Deregulation and restructuring of the global electricity supply industry and its impact upon power plant suppliers

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Abstract

This paper analyses the deregulation and restructuring of the global electricity supply industry and its impact upon fuel usage, generation technologies and suppliers of power plant. Deregulation encouraged the growth of new independent power producers whose business requirements transformed the power plant industry. The plant suppliers had to develop new capabilities and services to compete in the global market. Economies of scale and scope became crucial given the cost of developing the new technologies and providing the services required by the operators. This led to the global consolidation of the power plant industry because only large-integrated power engineering companies had the necessary resources and capabilities to compete in the new global environment.

Keywords: Deregulation; Electricity supply industry; Power plant suppliers; Capital goods

1. Introduction

The deregulation and restructuring of the electricity supply industry is one of the most important global energy developments of the last century. Up to the 1980s most countries relied upon state-owned monopolies to finance, construct, own and operate the electricity supply network. Since the mid-1990s, more than 30 countries or regions within countries have introduced policies to reform their electricity supply industries (Besant-Jones and Tenenbaum, 2001).

Power plant manufacturers supplying equipment to the electricity supply industry form an important industrial sector. Annual world orders for turbine generation equipment total more than 100 GW and have an estimated value of $40 bn (€34 bn)\textsuperscript{1} (Marsh, 1998). Power plant suppliers produce customised products on an engineer-to-order (ETO) basis or standard products on a make-to-order (MTO) basis. Large steam turbines tend to be manufactured on an ETO basis, as the designs are optimised to take account of the local operating conditions (e.g. ambient temperature, type of fuel, etc.) of the power station. In contrast, gas turbines are normally standard units that are produced on an MTO basis, although there

\textsuperscript{1}Exchange rates are based upon the average $/€ for the year indicated unless otherwise stated. The data were obtained from http://www.oanda.com/convert/fxhistory.
may be some ETO requirements that are site specific.

The steam power plant market is mature and cyclical, with supply exceeding demand. Prices have reduced in real terms over the last decade. The market for gas turbines has grown rapidly since deregulation. Customers require fast and reliable delivery. Demand has shifted from specific items of plant towards turnkey contracts and through-life solutions.

Previous research undertaken in the low volume capital goods sector has focused on operational issues including: production control (Bertrand and Muntslag, 1993); information systems (Wortmann, 1995); the co-ordination of marketing and manufacturing (Konijndijk, 1994); supply chains (McGovern et al., 1999; Hicks et al., 2000b); manufacturing layout (Hicks, 2004); scheduling (Pongcharoen, 2001; Song, 2001b; Pongcharoen et al., 2002; Song et al., 2002) and company structure (Hicks et al., 2000a, 2001).

There has been no systematic and comprehensive review of the impact of deregulation of the electricity supply industry on capital goods suppliers. Deregulation is the most important change that has affected power plant suppliers since 1989. This is because new market mechanisms have changed the economics of power generation, the relative attractiveness of different types of fuel and power plant, the source and availability of finance and the willingness of power generators to accept risk.

The primary objective of this paper is to explore the impact of deregulation and the restructuring of the global electricity supply industry on the power plant suppliers. Policy outcomes are described and analysed. In particular, how the introduction of competition in one industry led to rationalisation and consolidation in another. The competitive forces that were unleashed undermined the cosy relationships that had previously existed between the indigenous power plant suppliers and the state-owned utilities. The concomitant growth in independent power producers (IPPs) placed new demands on the suppliers, which encouraged the power plant companies to develop new capabilities in project management, project finance and the provision of new services. Furthermore, the inherent risks in the new competitive environment, along with the returns demanded by investors, provided a stimulus to gas turbine applications at the expense of steam turbine production. These changes benefited the large integrated power engineering companies, because only they had the financial resources and capabilities to compete in the new global market. The power plant industry is now dominated by three global companies: Alstom, General Electric (GE) and Siemens, which together satisfy 80% of global demand. Finally, the strategic and financial strategies of the three companies are analysed.

Table 1

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<td>19,385</td>
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</table>
in the context of the global demand for power plant.

2. The global market for electricity

Marsh (2000) estimated that the worldwide electricity supply industry was valued at $1000 bn (€1085 bn) per year. Table 1 shows the breakdown of world electricity consumption by region. In 1999, world electricity consumption totalled 12,833 billion kilowatt hours (KwHr) and is projected to increase to 22,407 billion kilowatt hours by 2020. There is a considerable increase in demand forecast for all regions of the world. However, the growth in demand in developing countries is predicted to increase faster than in industrialised countries. There will therefore be a particularly strong demand for power plant in the developing countries.

2.1. Energy usage for electricity generation

Fig. 1 shows world energy demand from 1970 to 1990 with forecasts up to 2020. The increase in demand for electricity is being driven by the widespread use of computers, domestic appliances, telecommunication products and electrically powered transportation systems. The use of natural gas for the generation of electricity is expected to grow rapidly over the period to 2020. United States demand for natural gas is expected to increase its share of the electricity fuel market from 15% in 1999 to 32% by 2020. Likewise in Western Europe, gas is expected to double from 14% to 28% over the same period. In Central and South America gas is projected to grow from 11% to 32% (EIA, 2002). Gas has become a preferred fuel for a number of reasons. Compared with coal-fired power stations, new combined cycle gas turbines (CCGTs) have low capital cost. Shorter construction times allow for greater flexibility in deciding when to build new stations. Modular design makes them ideal for turnkey contracts. They consume less fuel and have lower emissions of carbon and nitrogen dioxides (Hicks et al., 2000a).

