Energy Conservation and Electricity Sector Liberalisation: Case-Studies on the Development of Cogeneration, Wind Energy and Demand-Side Management in the Netherlands, Denmark, Germany and the United Kingdom

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ABSTRACT

In this paper, the development of cogeneration, wind energy and demand-side management in the Netherlands, Denmark, Germany and the United Kingdom are compared. It is discussed to what extent these developments are determined by the liberalisation process. Three key liberalisation variables are identified: unbundling, privatisation and introduction of competition. The analysis suggests that unbundling prior to introduction of full competition in generation is particularly successful in stimulating industrial cogeneration; simultaneous introduction of competition and unbundling mainly stimulates non-cogeneration gas-based capacity; and introduction of competition in itself is likely to impede the development of district-heating cogeneration. Furthermore, it is argued that development of wind energy and demand-side management are primarily dependent on the kind of support system set up by policy makers rather than on the liberalisation process. Negative impacts of introduction of competition on integrated resource planning and commercial energy services could nevertheless be expected.

Introduction

In the nineties electricity sectors world-wide have entered a process of fundamental change in which economical and environmental matters play a key role. On one hand, many national electricity sectors are liberalised with the aim to improve economic efficiency. On the other hand, now that legally enforceable greenhouse gas emission targets have been agreed on at the 1997 Kyoto Climate Change Conference, energy conservation is increasingly becoming a crucial issue in electricity supply.

Given these two emerging trends which are likely to determine the future organisation of electricity sectors in many countries, an important question is if, and how energy conservation and electricity sector liberalisation can be reconciled. In this paper, empirical evidence from developments in several countries is examined.

Research Method

The research project described here was set up as a comparative case-study of the Netherlands and three other countries: Denmark, Germany and the United Kingdom. These countries were selected based on a quick-scan of electricity sector structures in all OECD countries[1].

'Energy conservation' in this project was defined as *all measures that contribute to a reduction in the use of fossil fuels and nuclear energy as primary energy sources for electricity supply*[2].

[1] The Netherlands are the 'base-case'. Criteria for selection of the other countries were the existence of cogeneration, wind energy and demand-side management measures, variation in policy attitude towards and implementation of the liberalisation process and assumed availability and accessibility of data.

Following from this definition, three key fields of energy conservation were identified: (1) a reduction of end-user demand; (2) the use of renewables as a primary energy source; and (3) the use of more efficient fossil fuel generation technologies. Per country, three case-studies have been examined, one for each field of energy conservation identified: the development of demand-side management and energy efficiency, of wind energy and of cogeneration of heat and power.

'Liberalisation' was defined as consisting of three separate organisational changes, of which the actual implementation can vary per country: (1) a change in *vertical structure* of the electricity supply system, in its most drastic form a complete organisational unbundling of generation, transmission, distribution and end-user supply of electricity; (2) a change in *market structure*, specifically the introduction of competition in electricity generation and end-user supply; and (3) a change in *ownership* of utilities, in practice often a privatisation of formerly public organisations.

In each of the four countries, and for each of the three energy conservation options examined per country, research consisted of a description of developments, an examination of underlying factors and an analysis of the importance of the three liberalisation variables identified. Information was collected by an extensive literature search in every country and in-depth interviews with officials from utilities, non-governmental organisations, policy makers and independent researchers.

This paper will start with a very brief overview of the liberalisation process in the four countries examined. Subsequently, the development of cogeneration, wind energy and demand-side management in the four countries will be compared and the link to liberalisation discussed. Finally, some general conclusions regarding the importance of the three liberalisation variables identified will be given.

Liberalisation of the Electricity Sector: Implementation in the Netherlands, Denmark, Germany and the United Kingdom

Key features of the existing electricity sector structure in 1997 in the four countries examined are listed in Table 1. In the Netherlands, generation and distribution are formally unbundled since 1990. Introduction of full competition in generation is envisaged by 1999. Supply competition will be gradually introduced over a period of several years from 1999 on, starting with very large consumers. To be able to compete with utilities abroad policy makers want the present four generators to merge into one organisation owned by some distributors and local authorities[3]. Privatisation of utilities is considered after the introduction of supply competition has been completed.

