.428908 = 2.1%). No other reform initiatives were shown to have a significant effect on efficiency.

In gas markets the introduction of retail competition would be associated with gas prices being about 15.0% lower than otherwise, on an indicative basis and holding all other factors constant (where 30.446/203.2362 = 15.0%). The unbundling of gas production/import from other segments of the market would be associated with about 23.4% lower gas prices. Both these percentages would be lower if initial gas prices were higher than the average in the OECD sample, as they are currently.

The econometric results also suggest that the introduction of retail competition would be associated with 24.3% higher utilisation of pipeline capacity than otherwise on an indicative basis (where 1.4587/6.013908 = 24.3%). Third party access was projected to reduce capacity utilisation, but this reflects the difficulty of instituting an effective third party access regime in European gas markets. Private ownership is projected to about double capacity utilisation, probably reflecting that private gas operations tend to serve dedicated industrial users.

As noted, these results are indicative only and are not fine tuned to the individual circumstances of each APEC economy. However, they do suggest that the slow, incremental approach to reform of APEC energy markets is worth reviving or continuing, despite the considerable burdens imposed on regulatory capacity. APEC economies learn from the general lessons of reform in other economies, and they can learn from close interaction and cooperation among industry regulators. APEC processes are well tuned to providing the sort of experience sharing and capacity building that can make the regulatory burden easier. They can also learn from doing. The results of this paper suggest that the gains to industrial users and, by inference, to households would be considerable.

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ANNEX 6: TABLES 6.2–6.12

Table 6.2: Electricity regulation in APEC economies, 2009 (reforms since 2004 in italics).

	Upstream ownership	Upstream competition	Transmission ownership	Unbundling	Third party access	Wholesale pool	Downstream ownership	Downstream competition	Source*
Australia	Partially privatised	Ownership of generation remains concentrated, with significant state regulation	Partially privatised	Interconnected national grid operated by 8 TSOs	13 DSOs operate distribution networks under state TPA regimes. Australian Energy Regulator to take over regulation by 2010	National Electricity Market is a compulsory wholesale pool operated by National Electricity Market Management Company. Wholesale prices are market-based.	Partially privatised	Retail competition has been introduced since 2003	IERN
Canada	Most generation companies are Crown corporations, but generation in Alberta is mostly private.	18 generators, but 85–90% of the market is served by the provincial majors (BC Hydro, Hydro Quebec etc.)	Partially privatised, vertically integrated	Some vertically integrated (BC Hydro). Some functionally unbundled (Quebec, Saskatchewan, Manitoba, Nova Scotia, Ontario). IERN also describes the situation as 'mostly' vertically integrated.	*Several provinces have adopted the Open Access Transmission Tariff which allows IPPs to bid on new generation development and use the transmission system to gain access to wholesale markets (see also retail access details).*	BC, Saskatchewan, Quebec, Manitoba, New Brunswick and Alberta have a competitive wholesale pool. It is mandatory in Alberta.	Partially privatised	Ontario: retail access since 2002. Alberta: Retail access since 2001. BC, NB: Industrial open access.	IERN
Chile	Fully privatised	31 power generation companies, very often vertically integrated along the supply chain	Fully privatised	Yes - most transmission facilities were owned by TRANSELEC, majority owned by Hydro Quebec.	Free access to transmission services for generators; regulated third party access regime.	Wholesale prices are market based for sales to eligible customers and to Centros de Despcho Economico de Carga. Sales to distributors (which mainly supply non eligible customers) are regulated.	Fully privatised	34 distribution companies. Eligibility levels set at 2000KW (and 500-2000KW under certain circumstances).	IERN

Table 6.2 continued: Electricity regulation in APEC economies, 2009 (reforms since 2004 in italics).

	Upstream ownership	Upstream competition	Transmission ownership	Unbundling	Third party access	Wholesale pool	Downstream ownership	Downstream competition	Source*
China	Dominated by state-owned enterprises. Even the new generation and grid companies created in accordance with 2002 reform plans are under the direct ownership and control of State-owned Asser Supervision and Administration Commission	90% of electricity produced by state-owned or state-controlled enterprises, despite a number of small power plants. The government determines the output that each generator is to produce, and approves selling prices.	Dominated by state-owned enterprises. Six state-owned regional networks in charge of transmission and distribution.	The separation of transmission and distribution has not yet taken place. However, in the reform experiments in the North East and East, there are separate grid operating companies.	The North East China and East China regional electricity markets are described as being power exchange markets with a single buyer – hence no third party access because there is no retail choice.	*Trading activity low, mostly between generators and provincial electricity companies, which act as single buyers. Two pilot projects to develop regional trading markets (one in North East, one in East) were launched in 2007*	Dominated by state-owned enterprises	Under each of the regional grid companies, there are provincial grid companies that have monopolies over distribution and sales within a specified area in accordance with the Electricity Law 1995.	TPR, Ni (2005).
Hong Kong, China	Two vertically integrated private companies with regional monopolies, operating under agreements that expire in 2018. Duopoly appears natural, as neither has exclusivity.	None	Two vertically integrated private companies with regional monopolies, operating under agreements that expire in 2018. Each owns its exclusive transmission grid	None	None	None	Two vertically integrated private companies with regional monopolies, operating under agreements that expire in 2018. An earlier government consultation document on post-2008 arrangements proposed continued regulation with more flexibility (shorter duration of agreement, lower permitted rate of return). This has now been accepted.	No competition, but rates of return regulated, and high by global standards for regulated private companies	TPR

Table 6.2 continued: Electricity regulation in APEC economies, 2009 (reforms since 2004 in italics).

	Upstream ownership	Upstream competition	Transmission ownership	Unbundling	Third party access	Wholesale pool	Downstream ownership	Downstream competition	Source*
Indonesia	State-owned electricity utility PT PLN (Persero) owns two-thirds of generating capacity. IPPs provide the rest under Power Purchase Agreements. Under new government regulation 3/2005 IPPs must be in joint venture (maximum 95% foreign ownership).	Retail prices were controlled, often at less than cost of production, so incumbent operated at a loss. This deterred investment in IPPs. There have also been disputes over payments by PT PLN to IPPs. There were take-or-pay contracts at high prices, to favour IPP owners who had political connections. Under new regulation 3/2005, there will generally be competitive bidding for new capacity	State-owned electricity utility PT PLN (Persero) dominates, and presumably owns the transmission capacity.	None	None	No - IPPs sell to PT PLN on long-term contract.	PT PLN has monopoly on retail sales.	Electricity Law of 2002 anticipated retail competition by 2008, but the law was annulled by the Constitutional Court. A new government regulation has been drafted (3/2005) but PT PLN retains the sole right to distribute and sell electricity. However, regulated retail price has been raised - now about production cost. New law was finally passed in September 2009 - will allow private investors and local authorities to generate, transmit, distribute and sell electricity without working through PLN. Authorities to retain some control over prices.	TPR, Nikombori rak and Manachotp hong (2007).

Table 6.2 continued: Electricity regulation in APEC economies, 2009 (reforms since 2004 in italics).

	Upstream ownership	Upstream competition	Transmission ownership	Unbundling	Third party access	Wholesale pool	Downstream ownership	Downstream competition	Source*
Japan	Privatised	10 regional private utilities responsible for generation, transmission, distribution and supply in their respective service areas. Only a small percentage provided by IPPs.	Private	None	The regional utilities own and operate transmission and distribution grids under a TPA regime.	*The Japan Electricity Power Exchange is a voluntary market where both spot and forward trading takes place. It was established in November 2003 and started operation in April 2005*	Private	*Eligibility levels set at 50 KW since 2005. Full market opening (including residential customers) to be introduced in 2007*	IERN
Korea	Majority state-owned KEPCO generates 94% of all power. A few IPPs supply to KEPCO under long-term contract. KEPCO generating capacity split into 6 separate Gencos, but these are still subsidiaries of KEPCO - privatisation not attempted since liberalisation was suspended in 2004.	*KEPCO generates 94% of all power and handles distribution and transmission. A few IPPs supply to KEPCO under long-term contract. KEPCO's monopoly on non-nuclear power generation abolished in 1999, and its generation capacity was split in 2001. These gencos compete with each other in a generation pool.*	KEPCO manages transmission and distribution, its wholly owned subsidiaries manage generation.	*KEPCO generating capacity split into 6 separate Gencos, but these are still subsidiaries of KEPCO - privatisation not attempted since liberalisation was suspended in 2004, based on the two-thirds recommendation of a joint study team, who thought the benefits of an integrated regulated monopoly outweighed the benefits of competition.*	*A regulated third party access system for transmission was introduced to facilitate trade between generators and large customers, using rate of return on assets to determine the transmission fee.*	*Gencos compete in a wholesale power pool (one-way bidding).*	KEPCO manages transmission and distribution, and is majority state-owned.	None. Eligible customers can buy electricity directly from Gencos, but distribution services (billing etc) are still a KEPCO monopoly.	TPR, Cho, Gulen and Foss (2007).