Coal will remain an important fuel for electricity generation, though its share of the world’s electricity fuel market is projected to decline from 36% in 1999 to 32% by 2020. In the United States, coal’s share of the market is expected to decline from 51% to 46% over the same period. A similar trend is forecast for Western Europe, where coal held a 23% share in 1999, which is forecast to fall to 15% by 2020. Forecasts for Asia project a decline from 62% to 51% over this period. Nuclear generation is also expected to decline in many regions of the world as a result of operational safety concerns, waste disposal issues, concerns about nuclear arms proliferation and decommissioning and operating costs. The use of oil for electricity generation has declined since the second oil crisis in 1979. Oil accounted for 23% of electricity fuel use in 1977, but in 1999 its share was under 10% (EIA, 2002).

2.2. Deregulation and restructuring of the electricity supply industry

Throughout the world there has been a shift from engineering-led, vertically integrated electricity industries operating on a cost-plus basis to competitive markets. Electricity reform has been motivated by: technological developments, particularly the improved efficiency of gas turbines; the need for increased investment, especially in developing countries; high electricity prices and a shift away from the view that electricity supply is a natural monopoly. Countries have introduced a
range of measures to stimulate competition including:

- the privatisation of electricity assets;
- attracting foreign investment;
- the unbundling of energy services and assets through the separation of the ownership of generation, transmission, distribution and marketing;
- the creation of electricity trading arrangements (pools) and retail competition;
- the establishment of independent system operators;
- the deregulation of electricity prices;
- open access to the grid (EIA, 2002).

Most industrialised countries saw privatisation as a way of increasing efficiency and transferring the requirement for capital to the private sector. The way that privatisation has been implemented varies from country to country. The privatisation model adopted by the United Kingdom, in which a state-owned enterprise is split into smaller entities and then transferred to the private sector, is common. However, in less developed countries ‘privatisation’ is interpreted as allowing private, and in many cases foreign capital, to finance and operate a plant that would have previously been procured and operated by government. Investors are rewarded from revenues generated from the operation of the facility. At the end of the concession period ownership is transferred to the government. This arrangement is attractive to some host governments because it addresses power supply problems at the margins without disturbing the structure of the domestic industry; thereby avoiding some of the difficult issues raised by privatisation (Dunkerley, 1995).

Power projects have traditionally been financed by the public sector. In developing countries, the World Bank has also played a prominent role as a financier and policy advisor to governments. Indeed, the Bank has been the largest provider of capital for power projects in these countries (World Bank, 1993). For example, between 1984 and 1999, the World Bank provided $7bn (€6.6bn)\(^2\) for energy-related projects in China, of which about half was for the construction of twelve coal-fired power stations (Martinot, 2001).

In the early 1990s, the funding of energy projects in developing countries by governments and multi-lateral agencies was declining, while demand for electricity was increasing rapidly. The World Bank estimated that these traditional sources of capital would be able to finance only 10% of the $100bn (€85.4bn) needed annually to meet the energy requirements of these countries (Strickland and Sturm, 1998). The Bank concluded that developing countries would need to raise finance from the private capital markets to meet their electricity requirements. This was reflected in the new lending policy of the World Bank. One of the new conditions was that countries should restructure their electricity supply industry. This policy resulted in “the unbundling, commercialisation, and privatisation of state-owned utilities, the introduction of independent regulation, and the attraction of private investment and management services” (Strickland and Sturm, 1998, p. 874).

Asia and Latin America became major targets for private investors. Between 1990 and 1999, Asia’s electricity sector attracted $93bn (€87.3bn)\(^3\) billion of private investment, of which 72% was for greenfield projects (EIA, 2002). Private sector investment has largely been restricted to generation projects, with transmission and distribution being controlled by government. The drawback for investors is that for political reasons tariff rates may be set too low, and hence be insufficient to cover the cost of generation without the support of government subsidies. Over the same period, Latin America attracted $78bn (€82.8bn) of private investment (EIA, 2002). In many of these countries, transmission and distribution as well as generation were open to private investment. Indeed, in some cases, foreign investors were allowed to acquire domestic utilities.

These changes have made the global markets for power plant more competitive. The once cosy relationships between power plant suppliers and local state-owned utilities have been replaced by tough international competition between global power plant companies.

\(^2\)The $/€ conversion rate is based upon the average for 1999.

\(^3\)The $/€ conversion rate is based upon the average for 1999.
3. The impact of deregulation on power plant suppliers

This section examines the global changes in the demand for gas turbines and steam turbines for fossil-fuelled and nuclear power plant. The world’s installed capacity is analysed in terms of its age, which influences orders for new plant, retrofit and refurbishment services.

3.1. Power plant orders by type

Fig. 2 shows the annual demand for power plant for the period 1975–1999. Until the late 1980s, the majority of demand was for steam turbines supplied to state-owned utilities. Gas-powered units were generally limited to providing backup and producing power during peak demand periods. However, the demand for gas turbines increased dramatically during the 1990s, when many countries deregulated their electricity supply industries. In 1999, orders for gas turbines totalled 67 GW, which was 58% of total demand. The total orders for steam turbines were 17 GW for combined cycle (CC) plant, 31 GW for fossil fuel generation and approximately 8 GW for nuclear power stations. This increase in gas turbine orders (at the expense of steam turbines) reflects the preference for the use of gas as a fuel.

3.2. Power plant orders by region

In the early 1990s, Asia was the most important market in the world for new power plant. Between 1993 and 1997, Asia and Australia accounted for 51% of power plant orders by volume measured in gigawatt output (Marsh, 1998). However, the Asian economic crisis is 1997–1998 led to many projects being put on hold. This market is picking up slowly. Fig. 3 shows that in 1999 the United States accounted for half the total orders, followed by East Asia (mainly Japan and China) 23% and Western Europe with 7%.