In Denmark, supply competition for distributors and a small group of very large end-users has been formally introduced in 1996, but in practice this competition is very limited. Although there is no formal monopoly in electricity generation, in the existing situation the pool operators act as vertically integrated utilities with a dominant position in generation as well as supply. Substantial changes to this situation are currently not envisaged. Furthermore, as it is planned to maintain public influence in the utilities privatisation in the near future appears unlikely.

Germany has put forward a proposal to introduce competition in generation and supply for all end-users in a single-step process. In May 1998 this proposal came into force. Although access to the

[2] Although nuclear energy is sometimes promoted with reference to its contribution to saving fossil fuels and reducing CO_2 emissions, it remains a controversial technology due to its waste problems and the danger of accidents. Therefore it was chosen to exclude nuclear energy from the energy conservation options examined in this research project.

[3] In April 1998 this planned fusion failed since no agreement could be obtained about the prices to be paid for electricity delivered to distributors.

Table 1: Existing Structure of the Electricity Sector in the Netherlands, Denmark, Germany and the United Kingdom in 1997

	Vertical Structure (integrated - unbundled)	**Market Structure** (monopoly - competition)	**Ownership** (public - private)
Netherlands	One network operator. Generation and distribution formally unbundled since 1990. Four large generators and 23 distributors.	Distribution companies have supply monopolies in their geographical areas. Limited options for competition in generation since 1990.	Network operator owned by generation companies. These are owned by distributors and partly directly by municipalities and provinces. Distributors owned by municipalities and provinces.
Denmark	Two non-interconnected networks, formally unbundled in generators and distributors, but practically closely co-operating under the two network operators.	Distribution companies hold supply monopolies in their franchise areas. Since 1996, supply competition for a very small group of large end-users. No legal monopolies for generation, transport and imports but in practice activities are controlled by the two pool operators.	Network operators owned by generators, and partly directly by municipalities. Generators owned by distributors. Distributors owned by municipalities or consumer co-operatives.
Germany	Eight interconnected networkoperators, owning the majority of generation capacity (85%). 50 generators supplying only to distributors, 70 generators with distribution facilities in rural areas and around 850 municipal distributors, sometimes also owning generation capacity.	Supply monopolies for utilities in areas defined by demarcation agreements between utilities and regulated by concession agreements with local authorities. Since 1990 limited negotiated third-party access.	Complex. Often mixed public/private, with substantial cross-ownership between utilities. Municipal distributors owned by local authorities.
United Kingdom	Three networks: Northern Ireland (non-connected) Scotland and England & Wales. Since 1990 the E&W system is unbundled in generation companies, a transmission company and 12 distributors.	Since 1990 electricity generation in England & Wales open to competition. Supply competition for very large consumers since 1990, for an intermediate group of end-users since 1994.	One public nuclear generator. The other generators, the transmission company and distribution companies in England & Wales are private.

grid is liberalised, an unbundling of utilities is not considered. Neither does the Act include changes to the existing mixed private and public ownership structure.

Competition in generation has been introduced in the United Kingdom in 1990, together with an unbundling of generation and distribution and a privatisation of all non-nuclear utilities. Supply competition for very large end-users was also introduced in 1990. In 1994, supply competition was extended with a group of intermediate end-users, and from late 1998 on the final group of small end-users will be able to chose their supplier as well.

Case-Study 1: Cogeneration

Of the four countries examined, cogeneration of heat and power (CHP) in Denmark has by far the largest share in national power production (40%), followed by the Netherlands (30%), Germany (14%) and the United Kingdom (5%) (Cogen 1997). In all four countries the share of CHP in total power production is presently increasing, though at varying rates and for different reasons.

In the Netherlands and the United Kingdom the installed cogeneration capacity has roughly doubled in the last ten years. Particularly industrial cogeneration and, to a lesser extent, small-scale CHP for space heating have contributed to this growth (CBS 1997; DTI 1997). In fact, the largest part (64%) of total installed capacity in the Netherlands in recent years consisted of cogeneration plant (PW/K 1997; Sep 1997). The growth of cogeneration in the United Kingdom, however, was dwarfed by a boom in the installation of electricity producing combined-cycle gas turbines - the so-called 'dash for gas'. Whereas no combined-cycle plants were operational in 1990, in recent years this technology became the dominant type of new power plant constructed (Sorrell 1996; Surrey 1996).