Table 6.2 continued: Electricity regulation in APEC economies, 2009 (reforms since 2004 in italics).

	Upstream ownership	Upstream competition	Transmission ownership	Unbundling	Third party access	Wholesale pool	Downstream ownership	Downstream competition	Source*
Malaysia	Tenaga is majority state-owned, and owns about 60% of generating assets. The IPP sector owns 40%. The first 5 IPP licences (in early 1990s) went to the politically well-connected, and Tenaga became minority shareholder in all but one of the first IPPs.	The IPPs signed long-term contracts with Tenaga, which were overseen by the government. These included take or pay provisions or fixed capacity charges, very beneficial to the IPPs. Since the Asian financial crisis IPPs have signed contracts on less beneficial terms.	Tenaga holds a monopoly over transmission and distribution in all of Peninsula Malaysia. Two smaller companies provide power in Sabah and Sarawak.	None	Described as being very limited.	None. Plans for a power pooling system were put on hold in the wake of the Californian power crisis, but there were moves to inject more competition into the process of bidding for power plant construction.	Tenaga holds a monopoly over transmission and distribution in all of Peninsula Malaysia. Two smaller companies provide power in Sabah and Sarawak.	None.	Rector (2005)
Mexico	Under Article 27 of the Constitution, the State has exclusive responsibility for generating, transporting, transforming, distributing and supplying electricity as a public service. The public electricity system is dominated by CFE, a decentralised state-owned entity that operates most of the electricity plants, and all of the transmission and distribution network jointly with LFC.	In 2006 CFE bought 26% of its energy from IPPs. IPP (small scale production), cogeneration, self-supply, import and export are not deemed a public service.	Under Article 27 of the Constitution, the State has exclusive responsibility for generating, transporting, transforming, distributing and supplying electricity as a public service. The public electricity system is dominated by CFE, a decentralised state-owned entity that operates most of the electricity plants, and all of the transmission and distribution network jointly with LFC.	None. The system operator, the State-owned National Energy Control Centre, is part of CFE.	None. IPPs can sell only to CFE. In 2002 there was a proposal by the Executive to, among other things, convert the National Energy Control Centre into a decentralised entity responsible for dispatch and capable of guaranteeing non-discriminatory access to distribution networks. This was not adopted by Congress.	Apparently none.	Under Article 27 of the Constitution, the State has exclusive responsibility for generating, transporting, transforming, distributing and supplying electricity as a public service. The public electricity system is dominated by CFE, a decentralised state-owned entity that operates most of the electricity plants, and all of the transmission and distribution network jointly with LFC.	Private generators are not allowed to sell to end users. End-user prices are subsidised.	IERN, TPR

Table 6.2 continued: Electricity regulation in APEC economies, 2009 (reforms since 2004 in italics).

	Upstream ownership	Upstream competition	Transmission ownership	Unbundling	Third party access	Wholesale pool	Downstream ownership	Downstream competition	Source*
New Zealand	Partially privatised	5 companies produce 95% of the electricity generation	Transmission is publicly owned, while distribution is partially privatised.	Transmission is owned and operated by Transpower.	Yes (see also retail competition)	Yes.	Transmission is publicly owned, while distribution is partially privatised.	There are 28 distribution companies that sell mainly to retailers. Retailers include the big 5 generation companies, plus at least 4 others. All end users can choose between retailers.	IERN
Peru	Partially privatised	State-owned Electroperu SA is the dominant player. Other IPPs are Edegel SAA and Egenor Duke Energy Internacional SAC. The private sector produces four-fifths of the energy and competes for non-regulated customers.	Partially privatised	Yes. The majority of the transmission system is controlled by ISA Group.	Yes - generators compete for customers.	No. The wholesale market relies on bilateral medium or long-term contracts for non-regulated customers.	Partially privatised, mainly private.	Two big private companies, plus the rest operated by the State. Eligibility is set at 1 MW.	IERN

Table 6.2 continued: Electricity regulation in APEC economies, 2009 (reforms since 2004 in italics).

	Upstream ownership	Upstream competition	Transmission ownership	Unbundling	Third party access	Wholesale pool	Downstream ownership	Downstream competition	Source*
Philip-pines	Partially privatised	State-owned PSALM took over operation of generation assets of the vertically integrated National Power Corporation when it was broken up in 2001. These assets are to be privatised. The Electric Power Industry Reform Act of 2001 (EPIRA) states that 70% must be sold before open access and retail competition. As of May 2008, privatisation was still not complete. There are also IPPs.	Transmission is publicly owned, while distribution is partially privatised.	*Yes. State-owned National Transmission Company operates the national grid.*	No. See also retail competition.	No. Wholesale prices regulated by the Energy Regulatory Commission. IPPs had long-term contracts with NPC prior to EPIRA. Immediately after EPIRA, lack of contracts may have thwarted privatisation. EPIRA now allows short-term transition contracts until one year after open access. But still a 'chicken and egg' problem.	Partially privatised. Distribution: 17 privately owned companies and 119 cooperatives. Accounting separation between regulated and non-regulated assets for DSOs was promulgated in 2003 and is due for amendment in 2006.	The implementation of retail competition and open access was tentatively set up on 1 July 2006, but it is totally dependent on the realisation of NPC's generation asset privatisation plan.	IERN, Mira and Singson (2007), Philippine Daily Inquirer
Russia	*System was dominated by vertically integrated Unified Energy System of Russia (RAO UESR), 52% government owned with 10% Gazprom stake. Foreign investors have taken stakes in the wholesale generation companies and territorial generation companies that were split off since 2006.*	RAO UESR has 70% installed capacity. A RAO UESR subsidiary owns the wholesale market. Mandatory bilateral contracts were at government fixed prices in transition to Target Market Model.	RAO UESR is sole owner of Federal Grid Company. It owns about 96% of transmission and 77% of distribution systems.	*Not really initially. Vertically integrated RAO UESR was sole owner of Federal Grid Company. But since 2006 six wholesale generation companies and 14 territorial generation companies have been split off, though RAO UESR retains shareholdings in these.*	*Not initially (customers were serviced by regional monopolies). But by 2008, competitive supply companies and retail competition were in place.*	*Not initially. But now a competitive wholesale market accounts for about 20% of generation.*	*Customers were served by regional monopolies. But by 2008, competitive supply companies and retail competition were in place. Supply companies privately owned.*	*As at 2008, simplified provisions in place for transition of consumers from one seller to another. Extent of real retail competition not clear. Aiming for full competition (ie phasing out of regulated prices) at both wholesale and retail level by 2011.*	IERN (from March 2006), RAO UESR present-ations.

Table 6.2 continued: Electricity regulation in APEC economies, 2009 (reforms since 2004 in italics).

	Upstream ownership	Upstream competition	Transmission ownership	Unbundling	Third party access	Wholesale pool	Downstream ownership	Downstream competition	Source*
Singapore	Generation dominated by 3 government-linked companies. Temasek announced in 2007 that they will be divested by 2008–09.	To curtail market power, the Energy Market Authority imposed vesting contracts in 2004, which oblige generators to produce a specified quantity of electricity and limit prices. Contracts to be rolled back from 2005.	One transmission company, SP PowerAssets Ltd, is a subsidiary of Singapore Power, a Temasek company.	Yes	*Yes (see also retail competition)*	Yes. Wholesale market run by Energy Market Company Pty Ltd. Singapore electricity pool introduced in 1998.	SP Services, another subsidiary of Singapore Power, administers billing, meter reading and customer databases.	*Retail competition being introduced in stages. By mid-2004, the 10 000 biggest customers (75% of total demand) could buy from the wholesale pool or from retailers. The Energy Market Authority is studying how to retail to households efficiently.*	TPR
Chinese Taipei	TPC is a vertically integrated state-owned monopoly, with monopoly rights until 2008. IPPs provided around 16% of power in 2004, and sell through power purchase agreements to TPC. TPC privatisation is on hold indefinitely.	IPPs provided around 16% of power in 2004, and sell through power purchase agreements to TPC.	TPC is a vertically integrated state-owned monopoly, with monopoly rights until 2008. TPC privatisation is on hold indefinitely.	None	None	None	TPC is a vertically integrated state-owned monopoly, with monopoly rights until 2008. TPC privatisation is on hold indefinitely.	TPC is a vertically integrated state-owned monopoly, with monopoly rights until 2008. TPC privatisation is on hold indefinitely.	TPR, Wang (2006)

Table 6.2 continued: Electricity regulation in APEC economies, 2009 (reforms since 2004 in italics).

