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Who Secures the Security of Supply? European Perspectives on Security, Competition, and Liability

The underlying problem for governments in approaching security of supply in the new competitive markets is that they need to be seen to be ''complacent'' about security of supply so that private investment to assure adequate security will be forthcoming. The alternative—governments promising to intervene when security is threatened—risks choking off the private investment that competitive markets might otherwise provide.

Enese Lieb-Dóczy, Achim-Rüdiger Börner, and Gordon MacKerron

I. Introduction

Modern economic and social systems are complex networks built on a division of functions. This means that the vulnerability of social systems to unreliable electricity and gas supplies has been increasing over time.[1] Supply interruptions can lead to far-reaching damage to industry, private consumers and, in extreme cases, even public order.

Security of energy supply, especially of electricity supply, has become a major policy issue in recent months. Major power failures in both North America and Europe have fueled existing debates about the adequacy of investment in production and networks—especially in liberalized systems. Pressure

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for public intervention in favor of higher levels of security is, as a result, growing. If such pressure proves effective there could be wide-ranging implications for public policy for energy. Such policy generally gives broadly equal prominence to three major objectives—security, economic efficiency, and environmental protection. There can often be major tradeoffs between these objectives. Action to enhance security may well conflict with either economic efficiency or environmental protection or both. New Government intervention to promote more secure systems may therefore have wide-ranging effects across the energy system.

This is, then, a good moment to review the economics of energy security at a general level, and then to ask questions about incentives for security in European gas and electricity markets where—apart from the networks—competitive structures are replacing monopolies. What constitutes an adequate measure of the security of supply? What incentives can a competitive market offer for security of supply? And who is liable for security of supply?

II. Definition of Security of Supply

Security of supply is fundamentally about risk. More secure systems are those with lower risks of system interruption. There are many possible ways in which systems can become more insecure. The most frequently debated is the risk that production capacity (generation for electricity; indigenous or imported production sources for gas) may be too limited for peak demands on the system. This is expected to be potentially acute for electricity, because storage capacity is normally very limited. However, there are several other possible sources of insecurity or risk: bad weather conditions destroying network infrastructure; poor maintenance or under-investment in network transportation systems; failures in primary fuel supply for electricity, possibly due to reliance on imports; and generic faults in generation plant (e.g., in nuclear power).

In practice, systems are never designed to provide a 100 percent level of security because the costs would be prohibitive.

The nuclear power example is a reminder of the need for ''technical'' security (or safety) as a precondition of adequate security. It is also a reminder that one of the main analytical problems in analysis and policymaking for energy security is that threats to security often come in the form of low-probability but high-consequence events (failure of Russian gas exports, or a nuclear accident causing similar reactors to close). Such cases are often of such low probability that there is no historical experience of their occurrence and therefore no completely firm basis for prediction either of the event or its consequence. This leaves open much scope for lobbying by interested parties.

III. The Theoretical Optimum Level of Security of Supply

Politicians often imply that electricity and gas systems are designed to provide a 100 percent level of security. In practice, systems are never so designed because the costs of getting to 100 percent security would be prohibitive. An example is the cost of securing rural electricity consumers against the risk that low-voltage overhead lines would be damaged in severe weather. To achieve this result would require all distribution lines to be put underground, at prohibitive cost—and no electricity system puts all local lines underground.

The ''right'' level of security that a system provides is, in principle, determined by the interaction between the cost of providing extra (marginal) security and the value to consumers of the increase in security so provided. The optimum level is where the marginal cost of more security is just matched by the value that consumers place on the increase. This level of security will be easily determined in principle

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provided two kinds of assumption are met:

- More security costs more to provide, but extra (marginal) security is more costly the closer we get to 100 percent security. This means that there are diminishing returns to each successive increment of security-enhancing spending. This is a plausible real-world assumption: In the example above, the undergrounding of rural distribution lines to get close to 100 percent security would cost much more than, for instance, undergrounding distribution lines for urban consumers.
- Consumers value marginal improvements to security less the closer we get to 100 percent security. This is also plausible. At levels close to 100 percent security consumers will tend to experience brief interruptions, of relatively little consequence; at lower levels of security, interruptions will tend to be longer and proportionally more damaging, implying higher marginal consumer valuations of security.

