EUROPÄISCHE AKADEMIE
zur Erforschung von Folgen wissenschaftlich-technischer Entwicklungen
Bad Neuenahr-Ahrweiler GmbH
Direktor: Professor Dr. Dr. h. c. Carl Friedrich Gethmann

GRAUE REIHE · NO. 44 · JULY 2008

The Regulation of Electricity Networks

Open Questions and Methods of Solution

Executive Summary

U. Steger, U. Büdenbender, E. Feess, D. Nelles

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The texts of the "Graue Reihe" contain current editions and documentations which are developed by scientists of the Europäische Akademie zur Erforschung von Folgen wissenschaftlich-technischer Entwicklungen Bad Neuenahr-Ahrweiler GmbH. The academy is concerned with the scientific study of the consequences of scientific and technological advance for individual and social life and for the natural environment. The publications of the "Graue Reihe" are printed in the form of manuscripts and are published in loose succession edited by the Europäische Akademie. They can be ordered at the Europäische Akademie on request in writing.

Europäische Akademie
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ISSN
1435-487 X

Editing
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Layout and Printing
Köllen Druck+Verlag, Bonn+Berlin, www.koellen.de

Foreword

In September 2005 the Europäische Akademie established the interdisciplinary project group "Societal implications of electrical power grids". Its aim was to bring together technical, economic and legal competencies to give scientifically sound recommendations regarding the regulation of electric networks and proposals for the relevant policy fields. The achievements of the perennial work of the research group intend to contribute to a consistently pursued dialogue of science, policy and the public on this topic, considering the fact that a reliable electricity supply is essential for every modern society, and therefore the energy system has to be able to provide the required amount of electric current preferably without any interruptions.

This booklet is an English translation of the subsumption of the project group's final report, which was presented to the public in Berlin, June 2008. The present volume shall make the central messages of the study available to a wider scope of recipients. The detailed Germanspeaking report may be obtained as: U. Steger, U. Büdenbender, E. Feess, D. Nelles: Die Regulierung elektrischer Netze. Offene Fragen und Lösungsansätze. Springer-Verlag, Berlin Heidelberg, 2008 (ISBN 978-3-540-68417-6).

The Europäische Akademie is highly indebted to the members of the working group, which consisted of Ulrich Steger, Chair (Lausanne), Ulrich Büdenbender (Dresden), Eberhard Feess (Aachen) and Dieter Nelles (Kaiserslautern). Their work was supported by Christoph Adamczyk (Lausanne), Karoline Mätzig (Dresden), Mirja Schwabe (Aachen) and Ruth Klüser (Bad Neuenahr-Ahrweiler). The latter coordinated this project.

Bad Neuenahr-Ahrweiler, July 2008

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Executive Summary of the Study "The Regulation of Electricity Networks. Open Questions and Methods of Solution"

In 1996 Europe started the process of liberalising the electricity sector and of regulating the natural monopoly of the grid. This journey turned out to be more complex and drawn out than originally thought, with results not always meeting expectations. No wonder that the academic and political debate is still going on and is currently more heated than before. Given the huge importance of electricity for every developed nation and the big economic interests at stake, we do not expect this trend to slow down.

This interdisciplinary investigation, however, does not intend to follow the beaten path of the controversy guided by interest groups. Instead, we looked for issues that are important for the effectiveness of future incentive-based regulation to ensure non-discriminatory competition before and behind the electricity grid. First, the book reviews the debates and identifies the specific questions for this book. Since much of our topic involves legal considerations, we focused predominantly on the German situation without losing sight of the European drivers and learning experiences. But we clearly had to leave out many questions and set priorities for our investigation. Therefore we tried to understand some basic questions of electricity grid technology and its implications for regulation, the history of regulation, the thinking in regulatory design where legal and economic aspects overlap, especially investigating the "information asymmetry" between regulators and regulated industry in the specific context of yardstick competition-based regulation and the trade-off between cost efficiency and high standards of security of supply.

Then we looked at the specific issues that we identified as emerging from the regulatory evolution: who will decide about future demand estimates, guiding investment decisions, the new model needed for innovation and the security of supply, the coordination between the choice of sites for power plants and the grid configuration and the implications of a common market for electricity on the grid layout and capacity. Last, but not least, we commented on the controversial topic of ownership unbundling from our research perspective.

1 The Technical Imperatives of Electricity Grid Regulation

Physical determinants of electricity grids have of course to be regarded when regulatory aspects are investigated. Electricity is not storable in significant amounts, but needs to be maintained at a consistent level of voltage to avoid breakdown. Electricity losses from the grid grow progressively with the load, thus operating at the technical maximum is both economically and ecologically questionable. The electricity grid of each country is a natural monopoly, as it would be a waste of resources to build competing grids. Independent of ownership or operator conditions, a regulatory framework needs to ensure non-discriminatory access to the electricity grid for producers as well as users.