	Upstream ownership	Upstream competition	Transmission ownership	Unbundling	Third party access	Wholesale pool	Downstream ownership	Downstream competition	Source*
Thailand	As at 2007, State-owned generator and distributor (EGAT) had 56.8% of production. Rest was from private suppliers and imports (from Myanmar, Lao PDR and China). Domestic generation was 96.4% of domestic consumption. EGAT was corporatised in June 2005, but a planned IPO was called off.	As at 2007, State-owned generator and distributor (EGAT) had 56.8% of production. Rest was from private suppliers and imports.	EGAT has a monopoly in transmission.	No – EGAT is vertically integrated, but there is accounting separation.	No. In December 2003 the government approved the Enhanced Single Buyer model, which establishes EGAT as the sole electricity buyer, transmitter and wholesaler.	In 2000 there were plans to unbundle transmission and distribution, to create an independent regulator and create a wholesale power pool. Plans were thwarted by EGAT objections and by election of Thaksin, which converted reform plans into plan to create a 'national champion'. Enhanced single buyer model looks like it uses (retains?) PPAs, but 'new capacity allocation' based on competitive bidding. However, no independent regulator (cf Republic of Korea) so claimed to favour incumbent.	EGAT sells to the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA).	None. In 2005 regulated retail tariffs were only about 0.6% higher than marginal cost. Different categories of customers receive different degrees of cross-subsidy.	TPR, Greacen and Greacen (2004), Sira-soontorn (2008).

Table 6.2 continued: Electricity regulation in APEC economies, 2009 (reforms since 2004 in italics).

	Upstream ownership	Upstream competition	Transmission ownership	Unbundling	Third party access	Wholesale pool	Downstream ownership	Downstream competition	Source*
United States	Mixed, mostly private.	IPPs have flourished.	Mixed, mostly private.	Transmission segment is now undergoing unbundling. Distribution segment is changing more slowly. Companies are operated on a vertically integrated, cost-plus business model.	Starting from 2000, retail customers in some states have been given the choice of electricity suppliers. This suggests third party access.	In 2001 the California Power Exchange went out of business. Internet-based B2B markets have emerged, using a pay-as-bid model (essentially bilateral contracts).	Mixed, mostly private.	Starting from 2000, retail customers in some states have been given the choice of electricity suppliers.	IERN, Finance-Tech.
Viet Nam	State-owned EVN dominates generation, transmission, distribution and sales of electricity in Viet Nam. Foreign and private participation has been permitted since 2002, but lack of a regulatory regime has inhibited investment.	IPPs provide 19% of generating capacity	State-owned EVN dominates generation, transmission, distribution and sales of electricity in Viet Nam. Foreign and private participation has been permitted since 2002, but lack of a regulatory regime has inhibited investment.	No	No	No	State-owned EVN dominates generation, transmission, distribution and sales of electricity in Viet Nam. Foreign and private participation has been permitted since 2002, but lack of a regulatory regime has inhibited investment.	No	EIA Country Analysis Brief

* IERN is the International Energy Regulation Network website (http://www.iern.net/portal/page/portal/IERN_HOME/IERN_ARCHIV/Country_Factsheets). APEC IAP is the APEC Individual Action Plan website (http://www.apec-iap.org/). EIA Country Analysis Briefs come from the US Energy Information Administration website (http://www.eia.doe.gov/emeu/cabs/contents.html). TPR is the Trade Policy Reviews of the WTO (http://www.wto.org/english/tratop_e/tpr_e/tpr_e.htm).
Sources: See last column.

Table 6.3: Gas regulation in APEC economies, 2009 (reforms since 2004 in italics).

	Upstream ownership	Upstream competition	Transmission ownership	Unbundling of transmission and production	Third party access	Unbundling of distribution and supply	Downstream ownership	Downstream competition	Source*
Australia	Private	Many private companies involved in exploration and production.	Private	Many major gas pipeline companies	National Gas Code regulates the gas distribution and transmission access regime.	Some companies vertically integrated in this way, but some separate retailers.	Private	Most States and Territories committed to implement full retail competition. Actual eligibility varies. Key reform dates are 1999 for NSW (partial) and SA, 2002 for NSW, ACT and Vic.	IERN
Canada	Private	At least 4 big companies	Partially privatised	Yes. Privately owned TransCanada Pipelines is the largest operator	Regulated third party access (according to OECD).	Yes (according to OECD). Natural gas distribution companies have been given franchise areas to serve customers (generally by local municipalities).	Private	Yes - fully liberalised since 1987.	IERN, OECD regulatory scorecard.
Chile	Partially privatised	State-owned ENAP is the main licensee for exploration and production. LNG terminal is owned by GASCO. Chile heavily dependent on imports from Argentina. Only one of four disjoint markets (the Magellan market) is supplied in part by ENAP.	Transmission partially privatised and distribution fully privatised.	Mostly. GASCO (LNG owner) has part ownership in one of 2 transmission pipelines to central area. ENAP owns the pipeline from its production fields to the Magellan basin. Other pipelines owned by third parties or end user (Methanex, a methanol producer in the Magellan region).	Unclear.	Apparently not.	Distributors are two GASCO subsidiaries plus two other private companies	More than one distribution company, but unclear whether there is competition or whether these are regional monopolies. OECD describes the natural gas market as a monopoly. Little prospect for sources other than Argentina, and it has cut supplies at various times.	IERN, Galetovic and de Mello (2005).

Table 6.3 continued: Gas regulation in APEC economies, 2009 (reforms since 2004 in italics).

	Upstream ownership	Upstream competition	Transmission ownership	Unbundling of transmission and production	Third party access	Unbundling of distribution and supply	Downstream ownership	Downstream competition	Source*
China	Dominated by the 3 large state-owned oil and gas holding companies - CNPC, Sinopec and CNOOC. All 3 have numerous local subsidiaries, which are listed on stock exchanges. CNPC and Sinopec are vertically integrated but their mandates are geographically separated.	CNPC dominates in gas production and sales, with 75.6% market share in 2006. LNG imports began in 2006. CNPC also involved in LNG imports. CNOOC provides offshore gas by pipeline to Hong Kong, China and Shanghai, and is the leading player in LNG. Some small size producers becoming active, mainly private or owned by local governments, to supply local markets.	One West to East pipeline became operational in 2004, and another has been approved. CNPC now owns about 80% of pipeline network.	One West to East pipeline became operational in 2004, and another has been approved. CNPC now owns about 80% of pipeline network.	Probably not. There is no specific law to regulate the natural gas industry. The existing legislation on pipelines concerns safety. Nevertheless, with growing interconnectedness, sharing of pipeline capacity apparently occurs.	Apparently. In 2002, the city gas business was opened to private and foreign companies, and more than 60 companies are now distributing in several cities.	Most distribution companies owned and managed by local governments. Natural gas delivered to some major industrial users directly by producers. In 2002, the city gas business was opened to private and foreign companies, and more than 60 companies are now distributing in several cities. LNG receiving terminals owned by joint ventures of local governments, has users and importing companies such as CNOOC and CNPC.	*Up until 2005, the price was tightly controlled, and not linked to production costs. This distorted use. In August 2007, the government issued a directive on which activities can use natural gas. Household fuel and combined cycle seems preferred, while its use to produce methanol is forbidden. Since 2005, controlled prices are adjusted annually in accordance with the price of other fuels, and producers can increase prices up to a limit, usually of 8%.*	TPR, Higashi (2009)

Table 6.3 continued: Gas regulation in APEC economies, 2009 (reforms since 2004 in italics).

	Upstream ownership	Upstream competition	Transmission ownership	Unbundling of transmission and production	Third party access	Unbundling of distribution and supply	Downstream ownership	Downstream competition	Source*
Hong Kong, China	Town gas is distributed by HKCG. LPG is supplied by six oil companies. Natural gas is supplied by pipe from the South China Sea and used solely by CLP for power generation. CLP plans for an LNG terminal recently scrapped after HK and Chinese governments signed MOU renewing 20 year supply agreements for natural gas and electricity.	Excluding natural gas, HKCG had about 80% of the market in the mid 2000s.	HKCG owns the pipes that service most households.	No.	No. Common carrier provisions investigated in late 1990s but there were deemed to be too few gas sources to make this worthwhile.	No.	Town gas is distributed by HKCG. LPG is supplied by six oil companies. Natural gas is supplied by pipe from the South China Sea and used solely by CLP for power generation.	Excluding natural gas, HKCG had about 80% of the market in the mid 2000s.	APEC IAP and other documents, CLP documents available from web.
Indonesia	Prior to 2001, Pertamina was both the oil and gas company and regulator. Under the 2001 deregulation and reform, upstream regulation is now under BP Migas. PT Pertamina is now limited liability and 100% government owned.	PT Pertamina and six major international companies dominate the natural gas industry. According to EIA, the six majors had about 80% market share in the mid 2000s. Just over 50% of gas was exported in the mid 2000s, but this is shrinking.	PT PGN has 87% share of transmission business and 93% share of distribution. It is 55% government owned. Listed on the Stock Exchange.	Apparently.	Yes. Gas transmission contracts are long-term, with minimum ship-or-pay volumes, with tariffs in USD. Access regulated by BPH Migas (downstream regulatory agency).	Apparently not.	PT PGN has 87% share of transmission business and 93% share of distribution. It is 55% government owned.	PT PGN has 87% share of transmission business and 93% share of distribution. It is 55% government owned. 98.7% of its customers are industrial.	EIA Country Analysis Briefs, PT PGN documents.