Provided these two kinds of assumptions hold then the shape of the two curves in **Figure 1**—the ''supply'' curve (marginal cost of more security) and the ''demand'' curve (consumer valuation of extra security)—will be as shown. There will be a single, cost-minimizing, value for the optimum level of security where the curves meet.

This is a useful theoretical result, not least in showing that pursuit of 100 percent security will tend to be very costly in relation to the consumer benefits that would result. However, it is clear that calculating such an optimum is difficult in the real world:

- There is no direct ''market'' for energy security, so that consumer valuations of alternative security levels need to be obtained by indirect survey methods.
- There are important elements of the ''public good'' in energy security.[2] For small consumers, the level of security achieved is identical to that provided to those consumers' neighbors, and this gives an incentive for consumers to misstate their valuations and try to ''free ride.''
- Because few consumers have experienced more than very short supply interruptions, their ability to conceptualize let alone value more serious and long-lasting interruptions is likely to be poor.

These qualifications mean that identifying a single optimum level of risk and security is, in practical terms, impossible. In addition, different consumer groups may well value security differently. Some consumers are likely to be willing to pay more than others to avoid risks of interruption—e.g., industrial consumers with continuous production—and some less, e.g., households with few electrical appliances. In practice, therefore, there will be a range of consumer willingness to pay for security (**Figure 2**).

However, provided both demand and supply curves are reasonably flat around the optimal level, none of the above qualifications will in practical terms be serious. It will be possible to define a broad ''zone of adequacy'' within which security will be adequate and where costs will not rise excessively if the precise optimum is missed in either direction.

Where consumers have relatively high willingness to pay to avoid interruption, there often exists the opportunity to provide such higher levels of security. This can occur when consumers are relatively large users of power and can directly pay for higher security levels. However, this capacity to differentiate between consumers is limited to relatively ''normal'' conditions: The electricity system is integrated, and

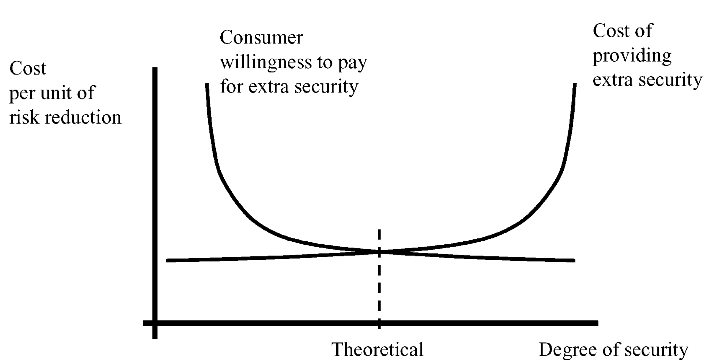

Figure 1: Theoretical Optimum on the Basis of the Costs and Benefits of Security

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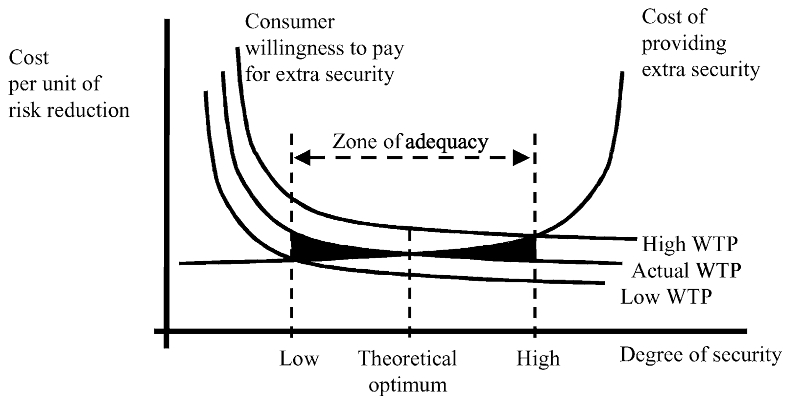

Figure 2: Optimal Security Where Consumer Valuations Differ

consumers with high valuations of security cannot be fully insulated from other consumers in times of serious insecurity and system breakdown.