2 The Regulatory Dynamics: Evolution of Regulatory Concepts

In the "good old days", the electricity industry was protected from competition in most European countries. This changed – with early pioneers in the UK and Scandinavia – when the EU Commission enacted a directive concerning common rules for the internal market in electricity on December 19, 1996. It covers competition in electricity generation and sales. The transmission and distribution grids remain natural monopolies. But everybody should have non-discriminatory access to the grid which should become more like "public streets", which everybody can use by respecting certain rules. To enforce these rules, most countries created regulatory authorities. In Germany, however, the first aim of the Energy Law of 1998 was not to regulate, but to mandate industry associations to negotiate the conditions for access to the networks (Verbändevereinbarung). It also contained some elements of benchmarking and – by transposing the European directive – a separation of the accounting between the grid and generation.

The approach was not as successful as anticipated, because of legal uncertainties, high transaction costs and an ongoing controversy about whether the "Verbändevereinbarung" was the appropriate instrument to guarantee an effective competition. In an international comparison, the grid fees in Germany still appeared to be relatively high. This criticism was not limited to Germany. The European Parliament and Comission therefore issued the directive 2003/54/EC concerning common rules for the internal market in electricity in summer 2003 which obliged member states to set up a national regulatory authority. Owing to conflicting interests and the influence by the Federal states (Bundesländer) on Germany's legal process, the German government transposed the directive into national law not before summer 2005, shortly before the federal election.

The energy law act introduced cost-based regulation with efficiency benchmarks and incentive-based regulation, starting on January 1, 2009. Our analysis is based on both – the cost based-based regulation and as an outlook on the incentive-based regulation. But many of the topics – e.g. the coordination between the grid operator and electricity generation sites – are independent of the specific regulatory approach.

In the German cost-based regulation, prices are based on the costs of the efficient grid operations of an individual grid operator and are approved in advance by regulatory authorities, using benchmarks e.g. Therefore the energy act refers to several regulations. The regulatory authorities are solely responsible for governmental supervision – the previous overlap with the antitrust authorities has been eliminated. The grid operator determines which fee grid users must pay, but it has to be appropriate, non-discriminatory and transparent.

The upcoming incentive-based regulation defines revenue caps only, calculated on the individual costs of the grid operator in the "steady state". After a few regulatory periods (five years each) in order to equalize the cost base, the revenue caps will be based solely on the costs of the most efficient "frontier" company. The efficiency frontier will move forward every year by an industry-specific progress factor. In the next six to eight years, however, there will be a transition period where the cost structure of the different grid operators will be harmonized using individual type related cost ceilings for the grid operator due to special duties or exceptions. These exceptions need to be presented in an official hearing. It should be noted that only costs that can be influenced by the grid operator are subject to regulatory control. Thus, the specific differentiation between influenceable and non-influenceable costs and the structure-based clusters for comparisons will be a main area of controversy between the regulators and the regulated company. Another area will be the use of standard costs (e.g. for depreciation) to harmonise investment cycles and age structures.

To compensate the electricity grid operators for short-term fluctuations in the amount of transmitted and distributed electricity, a regulatory compensation account will be set up. Regarding long-term demand increases in the distribution area (e.g. due to new settlement areas), an enlargement factor will be used. Operators of transmission grids will have to submit investment budgets for specific projects which will also be controlled by the federal regulatory authority (Bundesnetzagentur – BNA).

The main reason for the switch from cost-based to incentive-based regulation is the assumption that the grid operator has no incentive to reduce costs under a cost-based

regime as profits depend on individual costs. But the regulator is always handicapped by information asymmetry when isolating the price or revenue cap from the individual costs (see below). Incentive-based regulation allows the grid operator additional, but temporary, profits above the average risk weighted cost of capital to avoid the bankruptcy risk.These profits can be accomplished by further reducing costs, mobilizing efficiency potentials and innovations which only the operator – not the regulator – can identify. In the next regulatory period, however, the lowest cost level of the frontier enterprise becomes the new benchmark.

As experience in all developed countries show, the regulation of the natural monopoly electricity grid is an ongoing learning process. In all countries it is accepted that the grid cannot be exposed to competing investments: the individual investment might be more effective under competitive pressure, but in all likelihood this would be negated by a higher overall cost of the system. But the decisive difference between the "old" and "new" regulatory regimes lies in the individual costs of an individual electricity grid operator. The old regime, which was basically built on administrative cost control, suffered – first – from information asymmetry (see also Chapter 3): the operator knows its costs much better than the regulator and has every incentive to maintain this asymmetry. Secondly, there were no incentives for the operator to introduce cost reduction and innovation. This "handicap" had different variants (e.g. cost-based vs. rate-of-return regulation), but the fundamental disadvantages remained.

The new approach, therefore, is trying to "decouple" an individual operator's costs from regulated prices or revenues. In an ideal world, the most efficient operator would be benchmarked against the regulator-approved revenue ceiling (yardstick competition) and this benchmark would be permanently lowered as a result of productivity gains in the industry. However, in real life, this model is also fraught with uncertainties, especially when it comes to defining the revenue cap.

But the experience of these new approaches, especially in Great Britain where this system has been applied since 1990, is more on the positive side and regulators are "learning as they go". France – on the opposite side of the spectrum of possible regulatory approaches – is still sticking to its more centralized bureaucratic approach of regulation with a national, government-owned grid and a near-monopoly of the government-linked Electricité de France EDF. This considerable variance in the regulatory fundamentals explains the difficulty the European Commission has had in defining a common regime throughout Europe.