Table 6.3 continued: Gas regulation in APEC economies, 2009 (reforms since 2004 in italics).

	Upstream ownership	Upstream competition	Transmission ownership	Unbundling of transmission and production	Third party access	Unbundling of distribution and supply	Downstream ownership	Downstream competition	Source*
Japan	Partly privatised.	Domestic production negligible – 97% of demand met by LNG imports. Most import contracts in 1980–90s were long-term, tied to price of crude oil and not flexible. From 2001 the three major vertically integrated private companies (Tokyo Gas, Osaka Gas and Toho Gas) started to sign or renew on more flexible terms.	Partly privatised.	No. The three largest gas companies own and operate their transmission and distribution networks under a regulated third party access for large volume supply since 1999.	Yes. Regulated third party access for large volume supply since 1999.	No.	Partly privatised.	Most imports go to power generation or petrochemical feedstock - only about 1/3 to domestic consumption. Private companies have 97% of the market. Eligibility levels were at 0.5 Mcm by 2004, lowered to 0.1 Mcm by 2007. The price for non-eligible customers is regulated.	IERN
Korea	KOGAS is the main importer and distributor of natural gas and the largest purchaser of LNG in the world. KOGAS is 27% owned by government, 25% owned by (majority govt owned) KEPCO, and the rest split among local govt and institutional investors. State-owned KNOC is involved in domestic production, but this is a small fraction of consumption.	Not much. In 2005 POSCO and Mitsubishi started a fourth LNG import terminal, with about 7% of total import capacity.	KOGAS operates 3 LNG import terminals as well as the pipeline system. In 2005, POSCO and Mitsubishi started a fourth LNG import terminal, with about 7% of total import capacity.	No	KOGAS has a monopoly over wholesale trade, transmission and wholesale distribution.	KOGAS is the sole distributor to private city gas companies that have territorial monopolies and supply retail users through their distribution pipelines.	Partly privatised.	KOGAS is the sole distributor to private city gas companies that have territorial monopolies and supply retail users through their distribution pipelines. Wholesale gas tariffs must be approved by MOCIE, and retail gas prices by local governments. Essentially rate of return regulation.	TPR, EIA Country Analysis Briefs.

Table 6.3 continued: Gas regulation in APEC economies, 2009 (reforms since 2004 in italics)

	Upstream ownership	Upstream competition	Transmission ownership	Unbundling of transmission and production	Third party access	Unbundling of distribution and supply	Downstream ownership	Downstream competition	Source*
Malaysia	Wholly state-owned Petronas has a monopoly on all upstream natural gas developments. It also plays a leading role in downstream activities and LNG trade. Most natural gas production occurs from production sharing contracts operated by foreign companies in conjunction with Petronas.	No.	Through its listed subsidiary, Petronas Gas Bhd, Petronas has since 1984 been implementing the three-phase Peninsular Gas Utilisation (PGU) project. The entire PGU system now spans over 1,700km, comprising main gas transmission pipelines, supply pipelines and laterals. Also planning a Sabah-Sarawak pipeline.	No	No	Yes.	Gas Malaysia is sole provider of gas to non-power sector. It is 55% owned by MMC, 25% Tokyo Gas - Mitsui Holdings, and 20% Petronas Gas.	No	EIA Country Analysis Briefs, MMC website.
Mexico	Partially privatised. Government-owned PEMEX is licensed for production and first hand sale of gas on the wholesale market, while import, export and commercialisation have been liberalised and no authorisation is required.	No. However, as at mid 2007, the Regulatory Commission for Energy had granted private consortia, with domestic and foreign participation, 22 permits for distribution, 5 storage permits and 21 transport permits for serving the public.	Partly privatised. The Mexican natural gas transport system is composed of different unconnected pipelines operated by different TSOs under a third party access regime. The main pipeline is run by PEMEX. Several local DSOs operate the distribution pipelines under a regulated TPA/negotiated TPA.	No. However, transmission, storage and distribution rates and quality of services are regulated by the ERC.	Yes.	No. But ERC controls prices when DSOs act as supplier in their licensed area. Also, vertical separation (corporate unbundling) is required one step back – between distribution and transmission activities when the two systems are integrated.	Partly privatised.	Yes. The market is fully opened since 1995. End-user prices are market-based. ERC controls PEMEX's first hand sales prices as well as when DSOs act as supplier in their licensed area.	IERN, TPR.

Table 6.3 continued: Gas regulation in APEC economies, 2009 (reforms since 2004 in italics).

	Upstream ownership	Upstream competition	Transmission ownership	Unbundling of transmission and production	Third party access	Unbundling of distribution and supply	Downstream ownership	Downstream competition	Source*
New Zealand	Privatised.	81% of natural gas production comes from 2 fields - Maui (Shell, OMV NZ Ltd and Todd Petroleum) and Kapuni (Shell, Todd Petroleum). The rest comes from a number of fields.	Mainly private. NGC has one main network in the North Island - NGC has been acquired by Vector, which is majority private owned. The Maui pipeline is owned by a subsidiary of the Maui field owners. Other pipelines are privately owned.	Mostly.	Yes. *A regulated TPA regime has been in place for the Maui pipeline since 2005.* The NGC/Vector pipeline had open access arrangements before this.	Partly. 4 distributors, with NGC/Vector the main player. 9 gas retailers, including NGC/Vector, but also other players not involved in distribution.	Partly privatised.	9 gas retailers. Domestic prices are regulated by the Ministry of Economic Development.	IERN
Peru	Four main areas being exploited by domestic and foreign private companies. Also an LNG gas export terminal operated by a consortium led by Hunt Oil.	Yes.	One transmission pipeline operated under a regulated TPA regime by a consortium led by Techint based in Argentina.	Yes.	Yes.	No.	A company majority owned by Suez Group is the licensee distributor supplying Lima. Other major cities yet to be connected.	No	IERN
Philip-pines	Small but rapidly growing sector. 3 main areas of gas associated with oil. Main one is offshore. Domestic production used for power generation.	No. Imports under consideration.		No.	No.	NA	NA	NA	IERN

Table 6.3 continued: Gas regulation in APEC economies, 2009 (reforms since 2004 in italics).

	Upstream ownership	Upstream competition	Transmission ownership	Unbundling of transmission and production	Third party access	Unbundling of distribution and supply	Downstream ownership	Downstream competition	Source*
Russia	Gazprom is the 38% government-owned natural gas monopolist that dominates the sector. It accounts for 90% of production (2006). Three other private companies expected to be major contributors in the future.	Not much.	Gazprom controls the pipeline network.	No.	No.	Gazprom has the duty to supply gas to the domestic market at government-regulated prices.	Gazprom.	No	IERN
Singa-pore	Partially privatised. After 2002 reforms, two companies import gas: SembGas and Gas Supply, the latter being a wholly owned subsidiary of government-owned Temasek Holdings. Senoko Power (owned by Temasek) also imports, but solely for its own power generation.	Duopoly.	Government-owned Power Gas is involved only in the transport of gas. It remains the only licensed gas transporter and gas system operator.	Yes.	*Yes. The Gas Code of 2005 details the terms and conditions for gas transportation on an equitable and non-discriminatory basis.*	No.	SembGas, Gas Supply and City Gas (also a wholly owned subsidiary of Temasek) are involved in gas retailing. City Gas also manufactures gas.	Three players.	TPR

Table 6.3 continued: Gas regulation in APEC economies, 2009 (reforms since 2004 in italics).