There was a significant growth in investment in power plant construction in the United States from the late 1990s until 2002 because of the decrease in the energy-reserve margin (the percentage excess of excess generating capacity available during times of peak demand) due to low investment in earlier periods (Alstom, 2001). In May 2001, the United States Government published its energy plan in which the demand for electricity in the United States was forecast to increase by 45% by 2020. Due to the outdated and inefficient nature of much of America’s power generation capacity, it is estimated that between 1300 and 1900 new power stations will need to be built during this period (Marsh, 2001). However, the recent economic slowdown has triggered a temporary decline in orders. Electricity generators have also reduced investment to strengthen their balance sheets in the wake of the collapse of Enron (Alstom, 2002).

In the United States and some Western European countries gas turbines accounted for more than 90% of new power plant orders (Marsh, 1999). Gas turbines are available with capacities...
up to 250 MW. Power stations with large steam
turbines are mainly powered by coal or nuclear
fuel. A steam turbine in a fossil fuel power station
typically generates 500–700 MW, although some
1300 MW units were installed in the United States
in the 1970s. Steam turbines in nuclear power
plants were rated up to 1500 MW and the
technology is available to increase the rating up
to 2000 MW (Termuehlen, 2001). Thus, power
stations using gas turbines normally require more
turbines than those that use steam. However,
steam turbine plants require large and expensive
boilers to generate the steam. Coal-fired stations
additionally require coal pulverisation and desul-
phurisation plant. Small steam turbines are also
required for combined cycle plants. They have gas
turbines as the major prime mover generating
approximately two-thirds of the plant output with
the remaining third being produced by a steam
turbine (Termuehlen, 2001).

Steam turbines currently account for about half
the world’s generation capacity. Steam technology
is likely to continue to be the preferred option of
those countries with abundant coal reserves.
China, for example, is the second largest producer
of electricity in the world, with three-quarters of its
output generated by coal-fired plants (Martinot,
2001). India is similarly dependent upon coal
(Himberg, 1995). The market share for coal and
nuclear powered stations is predicted to decline.
However, higher natural gas prices may make the
construction of new coal-fired plants a more viable
option in the future. Environmental legislation has
stimulated the development of clean coal technol-
gies that minimise emissions and allow low-grade
coal to be used. These new technologies are
particularly important in Eastern Europe and Asia
because these regions are highly dependent upon
coal (Alstom, 2002).

3.3. Installed power plant

In 1950, the world’s power stations generated
100 GW of electricity. By 1999, the global installed
power generation capacity had grown to approxi-
mately 3500 GW, of which conventional steam
represented 54% of installed capacity, hydropower
21%, nuclear 11%, gas turbines 12% and diesel
2.3% (Alstom, 2001). More than half the world’s
installed capacity is located in North America and
Europe (Marsh, 1998). Fig. 4 shows the break-
down of global installed capacity by age. It can be
seen that nearly all of the capacity that was
installed prior to 1970 was based upon either
conventional steam turbines (ST) or hydro tech-
nologies. The period from 1970 saw the growth of
nuclear-powered steam turbines, although this
decreased in the 1990s when there was a substantial
growth in installed gas turbine capacity.

It can be seen from Fig. 4 that a significant
proportion of steam turbine installed capacity is
currently over 30 years old. This will increase over
the next 5 years. There is therefore a growing
market for the replacement and refurbishment of
aging steam turbine plant.

4. Services

There has been a strong growth in the provision
of services associated with power plant. The
overall global power plant market was approxi-
mately $125 bn (€139.6 bn) in 2001. This com-
promised 48% new equipment sales, 36% services
outsourced by the power generators, with the
remainder consisting mainly of civil construction
works. The service market is growing rapidly due
to increased outsourcing by electricity generators
together with the large number of coal-fired plants
that require modernisation (Alstom, 2002). The
market for services is becoming increasingly
attractive for power plant suppliers because it
attracts high margins.
Prior to deregulation, it was common for state-owned utilities to purchase individual items of plant such as turbines, boilers and other equipment for new power stations from different suppliers. They would finance and project manage the plant construction. However, after deregulation the power generators sought to procure entire power stations from a single supplier. With liberalisation the traditional utilities and independent power producers have become more cost conscious. Instead of demanding equipment with long life components, the power producers prefer to spread cost over the life of the plant by spending more on servicing in later years. Many services previously conducted in-house by the generators have been outsourced.

The plant suppliers have established closer ties with the operators to replace the previous arms-length relationships. This is because the power plant suppliers are being invited to participate and invest in new plant construction and to manage power stations in build-operate-transfer (BOT) and build-operate-own (BOO) agreements with utilities. After the concession period has expired, the ownership of the BOT scheme is transferred to the utility or government at no cost or at a pre-agreed price.

The intense competition for contracts for new power plant has encouraged the power plant suppliers to expand their maintenance, retrofit and refurbishment business for installed plant. This strategy was particularly appropriate for steam turbine manufacturers because of the decline in new orders coupled with the aging profile of the installed capacity.

These market changes have coincided with the development of information and communication technologies, which have enabled the suppliers to provide more sophisticated services. For example, Internet-based remote turbine health monitoring helps with the optimisation of the plant. Such systems relay information on vibration, fuel, temperature and power output. This allows engineers to analyse operational data and offer advice on problems as they occur. Suppliers are able to develop a library of performance data from their installations around the world, allowing them to offer more sophisticated service packages. These new technologies are incorporated in new plant and are supplied for older plant as a retrofit service.