The high installation rates in Denmark, on the other hand, were predominantly a result of converting existing coal-fired, heat-only district heating plant to gas-fired CHP (MEM 1996). A similar conversion of district heating plant has taken place in former East Germany. Whereas particularly small-scale cogeneration for space heating is presently booming in Germany, industrial CHP has remained roughly constant (Rumpel 1996a). The result is that overall growth rates for cogeneration in Germany are lower than in the other three countries.

Underlying Factors

Cogeneration in all countries has benefited from the decreasing world-market prices of natural gas since the mid-eighties and the development of new power generation technologies like that of the combined cycle turbine (Cogen 1997). However, other underlying factors of CHP development substantially vary per country (Slingerland 1997a,b; 1998 a,b).

Denmark is different from the other countries in that cogeneration is almost exclusively linked to district heating. Conversion of coal-fired district heating plant to gas-fired cogeneration units was very much inspired by the Governmental target to reduce CO_2 emissions by 20% in the period 1988 to 2005, to which CHP has to contribute about a quarter (MEM 1990, 1993). Development of cogeneration also was in line with the policy aim to increase exploitation of domestic natural gas reserves in the North Sea (MEM 1996). The utilities in Denmark, on the other hand, have been sceptic about the rapid growth of CHP. Fears of overcapacity even led them to put in a formal complaint about Governmental policy to the European Commission, which was not successful however.

In the Netherlands, it was predominantly the boom of 'decentral' cogeneration set up as a joint-venture between distributors and industrial end-users which has contributed to the large growth of

cogeneration since the end of the eighties. It has been so unexpected to power capacity planners and generators that in 1994 a moratorium with distributors was agreed in order to temper the growth rates of decentral CHP (Huygen 1995). Unbundling of distribution and generation has been an important factor behind this boom, as it gave distributors a business interest to search for ways to become less dependent on the generation companies (Boonekamp & van Hilten 1995; Moor & Boels 1995). A simultaneous horizontal integration of distributors, which increasingly became suppliers of gas as well as electricity, also might have contributed to the appeal of CHP to distribution companies. In this way, they could supply gas to industrial cogeneration plant and contractually receive the electricity in excess of that needed on the industrial site. However, due to legal provisions which effectively prevented new parties from entering the market and distributors from building own generation capacity larger than 25 MW, taking part in cogeneration joint-ventures with industrial end-users was also the only option available to distributors looking for access to larger power plant independent from the generation companies (Slingerland 1997a).

Initial investment subsidies provided by policy makers, reduced gas tariffs and higher tariffs for electricity delivered to the grid agreed in contracts with distributors made cogeneration an attractive option to industrial investors as well (Blok & Farla 1996). Furthermore, environmental considerations also played a role, since distributors as well as industries could list the CO_2 reductions obtained as an important contribution to the targets set in their emission reduction covenants with Government (Boonekamp & van Hilten 1995). In addition, to policy makers cogeneration development was in line with environmental considerations as well as with the aim to stimulate the use of natural gas as a domestic primary energy source.

In Germany, the utility attitude towards cogeneration is ambivalent. On one hand, small-scale projects are actively promoted by many utilities, resulting in a growth of 200 MW in 1990 to 1260 MW in 1996 (Rumpel 1996b; IZE 1998). The utilities have also signed a voluntary agreement to reduce CO_2 emissions in which cogeneration plays a role (BMU, BMWi, BDI 1996). On the other hand, the present overcapacity is often mentioned as an argument against cogeneration. Sometimes industries considering CHP are offered reduced electricity tariffs, whilst tariffs offered for electricity delivered to the grid were lower than the avoided costs until this practice was legally prohibited in 1996 (Cogen 1997). Policy support for cogeneration on a national level is limited mainly to tax-reductions on fuels used for CHP. In addition some Länder have founded energy agencies that also promote CHP, for instance by information and advice, as well as by offering contracting possibilities (NEA 1996).

Lower gas prices, partly due to gas market liberalisation, and technology development are seen as important factors for the revival of cogeneration in the United Kingdom in recent years. A number of specific regulatory barriers has been removed as well. In particular conditions for obtaining generation and supply licenses, as well as terms for top-up and stand-by contracts were changed in favour of CHP. Further policy support for cogeneration is limited to voluntary and information programmes (Sorrell 1996).