3 Is there an Information Asymmetry?

The "right information at the right time" is indispensable for effective decision-making. Economists argue that decisions in any organisation or corporation should be made by those who have superior information as long as there are no conflicting objectives which reinforces arguments for decentralized systems as the central collection, transfer and processing of information are time and resource consuming.

The unequal distribution of information (information asymmetry), however, poses an organisational dilemma, captured in the principal-agent theory. The agent has better information for example about his work than the principal. The agent can use this asymmetry to his own advantage (opportunistic behaviour). The principal is required to control his agent and try to align the interests of both (e.g. through profit sharing). However, this creates agency cost, which lowers the benefit for the principal.

In a regulatory setting this dilemma is relevant because the regulator's interests and the interests of the regulated company are opposed. The regulated company is interested in maximising its monopolistic profit. Hence, the regulator should prevent this and ensure that the results are as if the regulated company were active in a competitive market. The regulated company has every interest in hiding as much information as possible and making information collection and processing expensive for the regulator. This is not only a result of being close to the information that comes from operating the business, but is is also embedded in the legal framework of a market economy. Information forms part of the basic liberties that are protected by most constitutions. Any interference must be specifically justified and is subject to the rules of competition. As soon as competition is introduced before and behind the grid, regulation has a much clearer focus and less data to process. In addition, regulatory overlap has been eliminated and the staff at the regulatory authority BNA considerably increased. Since in the cost-based regulation grid users are only obliged to pay the access fee once it has been approved by the BNA, the grid operator has an incentive to comply with the legally defined, fairly comprehensive reporting and notification obligations which involve not only detailing the costs for the actual and previous period but also providing specific information on interruptions, on the age and maintenance standards of the assets, etc.

The further the regulatory regime moves away from cost-based regulation towards incentive-based and even yardstick competition, the more costs will be released from a system operator's individual costs. They will then be defined by the frontier operator.

Given the fragmented nature of the industry – consisting of nearly 950 local distribution service operators and four transmission service operators – the regulator is able to make comparisons which the individual operator cannot do, as it only possesses its own data. Modern information technology with an almost unlimited storage and process capacity, gives the regulatory authority a level of information for its decision-making that is not available to the grid operators. Sometimes the "tables are turned": when the regulator has ruled a high-cost operator as "comparatively inefficient", the regulated company can only disprove this ruling with comparative data that the regulator owns. Therefore the information asymmetry assumption does not shape the regulatory process in this case. The operators still have better information about their own costs, assets, etc. But the more the regulator uses benchmark and yardstick competition frameworks to ground its decision, the less relevant the operator's information advantage becomes.

4 Balancing Security of Supply with Low Prices

Another critical regulatory issue is the balance of security of supply with low prices. This topic is fraught with obstacles contradicting rational decision-making. The direct costs (lost revenues, repair costs) of a blackout can be calculated. But it is practically impossible to quantify the indirect costs in households, factories, transport chains, etc to a satisfying extent.

In addition, as Germany discovered during the Münsterland-incident in November 2005, any interruption of electricity beyond a short, local event has a high impact in terms of political and media interest. Political pressure on the grid operators is high. It is easy to cast the profit-driven electricity industry as the villain. Crisis management becomes imperative on the technical side, e.g. rapid availability of mobile generators for electricity, but even more important on the communications side. Immediate, credible and understandable information is the key. But it is hard to deliver, because in most cases the system operator has a limited overview of what has happened. Even if there is no legal obligation, a voluntary compensation fund might be set up as a gesture of goodwill and to calm the public mood.

Given the physical and psychological sensitivity surrounding the electricity grid, we wondered whether the grid could be a preferred target for terrorism. But even in countries with local terrorism, there have been no significant acts targeting electricity infrastructure over the last 20 years. The IRA once tried in England, but not in Northern Ire-

land. Even in Iraq most of the damage to electricity infrastructure has been caused by looting, not by terrorist attacks – which is not the case with oil and gas pipe lines. From a domestic terrorist perspective, it makes sense: the backlash from the suffering population would cost them support. And they also depend on the infrastructure for their operations. From a foreign terrorist perspective, it might be different, but there are obviously easier targets with a similar psychological impact so far.

Germany has one of the lowest interruption times worldwide (in 2005 without force majeure it was 19 minutes, with 30 minutes per year), compared with France (51/57 minutes), the UK (61/87 minutes) and Portugal (149/218 minutes). This clearly is the result of the earlier integrated monopoly with regional optimisation and high redundancies. Generally, across Europe n-1-redundancy is the technical standard. Even if one segment fails completely, the system will still work without interruption. But the interesting question is whether this high standard of supply quality and reliability can be maintained with the new regulatory framework. After all, regulation should decrease costs, at least in the public and political perception. And low costs and high quality are clearly conflicting goals in an electricity grid. Therefore we specifically need to analyse this aspect of the new regulatory framework.

5 Selected Topics Concerning the New Regulatory Framework

5.1 Responsibility for Investment Estimates and the "Right Decisions"

The first question we identified is that of the decision competence for future estimations of electricity demand. This issue is representative in the sense that it highlights the fundamental division of responsibilities between the regulatory authority and the regulated company, the grid operator, and the setting up of incentives in their context.