At one time, the plant suppliers managed spare parts and services on a transactional basis. Now they see services as a means of establishing close links with their customers, as well as an opportunity to provide product upgrades. Not surprisingly, the major suppliers have developed more service capabilities. The growth of independent power producers has encouraged the development of new services, including the provision of turnkey projects and the operation of power plant.

5. Independent power producers

Deregulation of the electricity industry in the industrialised and developing countries encouraged new independent power producers (IPPs) to enter into the market. In 1996, IPPs accounted for 30% of the market for new power plant, compared with less than 5% 10 years previously (Wagstyl, 1996). IPPs were first established in the United States and the United Kingdom following deregulation. They have spread to other countries that require private finance to fund their growing electricity needs (in particular developing nations in Asia).

Table 2 shows the expected growth in generator capacity between 1998 and 2007. It is predicted that 52% of the additional capacity to be installed worldwide during this period will be controlled by IPPs. It is forecast that 70–75% of capacity will be installed by IPPs in North and South America.

<table>
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<th>Utilities GW</th>
<th>IPPs GW</th>
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<td>195</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>370</strong></td>
<td><strong>411</strong></td>
<td><strong>781</strong></td>
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</table>
The corresponding figure for Europe is 47% and Asia 41% (Marsh, 1998).

There are several types of independent power producers including traditional utilities operating in new markets, merchant generators, fuel tolling companies and energy traders. Some traditional utilities facing competition in their own regulated markets have become IPPs in new markets (e.g. Electricité de France, Tractabel and Duke Energy). These utilities, whether state-controlled or privately owned, often finance new projects with loans secured against their balance sheets, whereas other IPPs have to raise project finance. In the case of government-owned utilities, new projects can be supported by government guarantees. In some countries IPPs operate through an ‘offtake’ contract in which electricity distributors agree to purchase a specified level of output from the generator at a specified price.

Merchant generators sell energy and capacity into an open market, such as a wholesale power exchange or ‘pool’, rather than under contract with a utility. They lock in margins through price indexation arrangements that pass up to 75% of the price risk back to the fuel supplier (Macalpine, 2001). It has been estimated that by 2002 merchant generators are likely to account for 20% of all United States generation capacity (McIsaac et al., 2000).

Another arrangement is fuel tolling. Here the generator acts as a ‘contract manufacturer of electricity’ (Bleveans, 2000). The fuel supplier contracts with the generator (a purchase power agreement) to convert its fuel into electricity, which is then consumed by the generator or sold to a third party. The fuel supplier pays a capacity fee to the generator for its conversion service and receives a power price netback from the plant. The capacity fee is designed to cover the fixed costs of maintaining plant availability, the variable costs associated with converting fuel into electricity, as well as a return to investors. The generator only takes a risk on plant availability and in return earns stable, but low returns. The fuel supplier bears the risks associated with fuel costs, but can earn high returns by effectively arbitraging differences between the fuel and electricity markets. Enron’s Sutton Bridge power project in the United Kingdom is an example of a tolling plant.

Energy traders such as Enron or TXU Europe view a gas-fired station as a call option in their trading portfolios. If the wholesale price of gas is higher than the electricity price, the trader will sell gas. However, if the electricity price rises, the trader can request that the power plant generates electricity. With a power plant efficiency of 50% the netback value of the gas to the trader is approximately half the electricity price.

These new entrants are imposing new demands, primarily of cost and speed, on power plant suppliers. This has encouraged a large growth in demand for combined cycle gas turbine plant, as these can be built relatively cheaply and can be operational within 2 years. They also produce lower emissions. Competition between the power plant suppliers has focused on developing ever more efficient turbines. However, during the 1990s, three major suppliers (Alstom, GE and Siemens) experienced problems with their turbines. As a result, the IPPs prefer to rely on tried and tested technology, or to secure manufacturer commitments, including consequential loss cover, for new technology. One of the consequences of the turbine problems was to drive a number of the EPCs (engineering, procurement and construction) contractors out of the market.

Building new power plant in any deregulated market (especially in developing countries) incurs considerable risks. These can be categorised as political, construction, operational, revenue, finance and legal (Gupta and Sravat, 1998; Wang and Tiong, 2000). All parties involved in the project incur risks whether it is the power purchaser, the project developer or the providers of finance. The successful mitigation of these risks is critical to a project’s financial feasibility (Himberg, 1995).

Typically, a consortium is organised to invest equity into a scheme, which may account for 25% of the project capital cost. This level of equity is usually required to convince lenders of the viability of the project and governments of commitment to the success of the BOT and BOO project over the concessionary period (Tiong, 1995). The consortium usually includes the power equipment
supplier, which contributes capital in return for plant orders. The remaining 75% of the project is normally financed by a combination of syndicated commercial bank loans, bond issues, bridge and backup facilities, and multilateral and export credit agency loans and guarantees (Dailami and Leipziger, 1998). This project finance is provided on a ‘non-recourse’ basis with lender’s rights relating only to the assets and future earnings of the project (Howcroft and Fadhley, 1998). The balance sheets of the parent companies are not put at risk. It has been suggested that risk management objectives are the main reasons why project finance is preferred to more traditional debt structures (Pollio, 1998).

In BOT schemes, the project sponsor normally incurs all of the risks throughout the construction and operating periods, providing guarantees in terms of insurance or liquidated damages that the project will be completed on time and satisfy the agreed operating criteria (Tiong, 1990). Banks assume little or no risk in the construction and start up phases when the project is absorbing cash and generating no revenues. Instead, project loans become ‘non-recourse’ only after the project is operational and lenders are assured that it satisfies the contractual requirements (Pollio, 1998). BOT schemes normally include a power-purchase agreement, whereby a local utility agrees to buy the output. Electricity and fuel price risks are therefore transferred to the utility.