Rather than on cogeneration, however, attention has focused on the 'dash for gas' in Britain. Particularly the newly unbundled distribution companies have, via majority shares in 'independent power producers' which entered the market after 1990, contributed to this dash for combined-cycle gas turbines (Surrey 1996). These plant provided a relatively easy-to-deal-with and cheap technology, which could be constructed largely off-site, delivered turn-key and supposedly operated comparatively error-free, which made that the newly unbundled distributors saw constructing combined-cycle turbines as a very good way to reduce their dependency on the generation companies (Bantock & Longhurst 1995). In order to protect their market share and to avoid having to retrofit part of their existing older coal

plant with flue-gas desulphurisation to make it comply with EU emission obligations, the generators in turn began to build combined-cycle turbines as well and hence contributed to the boom (Parker 1996). It has also been suggested that the Conservative Government had an interest in allowing the dash for gas to continue in order to reduce the power of the coal mining unions (Watson 1997).

Discussion: Electricity Sector Liberalisation and Cogeneration Development

A comparison of developments in the four countries indicates that unbundling of generation and distribution in the Netherlands, as well as the simultaneous unbundling, privatisation and introduction of competition in the United Kingdom has been conducive to a major boost in new generation capacity in these two countries. In the Netherlands this has been mainly cogeneration capacity, in the UK mainly electricity producing combined-cycle plant and to a much smaller extent cogeneration capacity. Distributors have been an important driver in this 'dash for new generation capacity'. Apparently newly unbundled distribution companies want to reduce their dependency on generators, and increase their control on the market by directly or indirectly setting up their own power plant. Existing generators on the other hand appear far less supportive of cogeneration. Central power generators in the Netherlands, the pool operators in Denmark and utility federations in Germany all have claimed, or do claim overcapacity as an argument against cogeneration.

The fact that a boost in new generation capacity in the Netherlands came about without privatisation or formal introduction of competition furthermore suggests that unbundling could very well be a decisive factor here, which by itself could bring about competition between power plant initiated by distributors and those of the generation companies. Formal introduction of competition in generation nevertheless is likely to contribute to an expansion of generation capacity. The British situation shows that in that case, apart from the distributors, other parties will initiate new power plant.

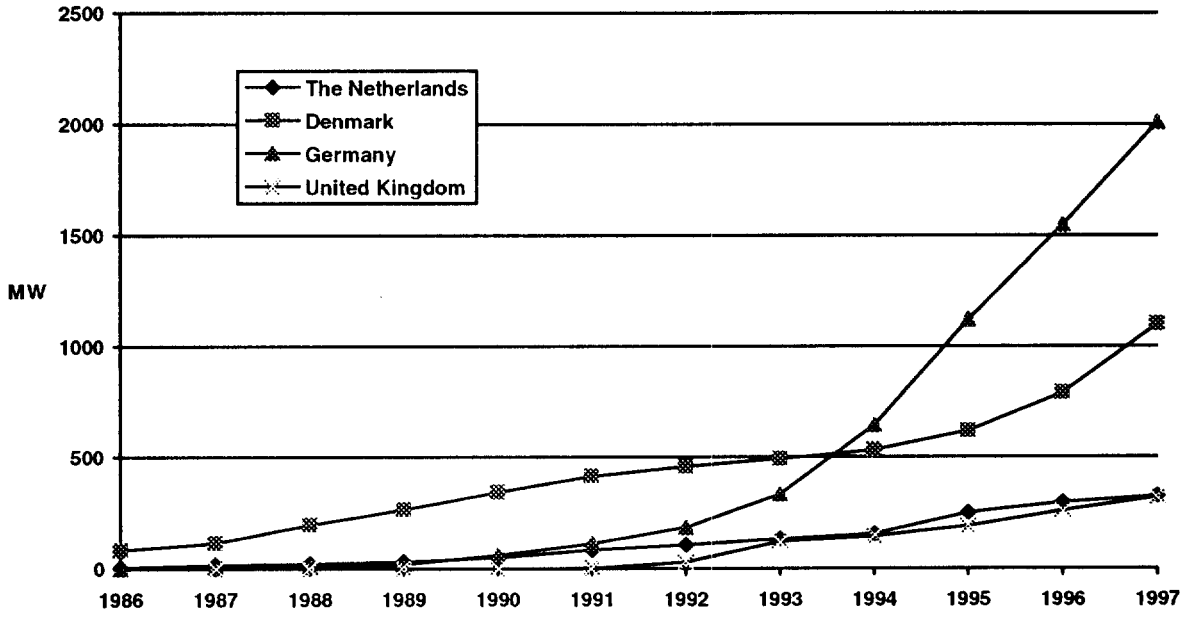
The developments in the Netherlands and the United Kingdom furthermore indicate that, if distributors can freely choose between generation technologies, they are likely to opt for electricity producing combined-cycle turbines rather than for cogeneration. The unbundling prior to introduction of full competition in generation in the Netherlands made it possible to take a regulatory influence on the kind of capacity constructed. In the absence of third-parties, the newly unbundled Dutch distributors could only choose cogeneration as an option for new power plant.