	Upstream ownership	Upstream competition	Transmission ownership	Unbundling of transmission and production	Third party access	Unbundling of distribution and supply	Downstream ownership	Downstream competition	Source*
Chinese Taipei	Natural gas is supplied mainly by the state-owned CPC. It is the sole provider of gas, wholesale and transportation services to local distribution companies, power generators and industrial firms. There are private LNG terminals.	No. But wholesale prices are set by a Natural Gas Pricing Formula based on full cost recovery principle.	Natural gas is supplied mainly by the state-owned CPC. It is the sole provider of gas, wholesale and transportation services to local distribution companies, power generators and industrial firms. There are private LNG terminals.	No.	No.	No.	Local distribution companies.	No. But retail gas prices are also regulated by the ministry and local government, also based on the full cost recovery principle.	TPR
Thailand	Chevron Texaco is the largest natural gas producer, with about 2/3 of production. Three other companies also produce. PTTEP has about 28% of market. It is a subsidiary of PTT, the partly privatised oil giant.	Yes.	PTT Pipeline Co, 100% owned by PTT, which is just over 50% government owned.	Yes.	*Yes. Unclear when this came into force, but may have been after 2004.*	No.	Only one distribution licence had been issued to PTT by the newly formed Energy Regulatory Commission in 2009.	No	TPR, ERC website, Dept of Mineral Resources website, Skeer (2004).

Table 6.3 continued: Gas regulation in APEC economies, 2009 (reforms since 2004 in italics).

	Upstream ownership	Upstream competition	Transmission ownership	Unbundling of transmission and production	Third party access	Unbundling of distribution and supply	Downstream ownership	Downstream competition	Source*
United States	More than 500 natural gas processing plants. Following reform in 1990s, the companies owning these shifted from primarily oil/gas producers to 'midstream' companies, which now dominate.	Yes.	Competition encouraged by FERC letting pipelines unbundle their gathering, transportation and storage services - can price these separately. FERC also revised transportation rate structures.	Yes.	Regulated TPA.	Yes	Since the late 1980s public utility commissions have encouraged local gas distribution companies to unbundle their services and allow customers to choose their gas supplier.	Only about 50% of states have actively pursued deregulation of gas distribution. One problem is special obligations (e.g., USOs).	IERN
Viet Nam	State-owned Petrovietnam dominates the natural gas sector. It has foreign partners such as BP, Chevron, Petronas etc in production and development. Most gas is sent directly to industrial and power sector end users, such as the Phu My power complex.	No	Presumably Petrovietnam	No	No	No	Presumably Petrovietnam	No	EIA Country Analysis Brief.

* IERN is the International Energy Regulation Network website (http://www.iern.net/portal/page/portal/IERN_HOME/IERN_ARCHIV/Country_Factsheets). APEC IAP is the APEC Individual Action Plan website (http://www.apec-iap.org/). EIA Country Analysis Briefs come from the US Energy Information Administration website (http://www.eia.doe.gov/emeu/cabs/contents.html). TPR is the Trade Policy Reviews of the WTO (http://www.wto.org/english/tratop_e/tpr_e/tpr_e.htm).
Sources: See last column.

Table 6.4: Economic and technological data for electricity, OECD economies, 1990–2008.

Variable	Variable name	Number of observations	Mean	Standard deviation	Minimum	Maximum
Electricity end-user price to industry, net of taxes, USD PPP/kWh	entpr	349	0.067587	0.028455	0.016	0.187
GDP, PPP (current international $, trillions)	gdp_ppp_s	399	1.190218	2.09913	0.046	14.204
Nuclear share in gross production (ratio)	nucshr	399	0.189979	0.2158379	0	0.783681
Hydro share in gross production (ratio)	hydroshr	399	0.2009344	0.2536616	0.0003546	0.9962215
Urban share of population (%)	urban	399	75.3015	10.94613	47.9	97.4
Utilisation rate = gross production (GWh)/net capacity (MWe)	eutil	374	4.428908	0.562455	2.715238	5.852232
Deviation of reserve margin from optimal = abs[(capacity – peak)/peak – 0.15]	eres	332	0.304555	0.1984277	0.0004457	0.9926048
Nuclear share in capacity (ratio)	nuccapshr	374	0.1209503	0.1447605	0	0.5509456
Hydro share in capacity (ratio)	hydcapshr	374	0.2659052	0.2393256	0.0006915	0.9907865
Coal share in capacity (ratio)	coalcapshr	332	0.1543606	0.1766962	0	0.6428536

Sources: See text.

Table 6.5: Economic and technological data for gas, OECD economies, 1990–2008.

	Variable name	Number of observations	Mean	Standard deviation	Minimum	Maximum
Gas end-user price to industry, net of taxes, USD PPP/10e+7kcal	gntpr	260	203.2362	118.1389	74.21	644.418
GDP, PPP (current international $, billions)	gdp_ppp	399	1190.218	2099.13	46	14204
Pipeline length (,000km)	gpipe_s	399	29.32738	87.17871	0	548.665
Urban share of population (%)	urban	399	75.3015	10.94613	47.9	97.4
Utilisation rate = gas consumption (million m^3)/pipeline length (kms)	gutil	391	6.013908	8.047427	0.023514	47.62
Gas share in electricity generation capacity (ratio)	gascapshr	327	0.1019645	0.1029867	0	0.5691414

Sources: See text.

Table 6.6: Policy data for electricity and gas, OECD economies, 1990–2008.

Economy	Year	ETPA	EWPP	EUNB	EOWN	GTPA	GRETC	GENT	GUNB_P	GUNB_T	GOWN
Australia	1990	0	0	0	1	0	0	1	1	0	4
	1991	0	0	0	1	0	0	1	1	0	4
	1992	0	0	0	1	0	0	1	1	0	4
	1993	0	0	1	1	0	0	1	1	0	4
	1994	0	0	1	2	0	0	1	1	0	4
	1995	0	0	1	2	0	0	1	1	0	4
	1996	0	0	1	2	0	0	1	1	0	4
	1997	0	0	1	2	0	0	1	1	0	4
	1998	1	0	1	2	1	0	1	1	0	4
	1999	1	1	1	2	1	1	1	1	0	4
	2000	1	1	1	2	1	1	1	1	0	4
	2001	1	1	1	2	1	1	1	1	0	4
	2002	1	1	1	2	1	1	1	1	0	4
	2003	1	1	1	2	1	1	1	1	0	4
	2004	1	1	1	2	1	1	1	1	0	4
	2005	1	1	1	2	1	1	1	1	0	4
	2006	1	1	1	2	1	1	1	1	0	4
	2007	1	1	1	2	1	1	1	1	0	4
	2008	1	1	1	2	1	1	1	1	0	4
Belgium	1990	0	0	0	3	0	0	1	0	0	0
	1991	0	0	0	3	0	0	1	0	0	0
	1992	0	0	0	3	0	0	1	0	0	0
	1993	0	0	0	3	0	0	1	0	0	0
	1994	0	0	0	3	0	0	1	0	0	0
	1995	0	0	0	3	0	0	1	0	0	4
	1996	0	0	0	3	0	0	1	0	0	4
	1997	0	0	0	3	0	0	1	0	0	4
	1998	0	0	0	3	0	0	1	0	0	4
	1999	0	0	0	3	0	0	1	0	0	4
	2000	1	0	1	3	1	1	1	0	0	4
	2001	1	0	1	3	1	1	1	0	1	4
	2002	1	0	1	3	1	1	1	0	1	4
	2003	1	0	1	3	1	1	1	0	1	4
	2004	1	0	1	3	1	1	1	0	1	4
	2005	1	0	1	3	1	1	1	0	1	4
	2006	1	1	1	3	1	1	1	0	1	4
	2007	1	1	1	3	1	1	1	0	1	4
	2008	1	1	1	3	1	1	1	0	1	4
Canada	1990	0	0	0	1	1	1	1	1	1	4
	1991	0	0	0	1	1	1	1	1	1	4
	1992	0	0	0	2	1	1	1	1	1	4
	1993	0	0	0	2	1	1	1	1	1	4
	1994	0	0	0	2	1	1	1	1	1	4