The power station developer would normally require an internal rate of return of 15–20% on the total project or 20–30% on invested capital (Himberg, 1995). The specific rate will depend upon the country’s risk profile, as well as risks associated with the particular project. In China, the main concern of the Government has been that the returns earned by foreign investors is excessive (Wang and Tiong, 2000). In some countries, government may impose restrictions on the profitability of IPPs in order to control the level of tariff charges to the public. Governments may pursue this policy by stipulating a maximum rate of return or by adopting a price-capping model (Lam, 1999).

Despite the attractiveness of many of these investments, raising debt capital is a major constraint. One explanation is that only 30–40 banks worldwide have traditionally provided project finance (Bond and Carter, 1995). A further constraint is that international commercial bank loans are typically for 7–12 years. However, power projects need financing for ten or more years if the tariffs necessary to service the debt are not to be prohibitive. Consortia have tried to resolve this problem by obtaining finance for ten years and then refinancing it later, usually after the construction work has been completed. Other innovations include 25 year IPP bonds and the development of local capital markets.

Power plant suppliers have had to respond to a new customer base in which the focus is primarily on minimising capital costs and plant construction lead-times. These changes arising from deregulation and liberalisation of the power generation industry has encouraged a consolidation of the power plant industry.

6. Rationalisation of the power plant industry

The success factors in the power plant industry are technology, quality, cost, company size and international spread (Alstom, 2001). There is global overcapacity in the market for steam turbines, but there is significant under-capacity for gas turbines.

The smaller power plant companies, particularly those in the United Kingdom, found it increasingly difficult to compete in international markets. Their previous advantage had been achieved through flexibility and the ability to design plant to satisfy specific customer needs. They supplied plant as part of a consortium with the customer financing and managing the project. However, the new electricity generators were now seeking project finance and turnkey solutions. They were also more cost conscious and demanded shorter delivery times than the publicly owned utilities.

The main problem was that some of the smaller companies had invested in assets and capabilities to meet the requirements of the state-owned utilities. Most of their orders were for the home market. These requirements were regulated and determined by the utilities in line with government policies. The liberalisation of the energy markets...
exposed their inability to develop the capabilities and resources to compete in the more competitive environment. Some of these companies were also locked into steam turbine technology, which was being displaced by gas turbines in the United States and Europe. The smaller companies became vulnerable to takeover as the larger integrated companies sought acquisitions and alliances to share development costs, mitigate risks, and to access global markets.

In the late 1980s, the General Electric Company of the United Kingdom and Alcatel Alsthom of France merged their power and transport businesses to form GEC-Alsthom (renamed Alstom in 1998). ASEA of Sweden and Brown Boveri of Switzerland merged their operations to form ABB. This trend continued into the 1990s. In 1997, Siemens purchased the energy operations of Westinghouse of the United States. Alstom merged its power engineering business with those of ABB in 1999. The following year Alstom bought out ABB’s share of the joint venture.

The mergers and takeovers of the late 1990s and the early part of this century are probably the final piece in the post-war restructuring of the world’s power plant industry. Large global companies have replaced former national champions. Three companies currently dominate the world power plant market: General Electric (GE), Siemens and Alstom. In 2000, these companies accounted for 80% of all new power plant orders worldwide rated by power output (GW). This high level of industry concentration has been brought about by the series of mergers and takeovers outlined above.

The consolidation of the industry is also a response to overexpansion by the power plant suppliers in the late 1980s and early 1990s. The suppliers were anticipating growing orders from independent power providers in Europe and North America following deregulation and from utilities in Asia (especially China) to meet their expanding electricity requirements. These orders did not materialise as quickly as forecast, leading to overcapacity. At the same time, there was downward pressure on electricity prices, which squeezed the profit margins of the generators. The operators in response demanded lower prices from the power plant suppliers, leading to a 30% reduction in prices between 1993 and 1996. The full order book since the late 1990s has reversed this position, leading to a waiting list for gas turbines. For example, the capital price for a new combined cycle plant rose from $400/kw (£447/kw) in the mid 1990s to $500/kw (£559) in 2001 (Maclaine, 2001).

6.1. The dash for gas

Another major change that has impacted on the industry is the growth in the past two decades in the use of gas as a fuel rather than steam generated from coal or oil. Table 3 shows that GE dominates the global gas turbine market with a 44% share in 1999, followed by Siemens with 27% and Alstom with 13%. Alstom is the leader in the steam turbine market with a 24% market share. The upsurge in orders for gas turbines in the United States from 1998 has largely benefited GE followed by Siemens. In 2000, GE secured 71% of new orders for gas turbines in the United States followed by Siemens with 23% (Marsh, 2001).

Alstom had previously licensed the technology for its heavy-duty gas turbines from GE. This agreement precluded Alstom from selling this equipment in the United States. However, following its merger with ABB, the new Group reached an agreement with GE, whereby the latter agreed to purchase Alstom’s heavy-duty gas turbine business and to revoke the technology licence. This would allow Alstom to sell ABB’s version of gas turbines anywhere in the world, including the United States.

Alstom and Siemens’ market position could improve if the demand for new coal-fired steam turbine plants increases. Some utilities may also add a steam cycle stage to existing gas-powered plants to increase efficiency. Any increase in orders from Asia may well be to the benefit of Alstom, the market leader in steam turbine technology. Steam turbines account for about half the world’s electricity generation capacity. This technology is likely to be the preferred option of those countries with abundant coal and oil reserves.