Investments, especially in high voltage transmission grids, take a long time for planning and realisation. Despite the recent Infrastructure Acceleration Act (Infrastrukturplanungsbeschleunigungsgesetz) in Germany, a time horizon of 8–10 years is plausible. Additionally, the investments are very specific and are sunk costs, i.e. once the money has been invested, no other purpose than electricity transmission is possible. As long as electricity demand is growing, any overcapacity is costly, but any temporary undercapacity will lead to increases in blackouts which can also be expensive. So "getting it right" is important but uncertain for both the grid operator and the regulator. In this

case neither of them has an information advantage. Both probably rely on a series of more or less specific estimations of energy demand by academic and other research institutions or specialized consultancies. Probably there is a "reasonable" range within these estimations. This range can probably be narrowed down, but not completely. Which is to be chosen? A marginal difference e.g. between 1.5 % and 2 % of the growth rate leads to a difference of eight percentage points in a 10-year period. This is sufficient to build a new power line sooner or later. As high capacities cannot be incrementally increased, the increase in step costs can be significant.

Our legal analysis led to the compelling conclusion that the decision was to be inevitably taken by the grid operator, not the regulator. This argumentation is based on three pillars:

– First, legally, the grid operator is still an enterprise with constitutionally ensured rights. As a result of its monopolistic characteristics it is subject to specific regulation. The basic role of the regulator is to control decisions, not to give orders or to act as an enterprise on its own. Therefore the regulator can check if the estimation made by the grid operator on electricity demand is reasonable and based on the best available research-based information. But it cannot decide for the grid operators or replace their estimates with its own. Any regulatory intervention has to be appropriate for the regulatory purpose. Domination of the demand projection would go beyond this principle, especially as the regulator cannot claim to have better information.
– Second, it is an economic and legal principle that those who take the decisions are also responsible for the results. But there is no way to make the regulator liable for interruptions of supply, based on the "right" predictions and the ensuing investments. There are no possible liability mechanisms to link a regulator to a blackout. The regulator's task is to ensure low prices and standards, as if grid operators were operating in a competitive environment.
– Third, there is the comparison with antitrust law. Antitrust authorities do not need to find the "right" price which would materialize in a competitive market environment. They interfere as soon as the market power is abused in so far as a price between the potential market price and a "not-abusive" price for the monopolist is achieved. Similarly, the electricity grid regulator asks to leave the reasonable range of estimates to the operator and does not "fix" its own projection.

As long as the grid operator's estimate is reasonably grounded, the regulator has to accept it and the consequential investment costs. Comparing with the reference grid and controlling the investment budgets are part of an efficiency control. Another issue is the specific extensions of a grid that might be optimal for a specific operator, but not for the overall grid configuration. This is checked by a reference grid to ensure efficiency, but not to test specific projects.

Does the grid operator have the right incentives to make an optimal decision from a macro welfare perspective? The right of a grid operator to choose its own demand estimates within a reasonable range does not mean that it has the incentive to choose the "optimal" decision. Not all decisions within this range are ex ante equally good or bad from an economic point of view. Decisions under uncertainty imply one ex ante decision which, taking into consideration the consequences of deviations from the actual development relative to the selected investment volume, maximizes the expected utility. In this respect the marginal cost of the grid investment for the security of supply equals the avoided marginal cost of a blackout. This, however, could only be achieved, if all costs and benefits were internalised by the grid operator. This implies that its revenues do not depend on the individual cost but on the average cost of the industry. And an internalisation of the benefits can be achieved by neglecting the based liability with strict due care standards. The difficulties of implementing such a concept are probably insurmountable. First, the costs of blackouts are hard to quantify, in particular the indirect costs. It would therefore be difficult for courts to allocate compensation payments. Second, it is often difficult to find the root cause as a result of multicausality and the involvement of several operators. Third, this makes it almost impossible for the regulator to define the right electricity transmission prices which need to be calculated independently of the operator's cost. Last but not least, it would be difficult to implement such a "radical" concept at the EU level.

Therefore, some more pragmatic ways have to be found to set the right incentives for the grid operator. The BNA suggested providing disincentives for below average quality operators through a combination of adjusting remuneration ceilings and a relatively low penalty payment for interruptions and violations of defined service standards. However, the regultation on incentive-based regulation does not include this latter provision. But besides this fact, the mechanism in the German incentive-based regulation does not necessarily lead to a danger in security of supply. Security of supply is a stated prior-ranking aim of the regulation model.

A different mechanism for investment control is designed for the transmission grid – the investment budget which performs critical functions for overall stability and reliability. The grid operator has to develop "relevant planning scenarios" that cover, for example, the change in the range of electricity flows caused by the use of renewable energies and the phasing out of nuclear power plants. In a second step the operator presents weak points and deficits to the regulator for which specific investment cases need to be built. The regulator compares the project with its reference-grid analysis which is basically a tool to control costs, not to prescribe specific investments. As we will see later, in real life the boundaries can get blurred. But the balance to be achieved from a regulatory perspective is low cost with high security standards. This regulatory framework includes a combination of ex ante budget proposals and ex post control and serves as a substitute for the missing economic incentive to choose the cost-effícient decision. But the principles of applied cost-transfers are closer to cost-plus regulation. However, we estimate that they will provide enough incentive to choose the upper range of reasonable estimates, but we suggest that this should also be observed carefully in the years to come.