In the Danish situation, policy support rather than interest of utilities has been the key driver to the development of cogeneration in district heating. Danish policy makers have already claimed an exemption to the EU liberalisation directive in order to protect the district heating plants in Denmark. The position of district-heating plant is also part of a conflict between the different categories of utilities in Germany. To protect their district heating plant against competition, municipal utilities claimed and obtained special provisions in the new electricity act. In particular the admission of competitors to local grids now can be refused if this would impede the economic operation of renewables or cogeneration plants, including district-heating. This suggests that, if full competition in generation would be introduced, new district heating would not be a preferred option of utilities. No clear effects of privatisation on cogeneration development could be discovered from comparison of the four countries.

Case-Study 2: Wind Energy

The particularly high growth rates in Germany in recent years, leading to an installed capacity of around 2000 MW at the end of 1997 (Figure 1), made that this country has succeeded the United States as world-leader in installed wind turbine capacity (Rehfeldt 1998). In Denmark, the installed capacity is expected to grow to 1100 MW in 1997 (DWTMA 1998). Although the Netherlands and the United Kingdom can be found in the top-10 of wind energy producers as well, capacity there is much lower: 325 and 320 MW respectively (Erp 1998; BWEA 1998). Despite ambitious targets set, recent installation rates in the Netherlands are relatively low. It is therefore likely that the installed wind turbine capacity in the United Kingdom will surpass that in Holland in the near future.

Figure 1 :Total Installed Wind Power Capacity in the Netherlands, Denmark, Germany and the United Kingdom



Sources: IEA 1997; Erp 1998; DWTMA 1998; BWEA 1998; Rehfeldt 1998. Danish figures for 1997 are estimates.

Underlying Factors

Looking at factors behind the remarkable success of wind energy in Germany, the introduction of the Stromeinspeisegesetz - 'Electricity Feed Law' - in 1991 stands out as probably the most important single regulatory measure. According to this law, utilities are obliged to pay a remuneration of 90% of the end-user tariff to private wind turbine investors feeding electricity into the grid (Bräuer & Hemmelskamp 1996). Although investment subsidies as provided by for instance the '250 MW Wind' programme certainly also have been important, it was particularly the Electricity Feed Law which provided long-term investment security to investors, and led to an ownership structure of wind turbines in which private investors rather than utilities were the key driving force behind the wind energy developments (Slingerland 1998a). The other side of the coin, however, is that there has been a fierce

opposition of utilities against the Electricity Feed Law right from the start, as the remuneration was regarded as too high, and it was seen to put unduly pressure on some utilities near the coast in whose areas virtually all turbines were built (Grawe 1996; Leuschner & Uhlmannsieck 1996).

In Denmark, where wind energy became a significant factor in power production long before the other countries, a similar ownership structure as in Germany has developed in which private parties have been the key driver to initial wind energy development. Unlike Germany, however, these parties were mainly small-scale wind turbine co-operatives of locals generating wind energy primarily for own demand (Hvelplund 1995). Government has particularly stimulated these private investments in wind turbines with investment subsidies from the seventies up to 1989 as well as by a fixed pay-back rate which is continued up to present. Part of this pay-back rate is considered to be a reimbursement of a CO_2 tax which was introduced in 1991. In recent years, however, the Danish utilities have signed agreements with Government to build substantial capacity themselves as well. A large part of this new capacity will be constructed off-shore (IEA 1997).

The United Kingdom and the Netherlands have a substantially different way of stimulating wind energy development. In the UK, the so-called 'non fossil fuel obligation' (NFFO) was introduced in 1990, which obliged distribution companies to buy a certain percentage of electricity produced from non-fossil sources. This could be financed by charging a 'non-fossil fuel levy' to end users (Mitchell 1995, 1996). Although this system was set up primarily to finance nuclear energy, renewables - including wind energy - up to now also benefit from this system.