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6.2. Financial performance of Alstom, GE and Siemens

The three companies that dominate the power plant market are GE, Alstom and Siemens, which are global multi-product companies. Table 4 compares the financial performance of the companies. The calculations are based upon ‘headline earnings’ (normalised data) as advocated by the Institute of Investment Management and Research (1993). The normalisation process aims to reflect the outcome of normal trading operations. Several items are excluded, for example, profits and losses on the sale or termination of operations; profits and losses relating to the disposal of fixed assets; amortisation of goodwill and profits or losses associated with the disposal of trade investments. In the case of General Electric, the activities of General Electric Capital Services (GECS) have been excluded to enable the engineering segments of the business to be directly compared with those of Siemens and Alstom.

In terms of group turnover, GE (excluding GECS) and Siemens are of comparable size and both are much larger than Alstom. GE is significantly more profitable than its rivals. Indeed, in 2001, Siemens made a substantial loss due to losses incurred in its semiconductor and information and communication businesses. Alstom’s and Siemens’s profit margins have been less than 6% each year, whereas GE’s margins have been around 25%. Similarly, the return on capital

Table 3
Global power generation equipment, market share % by GW output (Marsh, 2000)

<table>
<thead>
<tr>
<th>Company</th>
<th>Steam turbines</th>
<th>Gas turbines</th>
</tr>
</thead>
<tbody>
<tr>
<td>GE</td>
<td>17</td>
<td>44</td>
</tr>
<tr>
<td>Siemensa</td>
<td>11</td>
<td>27</td>
</tr>
<tr>
<td>Alstomb</td>
<td>24</td>
<td>13</td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Others</td>
<td>41</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

aIncluding Westinghouse.
bIncluding ABB.

Table 4
A financial comparison of Alstom, GE and Siemens

<table>
<thead>
<tr>
<th></th>
<th>Alstom</th>
<th>General Electrica</th>
<th>Siemensb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turnover (£m)</td>
<td>14,069</td>
<td>16,229</td>
<td>20,450</td>
</tr>
<tr>
<td>Normalised trading profit (£m)</td>
<td>590</td>
<td>226</td>
<td>899</td>
</tr>
<tr>
<td>Earnings before interest and tax (£m)</td>
<td>773</td>
<td>337</td>
<td>1108</td>
</tr>
<tr>
<td>Trading capital employed (£m)</td>
<td>6295</td>
<td>9146</td>
<td>11,326</td>
</tr>
<tr>
<td>Overall capital employed (£m)</td>
<td>6820</td>
<td>10,508</td>
<td>12,950</td>
</tr>
<tr>
<td>Trading profit/sales (%)</td>
<td>4.19</td>
<td>1.39</td>
<td>3.66</td>
</tr>
<tr>
<td>Return on capital employed (%)</td>
<td>11.33</td>
<td>3.21</td>
<td>8.56</td>
</tr>
<tr>
<td>Normalised earnings per share (£)</td>
<td>1.68</td>
<td>0.52</td>
<td>2.63</td>
</tr>
<tr>
<td>Maximum Price/earnings ratio</td>
<td>18.77</td>
<td>65.38</td>
<td>12.32</td>
</tr>
<tr>
<td>Current ratio</td>
<td>1.06</td>
<td>1.05</td>
<td>0.95</td>
</tr>
<tr>
<td>Stocks/sales(%)</td>
<td>25.25</td>
<td>20.50</td>
<td>24.64</td>
</tr>
<tr>
<td>Working capital/sales(%)</td>
<td>27.76</td>
<td>26.05</td>
<td>26.63</td>
</tr>
<tr>
<td>Debt/equity (%)</td>
<td>75.84</td>
<td>176.32</td>
<td>221.55</td>
</tr>
<tr>
<td>Debt/capital employed (%)</td>
<td>18.85</td>
<td>33.88</td>
<td>37.51</td>
</tr>
</tbody>
</table>

Notes: Figures for GE exclude GE Capital Services Inc, except for normalised earnings per share and P/E ratio which are based upon the consolidated accounts.
aDollar to Euro conversions obtained from the FX Currency Converter (http://www.oanda.com/convert/classic) on the balance sheet dates.
bSiemens 1999 figures translated from Deutsch Marks to Euro on the balance sheet date.
employed at GE has been substantially higher than at the other two companies. Alstom, in particular, is carrying heavy levels of debt. Traditionally, Alstom’s principal source of liquidity has been cash generated from its operations. The increase in working capital requirements, together with major acquisitions over the last 4 years, has proved a drain on internal resources. The creation of the joint venture ABB Alstom Power and the subsequent purchase of ABB’s stake were particularly significant. The Company has had to rely more on long and short-term borrowings. Alstom has also had to set aside provisions to solve technical difficulties and to compensate customers who have purchased the GT24–26 range of gas turbines. In comparison, GE has very low levels of debt (excluding GE Capital Services, which has very high short-term debt levels).

GE attributes its success to a number of factors. The Company has trained 80,000 people in Six Sigma and has completed 500,000 projects. GE has also invested $10 bn (€10.44 bn) in information technology between 1998 and 2001. Both Six Sigma and ‘digitization’ have been introduced into the supply chain to provide integration with customers and suppliers. GE seeks to balance its ‘long-cycle’ and ‘short-cycle’ businesses. The ‘long-cycle’ businesses include Power Systems, Aircraft Engines, Medical Systems and Transportation Systems. These businesses contributed approximately 40% of GE’s net earnings in 2001. The ‘short-cycle’ businesses including Appliances, Lighting, Plastics, Industrial Systems, Speciality Materials and NBC broadcasting contributed approximately 20% of GE’s net earnings. The Financial Services Businesses contributed the remaining 40% of net earnings (which have been excluded from Table 4). GE’s focus has changed. In 1980, it derived 85% of its revenues from the sale of hardware. In 2000, 70% of its turnover was from the sale of services (GE, 2000).