5.1.1 Interruptible Contracts

As a consequence of the regulatory mechanism described above and as a proposal for more efficient regulation, the introduction of interruptible contracts has been suggested. These allow for interruptions to electric service in exchange either for an overall reduction in the price of electricity delivered or for financial compensation at the time of interruption. The macroeconomic benefits of such contracts are twofold: first, interruptible contracts will be attractive to those electricity users, if a cut-off means that they incur the lowest cost. And second, the probability of widespread blackouts will be lower if preventive cut-offs are possible, even if no crisis is emerging. A further incentive for the producer and the grid operator is the lower peak generation and distribution capacity needed, thus leading additionally to a lower electricity cost.

International evidence suggests that four types of contracts are feasible to reach these goals: "pay in advance contracts" (lower prices based on expected duration), "pay-as-you-go contracts" (bonus for effective cut-off time), "optional binding mandatory curtailment plans" (mostly companies commit to a reduction in their electricity use for a specific time), and programmes demanding reductions during peak hours, mostly for households. Which type to choose depends on various factors, but it could be left to the market to figure out the best possible time and fields. The regulator should have an inter-

est in promoting interruptible contracts as they generate positive externalities. The demand in spot markets is reduced and the lower prices as well as the reduced probability of widespread blackouts benefit everybody.

5.1.2 Options for an Interactive Relationship between Regulator and Regulated Company

So far the grid investment process from a legal and economically efficient perspective. Empirical evidence, however, suggests that there are also elements of cooperative relations evolving, despite conflicting goals between the regulator and the regulated company. The regulator has to strike a precarious balance: it does not pay to be permanently "at war" with the regulated industry – on which the regulator depends for delivery of information and compliance with its rulings – nor does the regulator want to appear to be "too cosy" with the industry on which it has to impose rules and decisions that are good for the industry's welfare but not for its profit.

The regulated industry also tries to find a balance between conflict and cooperation. In the case of longer-term demand estimates the grid operator has three options: (1) a consensus-model which means that a consensus about investment needs is achieved by common research and dialogue (e.g. as done with the DENA – a study of the grid implications of the rapidly rising share of wind energy); (2) a confrontational and political pressure model, as for example in the planned changes in competition law, which was accompanied by media campaigns and lobbying; and (3) a negotiation model. This third form has been realized only implicitly so far: anybody who has observed a public hearing and has an eye for signalling can identify the messages which often focus on the limits of compromises – when a conflict becomes unavoidable. But there is no reason that the de facto influential negotiation processes cannot be formalized and bring about a public law contract. If the negotiation fails, each party is free to proceed as before.

5.2 In Search of a New Innovation Model

Reducing costs cannot only reduce the quality of electricity supply but also stifle innovation when companies are not rewarded for the specific risks inherent in new technologies, processes and services. In the former electricity industry there was a unique cross-industry model which worked only under the previous monopolistic cost-plus regulation and before: one company in the electricity industry bought the first-of-their-kind prototypes at a higher cost than the standard technology from a technology pro-

ducer and tested it, normally with higher operating costs, lower reliability, etc. After the testing the producer sold the upgraded version to the rest of the industry at lower prices. It is highly unlikely that this model will work under the tougher rules of incentive-based yardstick competition, as no individual grid operator would agree to a process that temporarily increases its costs but finally benfits the whole industry.

With the regulatory establishment of an ongoing technology-based productivity process, grid operators are under pressure to innovate. This is particularly apparent after the gains made by eliminating the inefficiencies from the previous monopolistic system of cost-plus regulation have disappeared. The efficiency levels of grid operators should be more on a par because of the benchmarking process with the frontier-enterprise. New innovation models are needed on the basis of different contractual frameworks. The improvements of the incentive-based regulation in comparison to the cost-based one are moderate, because renumeration ceilings are not completely isolated from the individual costs and some innovation-costs can be transfered via the investment budget mechanism.

When new contractual frameworks are to be developed, a decisive question relates to information and its asymmetric or symmetric distribution. If there is no information asymmetry between the technology provider and the grid operators, even if an innovation is highly uncertain, both can calculate the expected costs and benefits. They can agree on an upfront payment that rewards the first mover for his expected additional costs. However, it is more likely that the technology provider has the better information. This can be a disadvantage for the grid operator can be at a disadvantage, especially if the acquired technological knowledge is the result of a competitive bidding process in which the highest bidder has probably overpaid (winner's curse). A risk-sharing model will be more efficient than any government intervention can be. Since neither the uncertainties nor the risk disappear, they would just be imposed on the taxpayer.

Whether this new innovation pattern will emerge is an empirical question for years to come. It depends on the pressure to reduce cost on the additional period in which profits from innovation can be kept for the operator; and on risk aversion which results in a bias towards the status quo to avoid conflicts with the regulator.