	1995	0	0	0	2	1	1	1	1	1	4
	1996	0	0	0	2	1	1	1	1	1	4
	1997	0	0	0	2	1	1	1	1	1	4
	1998	0	0	0	2	1	1	1	1	1	4
	1999	1	0	0	2	1	1	1	1	1	4
	2000	1	0	0	2	1	1	1	1	1	4
	2001	1	0	0	2	1	1	1	1	1	4
	2002	1	1	0	2	1	1	1	1	1	4
	2003	1	1	0	2	1	1	1	1	1	4
	2004	1	1	0	2	1	1	1	1	1	4
	2005	1	1	0	2	1	1	1	1	1	4
	2006	1	1	0	2	1	1	1	1	1	4
	2007	1	1	0	2	1	1	1	1	1	4
	2008	1	1	0	2	1	1	1	1	1	4
Denmark	1990	0	0	0	1	0	0	0	1	0	0
	1991	0	0	0	1	0	0	0	1	0	0
	1992	0	0	0	1	0	0	0	1	0	0
	1993	0	0	0	1	0	0	0	1	0	0
	1994	0	0	0	1	0	0	1	1	0	0
	1995	0	0	0	1	0	0	1	1	0	0
	1996	0	1	0	1	0	0	1	1	0	0
	1997	0	1	0	1	0	0	1	1	0	0
	1998	0	1	0	1	0	0	1	1	0	0
	1999	1	1	0	2	0	0	1	1	0	0
	2000	1	1	0	2	0	1	1	1	0	0
	2001	1	1	1	2	1	1	1	1	1	0
	2002	1	1	1	2	1	1	1	1	1	0
	2003	1	1	1	2	1	1	1	1	1	0
	2004	1	1	1	2	1	1	1	1	1	0
	2005	1	1	1	2	1	1	1	1	1	0
	2006	1	1	1	2	1	1	1	1	1	0
	2007	1	1	1	2	1	1	1	1	1	1
	2008	1	1	1	2	1	1	1	1	1	1
Finland	1990	0	0	0	1	0	0	1	0	0	3
	1991	0	0	0	1	0	0	1	0	0	3
	1992	0	0	0	1	0	0	1	0	0	3
	1993	0	0	0	1	0	0	1	0	0	3
	1994	0	0	0	1	0	0	1	0	0	3
	1995	1	0	1	1	0	0	1	0	0	3
	1996	1	1	1	1	0	0	1	0	0	3
	1997	1	1	1	1	0	0	1	0	0	3
	1998	1	1	1	1	0	0	1	0	0	3
	1999	1	1	1	2	0	0	1	0	0	3
	2000	1	1	1	2	0	0	1	0	0	3
	2001	1	1	1	2	0	0	1	0	0	3
	2002	1	1	1	2	0	0	1	0	0	3

	2003	1	1	1	2	0	0	1	0	0	3
	2004	1	1	1	2	0	0	1	0	0	3
	2005	1	1	1	2	0	0	1	0	0	3
	2006	1	1	1	2	0	0	1	0	0	3
	2007	1	1	1	2	0	0	1	0	0	3
	2008	1	1	1	2	0	0	1	0	0	3
France	1990	0	0	0	0	0	0	0	0	0	0
	1991	0	0	0	0	0	0	0	0	0	0
	1992	0	0	0	0	0	0	0	0	0	0
	1993	0	0	0	0	0	0	0	0	0	0
	1994	0	0	0	0	0	0	0	0	0	0
	1995	0	0	0	0	0	0	0	0	0	0
	1996	0	0	0	0	0	0	0	0	0	0
	1997	0	0	0	0	0	0	0	0	0	0
	1998	0	0	0	0	0	0	0	0	0	0
	1999	0	0	0	0	0	0	0	0	0	0
	2000	1	0	1	0	0	0	0	0	0	0
	2001	1	0	1	0	0	0	0	0	0	0
	2002	1	1	1	0	0	0	0	0	0	0
	2003	1	1	1	0	1	1	1	0	1	0
	2004	1	1	1	0	1	1	1	0	1	0
	2005	1	1	1	1	1	1	1	0	1	1
	2006	1	1	1	1	1	1	1	0	1	1
	2007	1	1	1	1	1	1	1	0	1	1
	2008	1	1	1	1	1	1	1	0	1	1
Germany	1990	1	0	0	2	0	0	1	1	0	4
	1991	1	0	0	2	0	0	1	1	0	4
	1992	1	0	0	2	0	0	1	1	0	4
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	1994	1	0	0	2	0	0	1	1	0	4
	1995	1	0	0	2	0	0	1	1	0	4
	1996	1	0	0	2	0	0	1	1	0	4
	1997	1	0	0	2	0	0	1	1	0	4
	1998	1	0	1	2	0	1	1	1	0	4
	1999	1	0	1	2	1	1	1	1	0	4
	2000	1	1	1	2	1	1	1	1	0	4
	2001	1	1	1	2	1	1	1	1	0	4
	2002	1	1	1	2	1	1	1	1	0	4
	2003	1	1	1	2	1	1	1	1	0	4
	2004	1	1	1	2	1	1	1	1	0	4
	2005	1	1	1	2	1	1	1	1	0	4
	2006	1	1	1	2	1	1	1	1	0	4
	2007	1	1	1	2	1	1	1	1	0	4
	2008	1	1	1	2	1	1	1	1	0	4

Greece	1990	0	0	0	0	0	0	0	0	0	0
	1991	0	0	0	0	0	0	0	0	0	0
	1992	0	0	0	0	0	0	0	0	0	0
	1993	0	0	0	0	0	0	0	0	0	0
	1994	0	0	0	0	0	0	0	0	0	0
	1995	0	0	0	0	0	0	0	0	0	0
	1996	0	0	0	0	0	0	0	0	0	0
	1997	0	0	0	0	0	0	0	0	0	0
	1998	0	0	0	0	0	0	0	0	0	0
	1999	0	0	1	0	0	0	0	0	0	0
	2000	0	0	1	0	0	0	0	0	0	0
	2001	1	0	1	0	0	0	0	0	1	0
	2002	1	0	1	0	0	0	0	0	1	0
	2003	1	0	1	0	0	0	0	0	1	0
	2004	1	0	1	0	0	0	0	0	1	0
	2005	1	1	1	0	0	1	1	0	1	0
	2006	1	1	1	0	1	1	1	0	1	1
	2007	1	1	1	0	1	1	1	0	1	1
	2008	1	1	1	0	1	1	1	0	1	1
Ireland	1990	0	0	0	0	0	0	0	0	0	0
	1991	0	0	0	0	0	0	0	0	0	0
	1992	0	0	0	0	0	0	0	0	0	0
	1993	0	0	1	0	0	0	0	0	0	0
	1994	0	0	1	0	0	0	0	0	0	0
	1995	0	0	1	0	1	1	0	0	0	0
	1996	0	0	1	0	1	1	0	0	0	0
	1997	0	0	1	0	1	1	0	0	0	0
	1998	0	0	1	0	1	1	0	0	0	0
	1999		0	1	0	1	1	0	0	0	0
	2000		0	1	0	1	1	0	0	0	0
	2001	1	0	1	0	1	1	0	0	0	0
	2002	1	0	1	0	1	1	0	0	0	0
	2003	1	0	1	0	1	1	0	0	1	0
	2004	1	0	1	0	1	1	0	0	1	0
	2005	1	0	1	0	1	1	0	0	1	0
	2006	1	0	1	0	1	1	0	0	1	0
	2007	1	1	1	0	1	1	0	0	1	0
	2008	1	1	1	0	1	1	0	0	1	0
Italy	1990	0	0	0	0	0	0	0	0	0	0
	1991	0	0	0	0	0	0	0	0	0	0
	1992	0	0	0	0	0	0	0	0	0	0
	1993	0	0	0	0	0	0	0	0	0	0
	1994	0	0	0	0	0	0	0	0	0	0
	1995	0	0	0	0	0	0	0	0	0	1
	1996	0	0	0	0	0	0	0	0	0	1
	1997	0	0	0	0	0	0	0	0	0	2

	1998	0	0	0	0	0	0	0	0	0	3
	1999	1	0	1	0	0	0	0	0	0	3
	2000	1	0	1	2	0	0	0	0	0	3
	2001	1	0	1	2	1	1	0	1	0	3
	2002	1	1	1	2	1	1	1	1	0	3
	2003	1	1	1	2	1	1	1	1	1	3
	2004	1	1	1	2	1	1	1	1	1	3
	2005	1	1	1	2	1	1	1	1	1	3
	2006	1	1	1	2	1	1	1	1	1	3
	2007	1	1	1	3	1	1	1	1	1	3
	2008	1	1	1	3	1	1	1	1	1	3
Japan	1990	0	0	0	4	0	0	0	0	0	4
	1991	0	0	0	4	0	0	0	0	0	4
	1992	0	0	0	4	0	0	0	0	0	4
	1993	0	0	0	4	0	0	0	0	0	4
	1994	0	0	0	4	0	0	0	0	0	4
	1995	0	0	0	4	0	1	0	0	0	4
	1996	0	0	0	4	0	1	0	0	0	4
	1997	0	0	0	4	0	1	0	0	0	4
	1998	1	0	0	4	0	1	0	0	0	4
	1999	1	0	0	4	0	1	0	0	0	4
	2000	1	0	0	4	1	1	0	0	0	4
	2001	1	1	0	4	1	1	0	0	0	4
	2002	1	1	0	4	1	1	0	0	0	4
	2003	1	1	0	4	1	1	0	0	0	4
	2004	1	1	0	4	1	1	0	0	0	4
	2005	1	1	0	4	1	1	0	0	0	4
	2006	1	1	0	4	1	1	0	0	0	4
	2007	1	1	0	4	1	1	0	0	0	4
	2008	1	1	0	4	1	1	0	0	0	4
Korea	1990	0	0	0	0	0	0	0	0	0	0
	1991	0	0	0	0	0	0	0	0	0	0
	1992	0	0	0	0	0	0	0	0	0	0
	1993	0	0	0	0	0	0	0	0	0	0
	1994	0	0	0	0	0	0	0	0	0	0
	1995	0	0	0	0	0	0	0	0	0	0
	1996	0	0	0	0	0	0	0	0	0	0
	1997	0	0	0	0	0	0	0	0	0	0
	1998	0	0	0	0	0	0	0	0	0	0
	1999	0	0	0	0	0	0	0	0	0	0
	2000	0	0	0	0	0	0	0	0	0	1
	2001	0	1	1	0	0	0	0	0	0	1
	2002	1	1	1	0	0	0	0	0	0	3
	2003	1	1	1	0	0	0	0	0	0	3
	2004	1	1	1	0	0	0	0	0	0	3
	2005	1	1	1	0	0	0	0	0	0	3