Overall, provided the ''strict'' optimum is where both curves are reasonably flat, the conclusion is that policy may reasonably aim at a level of security slightly higher than the strict optimum without incurring disproportionate cost. This is partly because of the ''public good'' problem (consumers understating willingness to pay) and partly because, politically, it is much more comfortable to run at higher than lower levels of security.

IV. Competition and Security of Supply

So far this analysis says nothing about who is responsible for security and who will pay for it. Under the old monopoly electricity systems within Europe, it was clear that the responsibility lay with the monopoly company, and, to a significant degree, government, given that government always had ''regulatory'' responsibilities even where ownership was private. In these earlier days, there was centralized planning for primary fuel acquisition (in electricity) and for network capacity and adequate production/generation. This meant that most kinds of security were the subject of direct and explicit planning.

The introduction of competition adds complexity. *First*, government and regulators remain responsible for security in the network (transportation) activities. As natural monopolies, these will remain closely regulated for the indefinite future. It is noteworthy that the recent spate of major power failures in Europe and North America have all had their origins in the network parts of the electricity system. This makes it difficult to blame the liberalization of electricity systems for recent failures.

Second, reform processes are now leading to the replacement of monopoly franchises with competitive structures both upstream (production/generation) and downstream (retail supply) of the networks.

In the EU, the legal basis for the liberalization of the European electricity and gas industries was laid by the EC Directives 96/92 and 98/30 which aimed at the implementation of the Single European Market both for electricity and gas. The continental industries were characterized by national monopolies or quasi-monopolies allowing only for limited competition, if any. In Germany, many local and regional companies had previously enjoyed exemptions from the prohibitions of cartels and vertical restraints. The EC Directives have now been replaced by refined versions, viz. Directives 2003/54 (with the accompanying Regulation 118/2003 on cross-border electricity trade) and 2003/55. The new Directives tighten the rules for unbundling and regulation.

The Directives focus on grid access and the promotion of competition through non-discriminatory access for suppliers and shippers, rather than security of supply. But there are security implications in a number of the Directives' provisions. In the Electricity Directive, recital 23 aims to maintain a stable infrastructure and to achieve EC-wide security of supply, and recital 26 allows for public service obligations. Article 7 allows Member States to auction the right to build and operate new power capacities. Article 11 paragraph 4 permits Member States to allow grid operators and others to reserve up to 15 percent of annual national consumption for domestic fuels. Articles 9 and 14 state the

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responsibilities of the grid and net operators and thus require Member States to enable these companies to fulfill their duties. Finally, Article 24 allows for emergency measures.

Overall, security of supply does not have the status of a priority aim of the Directives, but rather is an issue to be monitored where there are apparent threats. This could give the impression that the demanding task of achieving security and safety for consumers of electricity and gas, each and every minute and continuously over the years, has been neglected. In these new competitive markets, especially in production/generation, decisions on investment are increasingly taken with no explicit view of the impact on system security, but only with a view to profitability. In the competitive parts of the market, no one is explicitly charged with responsibility for overall system security: It is assumed that a number of private firms, interested only in private profit, will collectively act to ensure adequate security levels. Is such faith in the market justified?