5.3 Ensuring High Safety and Reliability

With the given technical complexity of electricity grids, it might be tempting to cut back on safety since the cost reductions are immediate and assured, whereas the dete-

rioration of security of supply is uncertain in the future. The regulatory framework must provide sufficient incentives or controls to avoid this "moral hazard" for the grid operator, as the costs of blackouts or service delays (e.g. grid access) are relatively small compared to the overall damage. Customers have no economically viable ways to bypass the grid. However, the grid operator is not responsible for sufficient generating capacity only for the safety and reliable operation of the grid. This includes technical safety as well as sufficient transmission capacity. Therefore he needs to invest in advance; at the time the future demand is forecasted to increase (as discussed above). In addition, certain service standards are also required, e.g. to answer a request for an offer for connection to the grid within seven days.

To ensure the priority of safe and reliable networks without ignoring the costs of increasing safety, the government has pre-structured the standards to meet these requirements in general terms. But overall responsibility and "how to meet these goals" remain in the grid operator's realm of responsibility. This also includes wreckage recovery after any kind of damage, as well as crisis management. The necessary investments cannot be dictated by the regulator. They can only be proposed by the operator and then controlled by the regulatory authorities for efficiency and sufficiency.

To implement this "pre-structured" responsibility for a high security of supply, the energy law contains a requirement for detailed reporting of interruptions (time, scope and frequency), voltage and amplitude stability and technical standards based on ISO-norms. If there was a massive deviation from industry standards measured by customer service and benchmarking, the regulator could reduce the revenue ceiling in the incentive-based regulation. However, even though the BNA's proposal to introduce fines for individual violations (e.g. of service standards or time of blackouts) was accepted by the industry, it was discounted in the regulation on incentive-based regulation. Another option would be to hold the grid operator strictly liable for any damage caused by a blackout. But besides the lack of fines and the non-existent internalised liability the risk of decreased security of supply is low, because the lawmaker has put the security of supply before economical interests. Nevertheless, the introduction of interruptible contracts is still missing and could be enocuraged by the regulator.

5.4 Coordination of Power Plant Sites and Electricity Grid Requirements

Another unelaborated topic is the coordination of power plant sites between the electricity generating company and the grid operator. Even if they belong to the same cor-

porate group, the coordination will not be as easy as it used to be in the integrated energy companies during the monopoly era. And as operators of new power plants in Germany are legally privileged in grid access in case of capacity shortage until 2012 in order to stimulate new constructions, it is estimated that approximately 30 % of the power generation will be independent of the former integrated utilities by 2020. After a wave of mergers in the 1990s four companies own about 80 % of the generating capacity and the entire transmission grid. The regulator worked hard to ensure that the newcomers on the electricity generating market are fairly treated and that no discrimination by the original owners will block the newly developing competition in the electricity generation. But obviously it did not spend much time on the coordination problem between generating sites and the electricity grid. It is legally prescribed that the grid operator can only refuse grid access to a producer in exceptional circumstances. In the case of renewable energy and combined heat and power generation, it is even legally prescribed that the grid operator has to pay the induced grid expansion costs. Additionally, the power plant operator is also freed of any cost-sharing for investments in the grid, except in the rare case that its request for connection and access is unreasonable. If the chosen power plant site is reasonable, the grid operator has to comply with the generator's choice even when another site would have lowered the overall investment required in the grid. Site selection criteria which are in any case restricted by many legal, planning and political restrictions, differ from optimal grid criteria. The regulator, too, has to accept the investments that are triggered by specific choices of power plant sites. It can only control the efficiency of the investment.

The electricity generator does not need to pay the direct costs or the additional costs compared to an optimal grid site. The reason is twofold: first, it is technologically difficult to define who causes several grid costs. Second, it is not the power plant operator, but the electricity consumer who pays the grid costs which are independent of the distances between the contractual generator and the consumer. This dates back to the time of the integrated public utility where the grid was only used as a means of electricity transport. But in the new world grid expansion costs that stem from site choices are shared by all grid users – contrary to the causation principle. We doubt that this makes sense, since the efficiency gains from competitive electricity generation might be partly or even fully compensated by higher transmission costs. There are no incentives for electricity generators to consider the cost impact of their site choice on the grid.

Options for taking in the grid-induced costs including differentiation of the capacity purpose, e.g. growth over competition, would be difficult in practice. The direct site-induced cost of grid expansion can be partially allocated to the generator or, more generally, the generator pays a share of grid cost based on distance allowance. However, this requires a change in the legal framework.

From an economic point of view, the most efficient allocation of scarce grid capacity would be by auction. The price for input capacity would signal the grid bottlenecks in specific regions for all electricity generators. Auctions of cross-border exchanges have proved the efficiency of this tool, but extending it to a general approach certainly needs further development and anchoring in the regulatory framework.