	2006	1	1	1	0	0	0	0	0	0	3
	2007	1	1	1	0	0	0	0	0	0	3
	2008	1	1	1	0	0	0	0	0	0	3
Mexico	1990	0	0	0	0	0	0	0	1	0	0
	1991	0	0	0	0	0	0	0	1	0	0
	1992	0	0	0	0	0	0	0	1	0	0
	1993	0	0	0	0	0	0	0	1	0	0
	1994	0	0	0	0	0	0	0	1	0	0
	1995	0	0	0	0	0	0	0	1	0	0
	1996	0	0	0	0	1	0	0	1	0	0
	1997	0	0	0	0	1	0	0	1	0	0
	1998	0	0	0	0	1	0	0	1	0	0
	1999	0	0	0	0	1	0	0	1	0	0
	2000	0	0	0	0	1	0	0	1	0	0
	2001	0	0	0	0	1	0	0	1	0	0
	2002	0	0	0	0	1	0	0	1	0	0
	2003	0	0	0	0	1	0	0	1	0	0
	2004	0	0	0	0	1	0	0	1	0	0
	2005	0	0	0	0	1	0	0	1	0	0
	2006	0	0	0	0	1	0	0	1	0	0
	2007	0	0	0	0	1	0	0	1	0	0
	2008	0	0	0	0	1	0	0	1	0	0
Netherlands	1990	0	0	0	0	0	0	0	0	0	4
	1991	0	0	0	0	0	0	0	0	0	4
	1992	0	0	0	0	0	0	0	0	0	4
	1993	0	0	0	0	0	0	0	0	0	4
	1994	0	0	0	0	0	0	0	0	0	4
	1995	0	0	0	0	0	0	0	0	0	4
	1996	0	0	0	0	0	0	0	0	0	4
	1997	0	0	0	0	0	0	0	0	0	4
	1998	0	0	0	0	0	0	0	0	0	4
	1999	1	1	1	0	1	0	0	0	0	4
	2000	1	1	1	4	1	1	1	0	1	4
	2001	1	1	1	4	1	1	1	0	1	4
	2002	1	1	1	4	1	1	1	0	1	4
	2003	1	1	1	4	1	1	1	0	1	4
	2004	1	1	1	4	1	1	1	0	1	4
	2005	1	1	1	4	1	1	1	0	1	4
	2006	1	1	1	4	1	1	1	0	1	4
	2007	1	1	1	4	1	1	1	0	1	4
	2008	1	1	1	4	1	1	1	0	1	4
New Zealand	1990	0	0	1	0	0	0	1	0	0	4
	1991	0	0	1	0	0	0	1	0	0	4
	1992	1	0	1	0	0	0	1	0	0	4
	1993	1	0	1	0	0	0	1	0	0	4

	1994	1	0	1	0	0	0	1	0	0	4
	1995	1	0	1	0	0	0	1	0	0	4
	1996	1	1	1	0	0	0	1	0	0	4
	1997	1	1	1	0	0	0	1	0	0	4
	1998	1	1	1	0	0	0	1	0	0	4
	1999	1	1	1	2	1	0	1		0	4
	2000	1	1	1	2	1	0	1		0	4
	2001	1	1	1	2	1	0	1		0	4
	2002	1	1	1	2	1	0	1		0	4
	2003	1	1	1	2	1	0	1	1	0	4
	2004	1	1	1	2	1	0	1	1	0	4
	2005	1	1	1	2	1	0	1	1	0	4
	2006	1	1	1	2	1	0	1	1	0	4
	2007	1	1	1	2	1	0	1	1	0	4
	2008	1	1	1	2	1	0	1	1	0	4
Norway	1990	0	0	0	1	0	0	0	0	0	1
	1991	1	1	1	1	0	0	0	0	0	1
	1992	1	1	1	1	0	0	0	0	0	1
	1993	1	1	1	1	0	0	0	0	0	1
	1994	1	1	1	1	0	0	0	0	0	1
	1995	1	1	1	1	0	0	0	0	0	1
	1996	1	1	1	1	0	0	0	0	0	1
	1997	1	1	1	1	0	0	0	0	0	1
	1998	1	1	1	1	0	0	0	0	0	1
	1999	1	1	1	1	0	0	0	0	0	1
	2000	1	1	1	1	0	0	0	0	0	1
	2001	1	1	1	1	0	0	0	0	0	1
	2002	1	1	1	1	1	0	1	0	0	1
	2003	1	1	1	1	1	0	1	0	0	1
	2004	1	1	1	1	1	0	1	0	0	1
	2005	1	1	1	1	1	0	1	0	0	1
	2006	1	1	1	1	1	0	1	0	0	1
	2007	1	1	1	1	1	0	1	0	0	1
	2008	1	1	1	1	1	0	1	0	0	1
Portugal	1990	0	0	0	1	0	0	0	0	0	0
	1991	0	0	0	1	0	0	0	0	0	0
	1992	0	0	0	1	0	0	0	0	0	0
	1993	0	0	0	1	0	0	0	0	0	0
	1994	0	0	1	1	0	0	0	0	0	0
	1995	0	0	1	1	0	0	0	0	0	0
	1996	0	0	1	1	0	0	0	0	0	0
	1997	0	0	1	1	0	0	0	0	0	0
	1998	0	0	1	1	0	0	0	0	0	0
	1999	0	0	1	2	0	0	0	0	0	0
	2000	1	0	1	2	0	0	0	0	0	1
	2001	1	0	1	2	0	0	0	0	0	1

	2002	1	1	1	2	0	0	0	0	0	1
	2003	1	1	1	2	0	0	0	1	1	1
	2004	1	1	1	2	0	0	0	1	1	1
	2005	1	1	1	2	0	0	0	1	1	1
	2006	1	1	1	2	0	0	0	1	1	1
	2007	1	1	1	2	1	0	0	1	1	1
	2008	1	1	1	2	1	0	0	1	1	1
Spain	1990	0	0	0	2	0	0	0	0	0	4
	1991	0	0	0	2	0	0	0	0	0	4
	1992	0	0	0	2	0	0	0	0	0	4
	1993	0	0	0	2	0	0	0	0	0	4
	1994	1	0	1	2	0	0	0	0	0	4
	1995	1	0	1	2	0	0	0	0	0	4
	1996	1	0	1	2	0	0	0	0	0	4
	1997	1	0	1	3	0	1	0	0	0	4
	1998	1	0	1	3	0	1	0	0	1	4
	1999	1	1	1	3	0	1	0	0	1	4
	2000	1	1	1	3	0	1	0	0	1	4
	2001	1	1	1	3	0	1	0	0	1	4
	2002	1	1	1	3	1	1	0	0	1	4
	2003	1	1	1	3	1	1	0	0	1	4
	2004	1	1	1	3	1	1	0	0	1	4
	2005	1	1	1	3	1	1	0	0	1	4
	2006	1	1	1	3	1	1	0	0	1	4
	2007	1	1	1	3	1	1	0	0	1	4
	2008	1	1	1	3	1	1	0	0	1	4
Sweden	1990	0	0	0	2	0	0	1	0	0	4
	1991	1	0	0	2	0	0	1	0	0	4
	1992	1	0	1	2	0	0	1	0	0	4
	1993	1	0	1	2	0	0	1	0	0	4
	1994	1	0	1	2	0	0	1	0	0	4
	1995	1	0	1	2	0	0	1	0	0	4
	1996	1	1	1	2	0	0	1	0	0	4
	1997	1	1	1	2	0	0	1	0	0	4
	1998	1	1	1	2	0	0	1	0	0	4
	1999	1	1	1	2	1	0	1	0	0	4
	2000	1	1	1	2	1	1	1	0	1	4
	2001	1	1	1	2	1	1	1	0	1	4
	2002	1	1	1	2	1	1	1	0	1	4
	2003	1	1	1	2	1	1	1	0	1	4
	2004	1	1	1	2	1	1	1	0	1	4
	2005	1	1	1	2	1	1	1	0	1	4
	2006	1	1	1	2	1	1	1	0	1	4
	2007	1	1	1	2	1	1	1	0	1	4
	2008	1	1	1	2	1	1	1	0	1	4