6.3. Competitive strategy and financial performance of the power plant businesses

The success factors in the power plant industry are technology, quality, price, company size and international presence. The high level of capital investment undertaken by all three companies underlines the importance of technology and production. The strategy of the ‘big three’ was to establish a global presence in the major markets for power plant equipment and services. This allowed them to balance their production to meet the upturns and downturns in the respective markets. For example, from 1988 to 1998, there was an upturn in the demand for power plant in Asia. This was curtailed by the financial instability that occurred in the Asian Economies in the late 1990s. This downturn in Asia was, however, more than offset by the boom in demand for gas turbines in the United States in the late 1990s. By 2002, this growth in demand had slowed due to the economic downturn and market uncertainty caused by the demise of Enron.

In 1998, Siemens increased its presence in the United States through the acquisition of Westinghouse. In 2002, Siemens sales by region were Europe 19%, Americas 62% (of which United States 52%), Asia Pacific 11% and other 7%. Alstom had little exposure in the United States because its licensing agreement with GE prevented it from selling gas turbines in this market. The revoking of this agreement following Alstom’s link with ABB allowed the Company to increase its presence in this critical market. In 1999, 2.6% of Alstom’s turnover in power plant was in the United States with 37.8% in the European Union and 22.8% in Asia. By 2001, 27.8% of Alstom’s turnover was in the United States, with 23.2% in the European Union and 22% in Asia (Alstom, 2001). Thus, Alstom’s acquisition strategy had enabled the Company to compete in the United States, whilst maintaining a significant presence in the other major markets.

These acquisitions also allowed Alstom and Siemens to increase their installed capacity to 650 GW (Salmon, 2002) and 500 GW, respectively (Siemens, 2002). This strategy enabled the companies to expand their retrofit, refurbishment and

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5Based upon the average $/€ rate between 1 January 1998 and 31 December 2001.
services to a larger installed base. GE is more heavily focused upon high value adding services than its two competitors. In 2002, GE Power System’s turnover in energy services was $6 bn ($6.37 bn) and the Company aims to have a turnover of $10.5 bn ($11.14 bn) by 2005, of which $1.5 bn ($1.59 bn) will be due to planned acquisitions.

Table 5 compares the financial performance of the power plant businesses as stated in the companies’ segmental accounts. For Alstom and Siemens, the financial results of the power generation plant and power transmission and distribution businesses have been combined to make them comparable to GE (GE Power Systems includes power transmission and distribution).

At Alstom turnover increased from €5698 m in 1999 to €15070 m in 2001 due to the takeover of ABB’s power engineering business. As a result, Alstom is more heavily focused on the power plant industry, which contributed 60.9% of Group turnover in 2001. Although profit increased after the acquisition of ABB’s share of ABB Alstom Power in 2000, the profit margins declined from 7.9% to 4.5%. This was due to technical difficulties relating to the GT24–26 range of gas turbines (179 and 262 MW, respectively). In 2000, it was discovered that 79 turbines in service had failed to meet the specified performance criteria. A further 21 turbines remained to be delivered. In September 2000, Alstom established provisions of €1,625 m to cover the cost of technical modifications and additional contract costs. In February 2002, Alstom entered into a technology agreement with Rolls-Royce to acquire aero-engine technology to improve the operating performance and capability of the GT24–26 turbines. Alstom’s commitment to the power plant industry is clear. Its capital expenditure has increased from €153 m in 1999 to €401 m in 2001, which represents an increase from approximately 40% to nearly 71% of Group investment.

GE Power Systems is the market leader in the supply of power plant technology. Turnover increased from €10,005 m in 1999 to €22,817 m in 2001, whilst profits rose from €1686 m to €5850 m, as margins widened from 16.9% to 25.6%. The proportion of Group operating profit generated by GE Power Systems increased from 15.2% in 1999 to 33.6% in 2001. GE has significantly higher profit margins than its competitors because 50%
of Power Systems’ turnover is generated from the provision of high value added services. The comparable figures for Alstom and Siemens are approximately 30% of turnover. Another reason is that in 1995, GE invested heavily in the development of ‘F’ turbine technology, which was very successful. GE was also able to benefit from the application of its aero-engine technology to its heavy-duty industrial gas turbines. This gave the Company a considerable competitive advantage when the boom in demand for gas turbines occurred in the United States during the late 1990s. The application of Six Sigma in the Greenville gas turbine plant in 2000 enabled GE to reduce cycle times by 29% and to increase output by more than 200%. The Company is using e-business to reduce costs through online auctions and project management initiatives. It is estimated that this will deliver benefits of $3 bn (€3.3 bn) between 2000 and 2003 (GE, 2000).

GE’s approach to selling power plant may also be better suited to the American market. GE prefers to sell just gas turbines, leaving the organisation of plant construction to an ‘engineer-constructor’, which includes large consultancy groups such as Bechtel, Raytheon and Stone and Webster. Siemens and Alstom, in contrast, have based their strategy around turnkey projects in which they take the responsibility for plant construction.

GE started developing the service side of its business in 1996. Today, about one-third of its engineers are in services compared with almost none 10 years previously. The Company has focused on establishing long-term service agreements of between 12 and 18 years with power plant operators across the world. It offers operate and maintenance contracts on new projects as well as supplying the power plant equipment. In 2001, customer service agreements totalled $25 bn (€27.9 bn). This strategy helped to ensure predictable life cycle costs for customers and a predictable revenue stream for GE (GE, 2001). The Company estimates that contractual service agreements will deliver revenues of $33 bn (€35 bn) by 2005 (Abate and Artigas, 2002). GE Power Systems has contractual service agreements in place at 384 customer sites in 40 countries, including 66 contracts to operate and maintain customers’ facilities (GE, 2001).

