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# ORGANIZATION OF ELECTRICITY TRANSMISSION IN VIEW OF LONG TERM ENERGY POLICY GOALS

***Abstract***

European electricity transmission industry is facing both organizational reform due to the 3rd Package implementation, and more structural challenges related to electricity system greenification. Relying on literature, I will first analyze the contemporary TSO repositioning, avoiding dogmatic attitudes which have been prevailing in public debates over the last several years, to conclude that: (a) there is not a way to actually prove that either of the three organizational forms from the 3rd Package has clear advantages over any of the others, and thus (b) the debate should be ended pragmatically in a political arena following a political decision on what the goal really is (or, what kind of interests should be pursued). After analyzing the organizational issues I will turn to what I believe is the most important challenge in front of TSOs: gradual greenification of the electricity supply industry, with technical and economic difficulties related to it. I will stress the importance of sound and accountable policy making and enforcement.

# ORGANIZACIJA PRIJENOSA ELEKTRIČNE ENERGIJE U OKVIRU DUGOROČNIH CILJEVA ENERGETSKE POLIITIKE

***Sažetak***

Europska industrija prijenosa električne energije suočena je s organizacijskom reformom zbog primjene Trećeg paketa, ali i s drugim strukturalnim izazovima vezanim s povećanim udjelom proizvodnje iz OIE i primjenom drugih mjera zaštite okoliša („grinifikacija“ elektroenergetskog sustava). Oslanjajući se na literaturu, ponajprije ću analizirati repozicioniranje suvremenog OPS-a, pritom izbjegavajući dogmatske stavove koji su bili na snazi u javnim raspravama posljednjih nekoliko godina, kako bi se zaključilo da: (a) ne postoji način kojim bi se zapravo dokazalo da bilo koji od tri organizacijska oblika iz Trećeg paketa ima jasne prednosti u odnosu na druge oblike, a time bi (b) rasprava u političkoj areni završila pragmatično nakon odluke o tome što je zapravo cilj (ili, kakve interese treba slijediti). Nakon analize organizacijskih pitanja, osvrnut ću se na ono što smatram najvećim izazovom za OPS: postupna „grinifikacija“ industrije opskrbe električnom energijom, te vezane tehničke i ekonomske poteškoće. Naglasit ću važnost razumne i odgovorne izrade i provedbe energetske politike.

## *1. INTRODUCTION*

Reorganization of electricity system that has been going on since about two decades can be viewed in a light of deregulation doctrine which has been prevailing in western public policy ever since eighties. In electricity systems there are opportunities for competition in generation, wholesale trade, and retail. The networks are generally considered natural monopolies, and probably no one ever contested that fact. Yet, there have been quite a few debates about what should be the way network operators should be organized. This question, of course, is not that simple and the answer depends on one's standpoint. Economic science has not provided a clear solution, yet, as complexity of the problem is tremendous. It is hard to model complicated economic systems with simple theoretic models. It may be even harder to define more complex models. The literature is anything but unisonous about which of the organizational models from the 3rd Package electricity directive (European Community, 2009b) is "the best".

In this work I will first give an overview of contemporary economic literature on transmi-ssion system operator organization, with an inevitable conclusion that there is no clear conclusion about economic superiority of any of them. This will shift my attention to the area of policy choice. Since neither of the models can be firmly identified as "the best", seemingly there is more maneuver space for political decision-making regarding that point. However, in most of the theoretical works I had read there is an underlying assumption which I simply cannot support, namely that the regulatory system is "perfect", meaning that it works as it is (theoretically) supposed to. In my opinion this is an extremely unrealistic assumption which pollutes the models. Thus, assuming that the regulatory system *is not perfect*, the ownership unbundling model would emerge as *the best* canonic model among the three from the 3rd Package's catalog. However, the topic still deserves closer attention.