The funds for renewables generated by the levy are assigned to projects via a competitive bidding process to which potential investors can sign in. Subsidiaries of the main generators and distributors as well as third-parties so far have managed to get contracts. Although only a fraction of the projects which are awarded NFFO contracts is finally commissioned, the large number of potential investors which has subscribed to the bidding rounds held up to now seems to promise significant growth in future (OFFER 1997). It is uncertain, however, if the policy goal set for renewables will be attained since many projects will not yet be operational at the formal target date set, the year 2000 (ENDS 1997).

In the Netherlands, the remuneration for electricity delivered to the grid has to be negotiated with the distribution companies which, in the eyes of many private investors, has led to too low tariffs which had to be renegotiated too often (Janse 1997). As a result, by far the most projects up to now are initiated by distribution companies, or distributors in co-operation with other parties. Policy makers have stimulated the development of wind power in the past with direct investment subsidies. These were recently replaced by tax reductions. Wind energy investments of distribution companies are also partly financed by a levy charged to end-users which has to be spent by these utilities on energy efficiency and renewables projects (Novem 1996).

A system of tradable 'green electricity labels' will be introduced in the Netherlands in the near future. In this system, distribution companies will have to supply 3% of their electricity to end-users by the year 2000 from renewable sources (EnergieNed 1998). This has to be proved by the number of 'green labels' a distribution company holds, which can be obtained either by generating electricity from renewables itself, or by buying labels from another renewable electricity generator. It is hoped for that trading of these labels will create new incentives for the development of renewables, including wind energy.

Technology development, finally, has contributed to raising installation rates in all countries, as in a few decades the capacity per turbine has grown by roughly a factor ten. On the other hand, an impeding factor to wind energy development that has been found in all countries examined is the lack of

co-ordination of national policy with planning on a local level (Slingerland 1997 a,b; 1998 a,b). Lacking support of locals and local authorities, which finally have to issue permits for construction of turbines has been responsible for substantial delays and failures of projects (SCWA 1994; Wolsink 1996).

Discussion: Electricity Sector Liberalisation and Wind Energy Development

The comparison suggests that in all four countries the development of wind energy is ultimately dependent on the support system set up by policy makers. The way in which this support is organised substantially varies.

Examining the likely effects of liberalisation on wind energy development, the crucial question is if there can be any significant development of wind energy in the near future without these regulatory support systems. Most likely, the answer has to be no. Although the price of electricity generated by wind turbines is decreasing, it is still not quite competitive to fossil fuels. 'Green electricity', a term for an arrangement in which end-users voluntarily pay an additional amount to receive electricity generated from renewables, does not yet seem to provide a significant alternative to this regulatory induced support. Although green electricity is emerging in all four countries as a presumed 'market-conform' way of stimulating renewables, its importance so far is marginal - well below 1% of total distribution in the countries examined (EnergieNed 1997; ENDS 1997b; Janzing 1998). Furthermore, at close examination the link of green electricity to liberalisation appears weak since it is emanating in a predominantly liberalised system as the United Kingdom as well as in the still monopoly based electricity sectors in the other countries.

If wind energy development is still dependent on regulatory support, a second question is if liberalisation interferes with possibilities to keep up these support systems. The experience in the United Kingdom, where the NFFO system functions parallel to fully competitive electricity generation and largely competitive end-user supply, suggests that it is quite well possible to combine regulatory support for renewables and the introduction of competition in the electricity sector. Although it is not clear yet if there will be any new bidding rounds after full competition in end-user supply has been introduced in 1998, it is planned to maintain the levy after this date (Littlechild 1995). It is equally planned to maintain the regulatory support for wind energy after liberalisation in the other three countries, despite prospective changes to the Electricity Feed Law in Germany in order to reduce the remuneration and mitigate regional inequalities (BR 1997). It is neither evident that unbundling or privatisation of utilities interfere with providing regulatory support for wind energy. In the United Kingdom subsidiaries of the unbundled and privatised generators and distributors have initiated projects, whereas in the practically integrated and publicly owned Danish system utilities now have signed substantial wind energy contracts as well.