Turnover at Siemens has stagnated as the Company has concentrated on its information and communication and semiconductor businesses. However, a loss of over €6 m in 1999 was turned around into a profit of €730 m in 2001. The increase in the share of Group profits by the Power Generation and Power Transmission and Distribution businesses to 239.3% was due to substantial losses in the other operating businesses. Capital expenditure in the power plant business increased from €196 m in 1999 to €566 m in 2001. This was, however, a small proportion of the Group’s overall capital expenditure. For example, in 2001, 5.2% of the Group’s capital expenditure was in the power plant business. This compared to 26% for the information and communications operations and over 23% for the Infineon semiconductor business. Similarly 6% of Group research and development expenditure was in power plant compared to 38% in information and communications and 18% at Infineon.

The consolidation of the power plant supply industry may not yet be complete. GE is the dominant supplier. The Company is more profitable than its competitors. It has wider profit margins and earns a higher return on capital. GE has significantly lower levels of debt (excluding GECS). The relative financial weaknesses of Alstom and Siemens may undermine their ability to compete effectively. Alstom, in particular, may have to sell some of its profitable operations, such as its transmission and distribution business, if it is to reduce its high levels of debt. Alternatively, Alstom and Siemens may benefit from an increase in demand for steam turbines. Any stimulus to demand may depend upon the relative increase in the price of gas in relation to coal and nuclear power.

7. Conclusions

The deregulation and restructuring of the electricity supply industry is one of the most

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7 Conversion based upon the average $/€ rate for 2002.
important global energy developments of the last
century. The implementation of these policies in
both the industrialised and developing countries
has encouraged the consolidation and globalisa-
tion of the power plant industry. Deregulation,
together with the globalisation of the power plant
industry, tilted the economic balance towards the
large integrated power engineering companies. In
the global market, economies of scale and scope
became crucial given the cost of developing the
new technologies and providing the services
required by the operators.

Deregulation encouraged the growth of IPPs
whose business requirements transformed the
power plant industry. These new entrants were
primarily concerned with minimising the capital
cost and reducing the time required for construct-
ing new power stations. The shorter construction
times for gas-fired stations gave them a competi-
tive edge over stations powered by coal or nuclear
fuel, especially in Europe and the United States.

The new independent power producers also
faced considerable risks building power stations
in these newly deregulated markets. Prior to
deregulation, state-owned utilities took responsi-
bility for the financing and project management of
new power stations. After deregulation, the power
generators sought turnkey projects and ‘through-
life’ solutions to meet their requirements. To win
orders, the power plant producers were encour-
gaged to join consortia investing in new power
station construction projects. Many of these
projects were organised on build-operate-transfer
and build-operate-own agreements with utilities.
To participate in these ventures, the power plant
suppliers were required to develop expertise in
project management, project finance, risk manage-
tment techniques, as well as providing more
sophisticated services to the operators. Only the
large power plant suppliers were in a position to
bear the commercial and political risks associated
with these operations.

The market for services was expanding rapidly
due to the outsourcing strategies of the power
generators. However, only the large global com-
panies had the financial resources and capabilities
(or were able to acquire firms with the relevant
capabilities) to extend their activities into the
provision of services by developing their knowl-
dge assets. This also allowed them to increase
their margins by moving up the supply chain into
higher value added activities. The growth in
sophisticated information and communication
technologies assisted the power plant suppliers in
the extension of their supply chain activities.
Further, the aging profile of the steam turbine
power plant also benefited the large global
companies that possessed (or were prepared to
acquire) a large installed capacity base. They
expanded their maintenance, retrofit and refurb-
ishment businesses to satisfy the requirements of
the operators.

In summary, to compete in global markets the
capital goods companies supplying power plant
have had to develop capabilities in technology,
marketing, finance, project management and the
provision of services. The ‘big three’, Alstom, GE
and Siemens, have succeeded in meeting this
challenge. All three companies are operating on a
global basis and have developed the global net-
works to respond to the upswings and the down-
swings in the major markets. GE appears to be
better positioned than its rivals in terms of
geography and product offering. Its strategy has
been to rely on internal expansion to satisfy the
growth in demand for gas turbines. GE has also
acquired a number of service companies to
strengthen its position in the provision of services
to the operators. The Company has also focused
on operational excellence through the implemen-
tation of Six Sigma and ‘digitization’. In combina-
tion, this has allowed GE Power Systems to earn
higher margins and to be financially stronger than
its rivals.

Alstom and Siemens have expanded through
acquisitions to extend their global reach. Their
stated strategies are to increase their turnover from
the provision of services, where they are less
focused than GE. These two companies are,
however, financially much weaker than GE.
Alstom, in particular, is carrying heavy levels of
debt and will have to rely on disposals to
strengthen its balance sheet. Siemens, in turn, is
incurring heavy losses in its information and
communication and semiconductor businesses. It
is difficult to see how either of these two
companies will be in a position to challenge the dominant position of GE.

In conclusion, the deregulation and liberalisation of the electricity supply industry met the objectives of policy makers by introducing competition into the indigenous markets. The by-product, however, was that these policies led to the reduction in the number of power plant suppliers. The smaller manufacturers had invested in assets and capabilities to meet the requirements of the state-owned utilities. Their output was aimed at the home market. Some of these companies were specialist suppliers of steam turbine technology, which was displaced by gas turbines in Europe and the United States. The smaller companies became vulnerable to takeover as the large integrated companies sought acquisitions to extend their capabilities and to enter new markets.

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