Under the old monopoly systems there was generally an inbuilt bias towards ''excessive'' security—levels of security well to the right of the zone of adequacy in Figure 2, where the costs of marginal security greatly exceeded consumer valuations. This was because the political balance strongly favored a highly secure system. The costs of keeping a very high security level were difficult to see and could automatically be passed directly to consumers, while the political cost of frequent supply interruptions were high. In the old England and Wales system, the CEGB used to run an unnecessarily high ''planning margin'' (intended excess of capacity of over maximum demand) of 28 percent, in order to minimize security risks. In Germany an authority was created specifically to supervise investment and was designed to prevent superfluous and expensive investment.[3]

Under the old monopoly systems there was generally an in-built bias towards ''excessive'' security levels.

We might expect that under a competitive system the level of security would fall because private investors will be unwilling to maintain excess levels of capacity, with the effect of depressing prices in a competitive market. Such a fall in security levels would, however, be economically efficient (cost-minimizing), if security stays within the zone of adequacy. The avoided costs of ''excessive'' provision would more than compensate for the consumer losses of lower security. The empirical question, not yet easy to answer definitively, is whether incentives exist to make sure that security levels fall no further than the optimal range.

In principle, competition may have ambivalent effects in relation to adequate security provision. On the positive side:

- More competition forces energy providers to pay more attention to the needs of their customers. This means that customers can also define their preferences with regard to security—especially in terms of price. For example, large consumers for whom the current security level is too expensive, can, in a competitive system, negotiate interruptible contracts for a lower price. Competitive markets can also cause consumers in other industries (e.g., those heavily dependent on IT) to pay more attention to the reliability of their electricity supplies since supply failures have serious commercial consequences due to high down-time costs.
- Competitive markets lead to a differentiation of offers and a wider range of providers, as well as to more liquid and deeper associated markets with graduated mechanisms for the reduction and transfer of risk, for example, forward and hedging transactions. The financially close association within and between these markets increases security through network effects.

On the other hand, more competition within the energy sector could also reduce security:

- For small consumers, energy security has some public good characteristics—over wide ranges

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of security levels, provision is collective and cannot be varied because individual consumers value security differently. The classic theory of public goods suggests that this leads to under-provision compared to consumers' ''real'' valuations because consumers have an incentive to try and ''free-ride.'' If the market follows apparent consumer valuations, it may therefore under-provide security relative to the optimal levels.

- Security is a characteristic of the system as a whole. For example, adequate supplies remain worthless when distribution networks are in shambles. The more competition develops, the less influence individual market participants have on market outcomes and thus on security. When energy markets are not ''perfectly competitive'' larger electricity companies may have a greater interest in security than smaller companies. The responsibility and reputation of a large company are closely linked. Large companies cannot afford capacity shortages or reduced security. Vertically integrated companies are even less able to evade their general responsibility for generation, distribution, and supply and have a great interest in continuous supply. Companies with market power may be able to invest in the reduction of security risks. This suggests that greater degrees of oligopoly and market power may lead to higher security levels (though not necessarily optimal levels), and that highly competitive systems—such as that in the U.K.—may lead to lower security levels.

V. Incentives

Given that the impact of competition on security is, in principle, ambivalent, we now ask what detailed and concrete incentives are there, or could exist, to ensure that competitive markets provide adequate security. This question can be approached from the top down and from the bottom up.

In the top-down category there is the lively debate about the extent to which particular competitive market designs do or do not stimulate enough timely investment in new capacity. NETA, for example, the relatively new England and Wales wholesale market, is an energy-only market and contains no explicit reward for capacity or investment.[4] Other wholesale markets outside Europe (e.g., PJM in the U.S.) use explicit capacity margin instruments to incentivize investment. The U.K. Government has concluded that such mechanisms are not currently necessary. This makes it all the more necessary to consider whether the new competitive markets will contain any bottom-up incentives to ensure adequate levels of security.

Looking at security from the bottom up (i.e., the perspective of consumers), consumer welfare depends on two aspects:

- ''physical'' security of supply, i.e., the risks arising from a supply interruption, which can only be influenced through technical or practical measures, and
- ''financial'' security of supply, i.e., the question of an adequate financial compensation for the damages arising from a supply interruption, which includes the problems of proving the grounds for and the amount of the compensation claim as well as its enforceability with respect to the party under obligation.