The largely differing growth rates of installed wind turbines in the four countries nevertheless suggest that the way of organising this support substantially influences installation rates. So far, it seems that the support systems in Denmark and particularly Germany are much more successful in stimulating wind turbine installation than those in the Netherlands and the United Kingdom. A key difference between the support systems in the former and the latter two countries is that in Denmark and Germany policy makers have legally prescribed a fixed remuneration for electricity delivered to the grid, which provides some long-term investment security to potential investors. Although this has provoked much opposition of utilities in these two countries, it has also very successfully stimulated third parties to invest in wind energy.

Case-Study 3: Demand-Side Management and Energy Efficiency

In all four countries, utilities are presently involved in demand-side management and energy efficiency activities. The measures taken vary per country and sometimes per utility, but generally they include information and advice to customers as well as campaigns for energy efficient lighting, appliances and sometimes more efficient heating and insulation. Dependent on the country and the utility, also other measures are applied (IEA 1995; Slingerland 1997 a,b; 1998 a,b). A direct comparison of demand-side management and energy efficiency measures in the four countries is difficult, since an indicator for their relative success is lacking. Some general remarks regarding the way demand-side management and energy efficiency in the four countries are organised can nevertheless be made.

In all countries examined, energy efficiency activities are also provided on a commercial basis by utilities and third parties like engineering firms and energy service companies. The extent is generally described as low (Moor et al. 1994; EST 1997).

Underlying Factors

In Denmark, utility involvement in demand-side management is organised in a top-down way. It is legally prescribed that the two system operators each make every two years an integrated resource plan for their area, which basically is a systematic evaluation of all supply-side and demand-side options available (Elsam & Elkraft 1994). The integrated resource plan in Denmark is based on a close co-operation of system operators, generators and distributors, which have to supply data like demand forecasts, generation capacity available and expected results of demand-side management activities. The outcome of the planning process determines to what extent demand-side management and energy efficiency activities of the utilities contribute to the CO_2 reduction target set by Government.

The federation of electric utilities in Germany has agreed to reduce CO_2 emissions over the period 1988 to 2015 by 25%, but this is neither translated into overall obligations regarding demand management, nor is the share of the individual utilities in achieving this target specified (BMU, BMWi, BDI 1996). As a result, the level of demand-side and energy efficiency activities largely varies per utility. Some are very active, others hardly, dependent on whether policy makers on a local or regional level are a driver behind extensive demand management measures or not. The relatively high emission reduction target agreed to by the German federation of utilities is furthermore put into perspective by the very long period over which this goal has to be attained and the inclusion of reductions obtained by restructuring the former East German electricity sector. A condition for the realisation of the covenant's targets is furthermore that a future use of nuclear energy is assured.

Demand-side management and energy activities in the Netherlands are carried out by the distributors. The activities of their 'Environmental Action Plan', which include demand management, renewables and cogeneration projects, aim to reduce CO_2 emissions in the period 1990 to 2000 by 17 million tonnes - which equals 3% of the projected emissions for the year 2000 (EnergieNed 1996). All distributors have to contribute to this action plan according to their share in total distribution. The measures taken by distributors are financed by a proportional levy charged to captive end-users and co-ordinated on a national level by the umbrella organisation of the distributors.

In the United Kingdom, the involvement of distribution companies in demand-side management activities aiming at energy efficiency is regulatory prescribed via the so-called 'Standards of Performance'. These standards were set in 1994 by the electricity sector regulator, and require the companies to undertake projects designed to save over 6,000 GWh of electricity over the period 1994-

1998 (2% of projected demand) (OFFER 1994). The activities are financed by a fixed levy charged to captive end-users and co-ordinated on a national level by the 'Energy Saving Trust', in which Government, the distributors and some generators co-operate.

Discussion: Electricity Sector Liberalisation and Demand-Side Management

Comparison of the four countries suggests that demand-side management and energy efficiency activities are still predominantly dependent on the regulatory support provided. These support systems are quite diverse, and hence are likely to interact differently with liberalisation. Particularly introduction of competition and unbundling appear relevant here, privatisation does not show to have clear effects.

The support system in Denmark is specifically designed for a practically integrated situation in which distributors, generators and system operators closely co-operate. Preparing an integrated resource plan, which requires exchanging commercially sensitive data, is not possible in a situation where these parties compete. Up to now competition in Denmark in practice is very limited, but problems with integrated resource planning can be foreseen if the Danish electricity sector due to EU regulations in future would become more competitive and apart from formally, also practically unbundled.