5.4.1 The Common Market for Electricity

The EU's alleged aim of an integrated European market for electricity will lead to a massive increase in cross-border transmission. At the same time, long-term contracts are regarded as anti-competitive. This has far-reaching implications for the electricity grid, especially for a transit country like Germany. The grids, as mentioned earlier, were not designed for transmitting huge amounts of electricity. And there is no economic logic, as long as in most cases it is cheaper to transport primary energy than electricity. Any transit country is not directly involved in transmission, although such transit has considerable grid implications. But there is a mismatch between the contract duration (1–2 years) and the lifespan of investments (10–30 years). The risk of unacceptably high sunk costs is considerable. To manage the bottlenecks at borders, auctions of physical transmission rights are applied. Capacities need to be fully utilised and capacity that is not used has to be offered again, auctions can ensure that congestions are efficiently allocated, but not eliminated. Any revenue from congestion management at borders should be used for cross-border grid expansion. But by all estimates, this will not be sufficient to finance the investments needed to cope with the increased transmission. This is mostly borne by the electricity consumers of the transmission and destination countries. In addition, transmission costs increase with higher grid load. Again, it is difficult to allocate the induced cost to an individual contract, but in general terms the additional costs are borne by the consumers who therefore subsidise cross-border electricity transmission. The reason for this economically inefficient regime lies in the EU Commission's intention to develop pan-European competition. The interest of the generator dominates over the interest of the grid operator who is obliged to expand the grid accordingly.

As discussed before, a generalised, distance-dependent grid fee paid by the electricity generators or cross-border traders would set incentives to consider the grid implications of transmitting huge amounts of electricity across long distances. In light of the above observations, long-term contracts could be rated positively because they can decrease the conflict between short-term transactions and long-term investments.

5.5 No Need for Ownership Unbundling?

There is currently a hot political debate about whether power producers should give up ownership of the electricity grid to stimulate more competition and to ensure non-discriminatory access for newcomers. We doubt that such a step is needed. The constitutional and legal risks of such a step are considerable, but manageable. But question the benefits. First, we believe that the newly designed regulatory framework can be an effective tool to ensure non-discriminatory access and it should be given a chance to demonstrate its merits. Second, many of the open questions discussed above are independent of the legal ownership structure, but nevertheless critical for effective regulation. There are countries where competition still needs to be improved in the electricity sector, notably France. Though ownership unbundling could take place pretty easily, without instilling competition, there will be government-owned or influenced entities on "both sides". Once auctions play a more important role, a redesign according to bottlenecks and not ownership of the electricity grid will be needed. How this can be achieved will be one of the open questions.

Based on this analysis, we can summarise our conclusions and recommendations as well as defining some open questions.

6 Conclusion, Recommendations and Open Questions

In Europe as well as in other developed countries, the dynamic transformation of the electricity industry from an integrated public utility monopoly to a competitive generation and sales of electricity with a regulation of the grids is anything but completed. The experience so far has probably raised more questions and dilemmas than originally expected. The different approaches and conditions in the EU might, on the one hand, slow down the process towards a common market for electricity but, on the other hand, they allow enriching learning and comparison of experiences, results and toolboxes. Learning does not mean copying but it needs a systematic approach, a platform

for dialogue, where research and regulatory and industry experience come together and, as a result, improve the regulatory frameworks or management practices, e.g. regarding the modelling of auctions.

In any case, the laws of physics cannot be abolished, but they sometimes impose less than optimal limits on regulatory design. For example, electricity grid losses increase disproportionately as the grid reaches its capacity limits, but this is not recognised in the regulatory framework.

Focusing on Germany, we became aware of a couple of specific points that sometimes run counter to conventional knowledge or that emerge as the regulation of the electricity sector evolves – sometimes as results of the "Law of Unintended Consequences" (each government intervention has the intended, but also unintended, impacts):

– Conventional knowledge assumes that an "information asymmetry" exists, disadvantaging the regulator in its decisions relative to the regulated companies. In some areas, it is still true in the current and future regulation of the electricity grid. The operator still knows more about its operation, the technical details, the way the system works, the specific cost of certain assets, etc. Nevertheless, this knowledge becomes irrelevant as the regulator does not base its decisions on the individual costs of an operator, but instead imposes revenue ceilings which are increasingly independent of the specific cost. As the regulator does not need to share all this processed information, it knows more than the individual grid operator in the vital areas of the operator's decision-making. This is an important pre-condition for effective regulation of the electricity grid and should be considered in the public policy and academic debate.

– It is almost impossible to quantify the full cost of blackouts in advance. However, it is plausible to assume that the full indirect cost for the economy is two- or even three-digit multipliers of what the grid operator has to bear. This explains why there is much emphasis on the security of supply and it is rational to shift investments to the upper range of reasonable expectations. As the pressure of the regulator is on cost cutting, it is not easy to see how the provisions of the regulation play out. Our analysis of the legal situation led us to conclude that the decision competence for estimating future demand has to be taken by the grid operator. Moreover, the regulator has no "better" information about the future demand in the next ten years than the operator has. Both probably rely on studies of research institutions and consultancies.

Being regulated as a "natural monopoly" does not turn an enterprise into a government agency.

However, this does not answer the question of whether the operator has the incentive to choose the "right" decision. On the one hand, the government has rejected the idea of imposing fines for low quality standards and did not consider the use of interruptible contracts – the most effective way to reduce the probability of an uncontrolled blackout. On the other hand, the transmission grid operators must submit budgets for their investments, based on scenarios and bottleneck analysis. The excessive cost of squeezing out the last tenth of a percent of blackout probability limits the security of supply. Although we find it useful to impose fines for violating service standards and to introduce more interruptible contract opportunities in the regulatory framework, we concluded that regulation would ensure sufficient investments in the electricity grid to maintain a very high standard of electricity supply.