We start by assuming that the majority of damages can be compensated financially. Financial compensation systems can in principle create effective incentives for an adequate degree of security of supply, since they directly influence the suppliers' profit function.

With respect to the amount of compensation payable, it has to be emphasized that different consumer groups place a different value on security of supply. However, we can generally assume that for all customer groups interruptions of which advance notice is given or which are of a short duration are more likely to be regarded as

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less serious than sudden or prolonged interruptions.

A. Small consumers

For small consumers, especially private households, security of supply is, as a rule, shared. For technical reasons (high costs for the provision of real-time meters and switches), no individual interruptions occur; neighbors are always also affected, so the question of differing preferences regarding security of supply cannot be reflected in the market. With low demand for energy relative to capacity, the physical security of supply is ''non-rivalrous,'' i.e., no consumer's consumption of ''security'' detracts from anyone else's security, even if they consume more. When capacity is tighter, an increase in consumption makes interruption more likely. The individual consumer may not be aware of this system-wide consequence of his additional consumption; the risk results primarily from the accumulation of such lack of awareness; it is a typical cumulative risk. On the level of the private customer, the physical security of supply thus has the characteristics of an ''impure'' public good.

Financial security—the provision of financial compensation for damages arising from a physical security failure—is a private good. A market for financial security would be characterized by insurance-type approaches.[5] However, no actual compensation or insurance programs for small consumers have so far been available. Theoretically, a supplier could offer customers at risk from damage a higher regular tariff (with the payments above the regular tariff representing the insurance premium) and then pay compensation in the event of a supply failure. However, because the customers with the highest risks of interruption, which cannot

easily be calculated externally by an insurer, would disproportionately take up this protection, adverse selection would arise and the costs for such insurance would be very high. Thus, with respect to the provision of financial security, market failure seems to be caused by adverse selection and the resulting excessively high costs of providing insurance schemes for individual customers.

There are even more reasons why a general insurance cover for such supply risks does not exist:

- Consumers are likely to undervalue previously offered security levels. Because of their limited experience of interruption, they are not able to evaluate the risks themselves and hence the value of the insurance premia offered.
- The transactions costs of an insurance solution are high, especially due to the difficulty of assessing individual risks.
- The aggregate damage may be very substantial and the premium may exceed electricity or gas bills.
- Consumers evaluate the effects of interruptions with reference to their own well-being and might not consider the generalized negative consequences of interruptions. Negative impacts arise in the entire area affected by the supply interruption (e.g., the impossibility for people to make journeys home from work by train or underground, the increased risk of looting and burglaries in a blackout situation, the down-time caused in factories, etc.). Small consumers do not include these costs in their decision-making because there is no incentive to do so; these costs are external to individual customers.

B. Large consumers

Large consumers, especially industrial customers, have clear individual preferences with regard to the level of physical security. They can choose a lower security level than that provided by the network supplier. Interruptible contracts allow the possibility of *intentional interruptions*. These do not solve the problems of physical security in the event of *unintentional interruptions*, i.e.,

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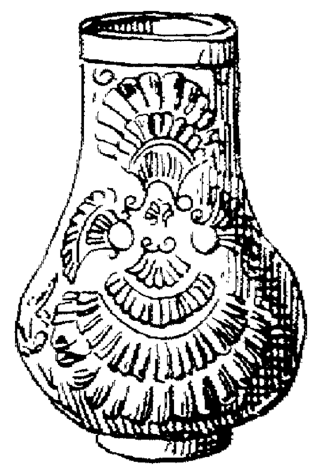
those interruptions which are not covered by the conditions of the supply contract and which were not therefore agreed with the customer beforehand.