The support systems in the Netherlands and Great-Britain are set up for unbundled, and in future fully competitive electricity sectors. They are remarkably similar in many respects. In both countries distributors are the key party in these activities, which are financed by charging a levy to end users. In either country a target on a national level has been set and individual distributors are, according to their share in total distribution, responsible for the actual implementation of measures. Implementation on a national level in both countries is co-ordinated by a single organisation. On the other hand, differences between the two systems appear in the way in which the target has been set (CO_2 reduction versus electricity savings), the period in which it has to be attained (ten and four years respectively), and the way the levy is charged (proportional versus fixed).

The support system for demand-side management and energy efficiency in Germany can be regarded as a variation of the Dutch and British system in which only a target on a national level has been set, without identifying the responsibility of individual utilities. As such it would be fit for a competitive situation as well, but the very low accountability of individual utilities in the German system, in combination with the long period over which the target has to be fulfilled, might well impede attainment of the goal set.

Finally, the development of commercial energy services is likely to be influenced by the introduction of competition. If, as is generally expected, prices will drop after the introduction of competition in generation and supply, its rather limited role so far could be expected to be further weakened.

Conclusions

One has to be very careful when trying to interpret the results of a cross-country comparison like the one in this paper. Only a few countries and variables have been studied in detail. Other factors, such as culture, geography and domestic primary energy sources will play a role as well when trying to apply the results to other countries. Nevertheless it is held that the overall comparison of the four countries made, which is summarised in this paper, suggests some underlying trends and patterns in the relationship between energy conservation and liberalisation which could be relevant to policy makers aiming to reconcile energy conservation and electricity sector liberalisation.

In the cogeneration case-study, it was argued that unbundling stimulates the construction of new power plant by providing incentives to the newly unbundled distributors to search for ways to get access to generation capacity, and by reducing countervailing power of generation companies against new power plant. Judged by the developments in Britain, these power plant are likely to be mainly gas based combined cycle plant if unbundling and introduction of competition in generation are simultaneous and there are no additional limitations to the kind of generation capacity constructed. Under those conditions industrial and small-scale CHP capacity can be expected to increase as well, though much less than non site-specific gas based capacity.

An unbundling prior to introduction of full competition in generation, as has happened in the Netherlands, can direct the demand of distributors for own generation capacity into a demand for cogeneration plant, but additional regulation seems required here. Limiting conditions in the Netherlands were that the construction of own capacity by distributors themselves was restricted, and third-parties were effectively prevented from taking part in public electricity generation. Developments in Germany and Denmark suggested that the introduction of competition is likely to have negative impacts on economic viability of district-heating networks, and consequently on cogeneration in these networks. However, the regulations of the EU directive on the European electricity market allow for a preferential treatment of cogeneration and renewables, and both countries seem willing to use this clause to protect district-heating.

In the second case-study, no evidence was found for effects of unbundling, privatisation or introduction of competition on wind energy development. Only the emerging green electricity schemes can be regarded as an instrument which is to some extent market based, but their importance so far is marginal. It was concluded that wind energy is predominantly dependent on the policy support received. Comparison of the four support systems suggested that a fixed pay-back tariff for electricity delivered to the grid as applied in Denmark and Germany is particularly effective in stimulating wind energy development by providing an incentive to third-parties to invest in wind energy. The German situation furthermore indicated that fixed pay-back rates could very well be maintained in a future competitive situation.

The development of demand-side management and energy efficiency activities in the third case-study showed to be mainly dependent on the regulatory support received as well, since the level of commercial energy services in the four countries appeared low and was expected to be further reduced by the anticipated lower prices after the introduction of competition. The situation in the United Kingdom suggested that this support could be set up and continued within a largely competitive and unbundled system. However, it was argued that a support system based on integrated resource planning by the system operators like in Denmark is only possible in a practically integrated situation where parties do not compete.

Finally, the comparison suggests that it is possible to reconcile energy conservation and electricity sector liberalisation. Some synergetic effects can even be expected, particularly in electricity generation and cogeneration. However, much depends on a careful additional regulation. Even the time-path of implementing the various steps in the liberalisation process appears important. Without such regulatory support wind energy and demand-side management are not likely to flourish in a liberalised electricity sector. Electricity sector liberalisation should therefore be seen as a re-regulation rather than as a de-regulation. If properly fine-tuned and based on a sound understanding of its effects, it can very well be used as an instrument for energy conservation.

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