United Kingdom	1990	1	1	1	3	1	0	1	0	0	4
	1991	1	1	1	3	1	0	1	0	0	4
	1992	1	1	1	3	1	0	1	0	0	4
	1993	1	1	1	3	1	0	1	0	0	4
	1994	1	1	1	3	1	0	1	0	0	4
	1995	1	1	1	4	1	0	1	0	1	4
	1996	1	1	1	4	1	0	1	0	1	4
	1997	1	1	1	4	1	0	1	1	1	4
	1998	1	1	1	4	1	1	1	1	1	4
	1999	1	1	1	4	1	1	1	1	1	4
	2000	1	1	1	4	1	1	1	1	1	4
	2001	1	1	1	4	1	1	1	1	1	4
	2002	1	1	1	4	1	1	1	1	1	4
	2003	1	1	1	4	1	1	1	1	1	4
	2004	1	1	1	4	1	1	1	1	1	4
	2005	1	1	1	4	1	1	1	1	1	4
	2006	1	1	1	4	1	1	1	1	1	4
	2007	1	1	1	4	1	1	1	1	1	4
	2008	1	1	1	4	1	1	1	1	1	4
United States	1990	0	0	0	3	1	0	1	1	1	4
	1991	0	0	0	3	1	0	1	1	1	4
	1992	1	0	0	3	1	0	1	1	1	4
	1993	1	0	0	3	1	0	1	1	1	4
	1994	1	0	0	3	1	0	1	1	1	4
	1995	1	0	0	3	1	0	1	1	1	4
	1996	1	0	1	3	1	0	1	1	1	4
	1997	1	0	1	3	1	0	1	1	1	4
	1998	1	1	1	3	1	1	1	1	1	4
	1999	1	1	1	3	1	1	1	1	1	4
	2000	1	1	1	3	1	1	1	1	1	4
	2001	1	1	1	3	1	1	1	1	1	4
	2002	1	1	1	3	1	1	1	1	1	4
	2003	1	1	1	3	1	1	1	1	1	4
	2004	1	1	1	3	1	1	1	1	1	4
	2005	1	1	1	3	1	1	1	1	1	4
	2006	1	1	1	3	1	1	1	1	1	4
	2007	1	1	1	3	1	1	1	1	1	4
	2008	1	1	1	3	1	1	1	1	1	4

Sources: See text.

Table 6.7: Simple correlations between policy and performance in electricity.

	Performance measures		
Policy variables	entpr	**eutil**	**eres**
etpa	-0.09	0.05	-0.16
ewpp	-0.06	-0.03	-0.04
eunb	-0.04	0.06	-0.17
eown	0.05	0.02	-0.14

Source: Own calculations.

Table 6.8: Simple correlations between policy and performance in gas.

	Performance measures	
Policy variables	gntpr	**gutil**
gtpa	0.20	-0.05
gretc	0.20	0.20
gent	-0.40	-0.28
gunb_p	-0.06	-0.29
gunb_t	0.16	-0.18
gown	-0.26	0.22

Source: Own calculations.

Table 6.9: Results of random effects panel regression for electricity prices.*

Dependent variable	**Industry price**
Constant	0.1571
	[0.000]
Third party access (etpa)	-0.0032
	[0.270]
Wholesale price pool (ewpp)	-0.0049
	[0.072]
Unbundling (eunb)	-0.0075
	[0.008]
Private ownership (eown)	0.0039
	[0.011]
Hydro share in generation (hydroshr)	-0.0276
	[0.047]
Nuclear share in generation (nucshr)	-0.0033
	[0.847]
Urbanisation (urban)	-0.0013
	[0.000]
GDP in PPP (gdp_ppp_s)	0.0010
	[0.352]
Time trend	0.0018
	[0.000]
Number of observations	347
Number of time periods	19
Number of OECD economies	21
Wald test that coefficients not significantly different from zero	100.06
	[0.000]
Breusch-Pagan chi-squared test that random effects equal zero	838.65
	[0.000]
Hausman test of no difference between random and fixed effects estimates	4.34
	[0.888]

* Numbers in parentheses after the coefficient estimates are Prob>lzl.
Numbers in parentheses after the Wald, Breusch-Pagan and Hausman tests are Prob>chi^2.

Table 6.10: Results of random effects panel regression for electricity efficiency.*

Dependent variable	Utilisation rate	Reserve margin deviation
Constant	3.9804	0.5256
	[0.000]	[0.034]
Third party access (etpa)	-0.0638	-0.0023
	[0.289]	[0.919]
Unbundling (eunb)	0.0944	-0.0317
	[0.111]	[0.152]
Private ownership (eown)	0.0077	-0.0019
	[0.780]	[0.871]
Hydro share in capacity (hydcapshr)	0.6381	-0.0126
	[0.152]	[0.939]
Nuclear share in capacity (nuccapshr)	2.3007	-0.2038
	[0.003]	[0.481]
Coal share in capacity (coalcapshr)	0.4208	-0.0126
	[0.284]	[0.939]
Urbanisation (urban)	-0.0028	-0.0031
	[0.760]	[0.355]
Time trend	0.0133	0.0036
	[0.014]	[0.078]
Number of observations	330	302
Number of time periods	19	19
Number of OECD economies	21	21
Wald test that coefficients not significantly different from zero	24.30	6.46
	[0.002]	[0.596]
Breusch-Pagan chi-squared test that random effects equal zero	811.45	869.64
	[0.000]	[0.000]
Hausman test of no difference between random and fixed effects estimates	17.49	6.90
	[0.025]	[0.547]

* Numbers in parentheses after the coefficient estimates are Prob>lzl. Numbers in parentheses after the Wald, Breusch-Pagan and Hausman tests are Prob>chi^2.

Table 6.11: Results of random effects panel regression for gas prices.*

Dependent variable	**Industry price**
Constant	320.5354
	[0.000]
Third party access (gtpa)	-4.75449
	[0.682]
Retail competition (gretc)	-30.4460
	[0.026]
Absence of entry restrictions (gent)	13.3761
	[0.474]
Unbundling of gas production/import (gunb_p)	-47.5065
	[0.002]
Unbundling of gas supply (gunb_t)	3.8747
	[0.780]
Private ownership (gown)	-2.9226
	[0.595]
Pipeline length (gpipe_s)	-0.3071
	[0.078]
Urbanisation (urban)	-1.7877
	[0.124]
GDP in PPP (gdp_ppp)	0.0183
	[0.018]
Time	-11.9693
	[0.000]
Time squared	1.4067
	[0.000]
Number of observations	256
Number of time periods	19
Number of OECD economies	21
Wald test that coefficients not significantly different from zero	531.42
	[0.000]
Breusch-Pagan chi-squared test that random effects equal zero	63.95
	[0.000]
Hausman test of no difference between random and fixed effects estimates	40.10
	[0.000]

* Numbers in parentheses after the coefficient estimates are Prob>lzl. Numbers in parentheses after the Wald, Breusch-Pagan and Hausman tests are Prob>chi^2.

Table 6.12: Results of random effects panel regression for gas efficiency.*

Dependent variable	**Pipeline utilisation rate**
Constant	15.8143
	[0.080]
Third party access (gtpa)	-1.1931
	[0.046]
Retail competition (gretc)	1.4587
	[0.015]
Absence of entry restrictions (gent)	0.6199
	[0.427]
Unbundling of gas production/import (gunb_p)	-0.7744
	[0.319]
Unbundling of gas supply (gunb_t)	-0.7000
	[0.271]
Private ownership (gown)	1.4720
	[0.000]
Gas share in electricity capacity (gascapshr)	2.2703
	[0.444]
Urbanisation (urban)	-0.1827
	[0.132]
Time	0.0089
	[0.872]
Number of observations	315
Number of time periods	19
Number of OECD economies	21
Wald test that coefficients not significantly different from zero	49.31
	[0.000]
Breusch-Pagan chi-squared test that random effects equal zero	1320.69
	[0.000]
Hausman test of no difference between random and fixed effects estimates	43.26
	[0.000]

* Numbers in parentheses after the coefficient estimates are Prob>lzl. Numbers in parentheses after the Wald, Breusch-Pagan and Hausman tests are Prob>chi^2.