In the event of an unintentional interruption, large customers connected to low voltage levels often find themselves in the same network and thus in the same risk situation as small customers. However, even medium- and high-voltage customers are not entirely isolated from the security situation at lower voltages. They draw their electricity from networks whose security of supply is partially determined by the networks supplying small customers. In this respect, there are situations in which no-one can escape the impacts of serious system breakdowns. Nonetheless, due to their different technical characteristics and economies of scale, large customers enjoy some choice in electricity and gas security, for example, through the installation of emergency generators. For the large consumer, the physical security of supply can thus have the character of a private good, but it may still have some characteristics of an impure public good.

By comparison, for large consumers, financial security is an entirely private good with respect to planned interruptions. Interruptible contracts determine the price reductions for pre-announced interruptions to supply. The price advantages define the customer's preference for compensation levels. However, with regard to unforeseeable interruptions in supply, the same comments apply as in the case of small consumers.

VI. Incentives Through the Law

Having examined both policy and consumer incentives to ensure adequate security in com-



petitive gas and electricity markets, there remains the question of the use of the law to ensure security. The principal means of checking that security levels are appropriate in social terms is to convert risks into costs, i.e., in particular, into compensatable damages. Claims for damages thus not only have the individual-related function of compensating the injured parties, but also—if necessary, determined through the premiums for insurance cover—the economic function of bringing the liable party to a new optimization of services offered. Under the *economic theory of law* the system of liability is accorded an importance going beyond the compensation of the individual case, both in terms of service content and price level.

The system of official supervision, in line with its objective of avoiding damages in the public interest, takes precedence over the rules on the settlement of individual damages. The system of official supervision is, in particular, intended to prevent damages which, due to their nature or scale, are not compensatable. Nonetheless, a wide range of damages can be compensatable.

The question arises whether, as a result of the transition to the competitive system, official precautionary measures (supervisory legislation) and the legal provisions for subsequent protection require adaptation or revision. However, we must remain realistic and can in the context of the EU disregard these models which require the overturning of the rules under civil procedural law on liability and its procedural implementation, along U.S. lines, for example. These rules carry cultural associations and, in their basic principles, are firmly fixed in their original social system. Only adaptations in individual cases can be considered.

The supervisory rules apply the yardstick of technical security (safety) and due care in operation. At present, no accumulation of cases of damage can be observed here which would give grounds for official intervention or even an extension of supervisory authority and corporate obligations under public law (e.g., periodical reports, officers at

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plants responsible for security of supply).

The system of liability for technical plant security is already elaborate: The primary consideration is the protection of affected third parties. The basis for claims includes, in addition to the law on illicit acts in the Civil Code, the rules on absolute liability in accordance with the EC Nuclear Energy, the Environmental Liability, the Public Liability and Product Liability Directives. As a rule, exemption from these is not possible and parties are bound to contract according to these laws. The contractual rules on liability, which are fundamentally subject to the autonomy of the parties, are extended to cover specific circumstances, e.g., negligence on conclusion of contract, assumption of implied or de facto contracts, or area of protection. Criminal and contractual liability can be based on technical rules. With increasing potential for damages, the tendency of the courts to assume organizational culpability and gross negligence is increasing.

The contractual liability system for electricity and gas contracts for each Member State therefore remains to be examined. In the liberalized market, contracts between all participants should take into account the fact that the issue is now no longer simply the technical security of supply (safety). The risks today are also affected by the numerous data transmissions which are part of the competitive system in an increasingly interacting and interwoven system. In view of the individuality of damage risks, these should as far as possible be treated specifically and remain contractually attributable. The customers affected by the risk could then decide for themselves, according to market principles, whether and to what extent they prefer (1) technical safeguarding

measures, (2) preventive measures, or (3) a contractual transfer of risk to their insurer or their supplier. The protection of commercial customers should be reduced to the protection under cartel law against misuse of market power and protection against ''unusual'' clauses. The latter are clauses which an honest party to a contract in the industry cannot anticipate because they are intended to unilaterally effect an unjustified transfer of risks.