This is also encouraged by incentives for the regulator as well as for the regulated companies to come to a consensus in important questions. A constant struggle simply has too high a cost, creating additional uncertainties and unpredictable political "fall out". In the regulatory process, there are many information exchanges as well as negotiations – implicit and explicit ones. In order to make this more transparent and encourage such negotiations, a "public legal contract" should be considered. If negotiation fails, the regulator is free to use his regulatory power.

– The electricity grid is faced with new challenges. Wind energy is increasingly being used which causes more transportation capacity from the barely populated northern German coast to agglomerations in the centre and the south. However, a new dimension will be reached with the EU Commission's intention to create a common market for electricity, stimulating competition through massive cross-border export and import flows. No sober analysis of the cost implications has been done yet. Our analysis reveals that exempting the electricity generator from any grid usage fee is de facto subsidising long-distance transmission. Especially in transit countries, such as Germany, the electricity consumer will have to shoulder higher transit costs, but will reap no benefits definitely. It is very difficult to apply the "causation principle" in an electricity grid and ensure non-discriminatory access for old and new generators. Nevertheless, we believe that despite the practical difficulties, a generalised distance-based user fee would help to correct the worst misallocations.

– In the long run, auctions for physical transmission rights will be the most effective economic tool for allocating the scarce cross-border capacity most effectively. We would like to strongly encourage more research.

– The dominance of the intention to promote competition can also be seen in the question of choosing the sites for power plants. Only unreasonable requests for grid access and connection can be denied. The grid operator has no chance to influence the choice of sites and has to cope with the investment impacts on the grid to ensure reliable and safe supply. The power generator has no incentive to consider the impact of its site choice on the electricity grid as it does not have to pay any user fee. Therefore, the costs are "socialised" by the consumers. This will trigger many discussions with the regulators in the future regarding the question of comparability of grid structures in the benchmarking process. The increasing use of renewable resources will also aggravate this situation due to additional transport capacity. This does not mean that it is easy to ascertain the implications for the cost of the grid of the different structures for generating renewable energy. Ignoring the huge costs implications of both long-distance electricity transmission and site choice can easily endanger the goal of low electricity prices. After all, the grid cost accounts for approximately one-third of the overall electricity cost, and it is unclear whether the efficiency gains from competition in the generation stage will be cancelled by the additional grid cost. Thus, in order to optimise site choices, we argue for a generalised, distance-based input fee and, in the longer term, for a switch to auctions to allocate scarce grid capacity. In any case, the development of grid costs relative to the gains of a competitive generation sector needs to be monitored carefully.

– In addition, the regulated electricity grid needs a new innovation model to sustain long-term technical progress towards lower costs and better security of supply. The previous model in the case of which a technology producer looked for a "volunteer" to shoulder the higher, first-of-their-kind costs, will not work under a tighter cost pressure of incentive-based regulation with extensive benchmarking, whereas the cost pressure is moderate in comparison to the cost-plus regulation. The industry must develop new contract arrangements that allow, despite all the uncertainties of innovation, the sharing of costs and benefits between technology provider and first mover. The regulator can support this innovation process by allowing the first mover to keep a higher profit for a longer time to be rewarded for taking the risk. In the long run, the "screws can be tightened".

– All the questions discussed above are relatively independent of the current controversy surrounding ownership unbundling. Most issues result from the grid as a natural monopoly and this requires regulation independent of the ownership questions. Even if the government is the owner of a national grid, there is still a need for regulation on prices, quality and non-discriminatory access. Our general view of the German regulation – based on our research – is sufficiently positive that it can achieve the goals set. Therefore, we do not see a need for a big regulatory change again.

Concluding, we can summarise our recommendations as follows:

– Create a learning platform in the EU to share the experiences of different and new approaches (e.g. auctions) to improve the regulatory framework and industry practice.

– Given the high cost of blackouts, ensure that the regulatory framework encourages investments in the "upper range" of reasonable demand projections to maintain the high quality of electricity supply.

– Include fines for low service quality in the incentive-based regulation, as proposed by the BNA.

– Consider the interruptible contracts as an effective tool to keep investments for short peak seasons low and diminish the risk of widespread cut-offs even further.

– The principle of electricity generation close to the consumer is still valid, both in economic and in ecological terms. The direct or indirect subsidisation of non-grid-optimal choices for power plant sites and long-distance electricity transport can endanger the goal of an overall cost-effective electricity supply. The additional grid cost might cancel out the efficiency gains of competitive generation. The electricity generators should therefore share in the high costs they induce.

– Auctions are probably economically the most effective way of allocating scarce electricity grid capacity. Their broader use under specific conditions should therefore be further developed and integrated into the regulatory framework in the years to come.

– We do not see any decisive advantages of ownership unbundling for the time being and would prefer to let the new incentive-based regulation work.

We admit that our research leaves a variety of questions open:

- What would practical, distance-based, generation fees for electricity generators look like?
- How will the innovation model work and what are the stumbling blocks?
- How can a public-legal-contract between the regulator and regulated company be designed in detail and what legal aspects should be specifically considered?
- How can auctions be developed further?

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