VII. The Problem of Time-Scales

The problem in the chain of liability under civil law lies in the time scales involved. Anyone investing in production installations or import agreements enters into a long-term commitment. However, cartel law, in particular the EU vertical restraints Directive 2790/1999, only allows a relatively short-term binding of the customer, unless this binding is restricted to a part of demand. This means that the contract with the consumer only has limited weight: Either it is short-term and involves high volumes or it is long-term and involves low volumes. In both cases, the damage potential which can be transferred to the supplier through liability is small. In the first case the subsequent new cover is the customer's responsibility. In the second case the residual cover, and thus the failure risk in the contract, is limited. The supplier who takes on such a reduced damage risk only has cause to cover just his limited risk upstream in its purchase contract. The cover contract is thus also restricted. Trade intermediaries do not absorb additional risk.

This means the producer/importer bears the risk that they commit themselves to long-term investments and can only sell on a short-term or low-volume basis. The producer/importer thus takes the risk that, in the event of business being poor, his investment will not pay off or that he will not be able to fulfill increases in purchasing commitments. This investment risk has to be compensated by adequately high prices that competitive markets may or may not produce. This is

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the manifestation, at the individual company level, of the top-down issue of investment incentives addressed earlier in this article. The civil law on liability cannot offer any incentives here, because nobody will assume liability for future supplies.

VIII. Conclusions

The introduction of competition into parts of the electricity and gas markets makes security of supply responsibilities more complex. Government and/or regulators remain responsible in the network parts of both industries, where natural monopoly regulation will continue. But in the newly competitive areas, especially production/import (gas) or generation (electricity), the initial assumption is that markets will provide the required degree of security. This has raised fears that the ''hidden hand'' may not work.

Economic analysis of security suggests that there is a ''zone of adequacy'' of security levels around a notional optimum, at which the costs of extra security are balanced by the value consumers give to such extra security. The advent of competition may give incentives for the market to provide a lower level of security than the excessively high levels that have prevailed under monopoly, but there is no clear reason in principle to believe that markets will either under-provide or over-provide in relation to the idea of adequate security levels. It is too early to judge how effective markets will be in providing security in production/generation. However, our analysis suggests that:

- It is difficult for individual consumers to achieve their preferred level of security, either because security is provided collectively (small consumers) or insurance cannot cover all eventualities (all consumers);

- The law cannot ''fill the gap'' mainly because investment in electricity and gas production is long-term and contract and liability law cannot cover such long periods when prices are unknown; and
- It may be necessary for governments so to design wholesale markets that there are explicit but stable incentives for timely investment in new capacity.

The underlying problem for governments in approaching security of supply in the new competitive markets is that they need to be seen to be ''complacent'' about security of supply so that private investment to assure adequate security will be forthcoming. The alternative—governments promising to intervene when security is threatened—risks choking off the private investment that competitive markets might otherwise provide to ensure adequate security.

Recent blackouts have had their origins in the regulated network parts of the electricity industry and so it is difficult to see them as a result of liberalization. It is too early to judge how far the new competitive markets in production/generation will provide adequate security. In the meantime, governments will need to remain officially complacent while carefully watching to see how investment levels develop in the new markets.■

Endnotes:

1. This may be illustrated by the failure of the electricity supply to the manufacturer of a component product who, on a just-in-time basis, supplies the manufacturer of an intermediate product who, in turn, has commitments to the manufacturer of the end product, who has to supply his customers.

2. *Security in gas and electricity markets*, Final Report for the DTI, NERA, Oct. 2002, available online under http://www.dti.gov.uk./energy/whitepaper/index.shtml/

3. German energy industry law (EnWG).

4. *Guidance and Commitment: Persuading the Private Sector to Meet the Aims of Energy Policy*, A Report for Powergen Plc, NERA, Dec. 2002, available at www.pgen.com/policy-regulation/pdfs/021217%20powergen%20policy%20final.pdf.

5. Here, insurance means the formation of risk pools to spread the effect of adverse events and not safeguarding through physical measures to reduce the probability of adverse events.

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