## *2. LITERATURE ON VARIOUS ASPECTS OF TSO INSTITUTIONAL ARRANGEMENTS*

In the contemporary literature on the 3rd Package institutional framework for TSOs the researchers take several different approaches to the issue. The three are most important: (i) Authors like Leveque, Glachant, Saguan, Rious,

Pollitt, Bolle, Breitmoser, Brunekreeft and others analyze economic aspects of TSO designs, trying to identify which of the three is optimal regarding social cost-benefit. They usually try to rationalize the debate, however, this proved not to be too easy because the phenomena studied in their works are too complex and consequently, the economic models employed were too coarse to enable clear conclusions. (ii) Some authors, e.g. Thomas, who is one of the most active, try to prove that the European Commission (EC) has not been successful in proving and justifying its course of action, which originally aimed to retain the ownership unbundling (OU) solution as the only one legally allowed. Therefore, supposedly, the EC should not have favored the OU and forced the network owners to divest their historic assets neither by the law, nor by rigid antitrust enforcement. However, the major pitfall in such argumen-tation is that legislatures are bound by constitutional limitations only and that they really do not have to prove their cases before public. (iii) Finally, there are authors, for example Willis, Diathesopoulos, and others, who analyze relevant European antitrust case-law which influenced processes around formation of contemporary EC policies regarding transmission system operation in an ex-post manner. They are important for under-standing of the logic of EU antitrust law enforcement that can be expected in future cases, since apparently the EC tends to use this legal tool to foster implementation of the rules.

An extensive analysis of the influence of TSO institutional arrangements on overall social benefit can be found in Pollitt (2007a) and Pollitt (2007b). He compares five institutional settings regarding their social cost-benefit: (i) Independent TSO (equivalent to OU from the 3rd Package); (ii) Legally unbundled TSO (equivalent to 3rd Package's ITO); (iii) Independent System Operator (equivalent to ISO from the 3rd Package); (iv) Hybrid ISO/TO operation (where both ISO and Transmission Owner are fully unbundled), and; (v) Traditional vertically integrated utility (VIU). These five arrangements were compared across a number of aspects: (1) effects on market competition; (2) ease and efficiency of regulation; (3) privatization aspects; (4) security of supply; (5) transaction costs of unbundling; (6) cost of capital and investment costs; (7) synergy and focusing effects; (8) double marginalization; (9) probability of foreign takeover; and (10) risk of voluntary government intervention. Pollitt concludes that the full OU is the best possible solution regarding overall social cost-benefit but for cost of capital as a fully unbundled operator as relatively small part of a system can lose a portion of its credit rating. He also refutes conclusions of other authors, such as Bolle and Breitmoser (2006), that the LTSO is the optimal arrangement. He notes that in the jurisdictions with most successful electricity sector reforms (New Zeeland, Victoria & South Australia, Chile, Argentina, Nordic countries, UK, New York, Texas, PJM) system operation has been independent from generation interests, without exemption. On the other hand, countries with slow and unsuccessful reforms (France, Germany, California) had not made the system operation fully independent. An apparent advantage of the LTSO option in achieving better transmission investment adequacy and lower cost of capital may as well be diminished or nullified by difficulties in regulatory oversight of a bundled structure and discrimination issues linked to it. As Pollitt notes, this could be a significant problem especially in less developed EU states as their regulatory authorities may not be sufficiently mature, yet. Further, if legal unbundling itself were implemented in a correct manner, the mutual ownership effects would be questionable. Therefore, the whole concept of LTSO may be questionable, too (that is, if the real political goal was not to actually obstruct the market reform). As regards regulatory oversight, OU and hybrid ISO/TO may require notably more effort from regulators than e.g. state-owned VIUs or LTSOs due to bigger information asymmetries and more market transactions. Moreover, vertically integrated utilities require rather an anti-trust monitoring than regulation, especially if private. To conclude, Pollitt prefers full unbundling of the TSOs as the socially most acceptable institutional arrange-ment.

The "French school" of power system economists tries to introduce more rationality into otherwise aflame EU-wide discussions about optimal TSO design by taking a "new institu-tional economics" approach. Glachant and Rious (2007) perform a modular analysis of TSO organization with respect to three basic modules each TSO has to have: (i) short-run network externality management (i.e. dispatching with congestion management); (ii) network development (i.e. long-run congestion management), and; (iii) coordination with neighboring TSOs. Leveque, Glachant, Saguan and De Muizon (2009) discuss criteria to compare transmission organizations. Assigning different weights to the five factors ((1) transaction cost savings; (2) incentive regulation implementation; (3) conflict of interests issues; (4) nondiscriminatory network access, and; (5) advantages of regional integration), they rank the three standard 3rd Package's solutions for different circumstances. They conclude that the full OU is most the best solution where cost savings and correct price signals for investments are crucial. This is the case where the transmission system is well connected with neighboring networks while internal network suffers from congestions. Note for example that quite a number of South-East Europe countries can fit very well into this category (Sabolić, Grčić, 2010). The ISO solution is most suitable for situations where internal networks are sufficiently developed but there is a need for more complex regional inter-TSO coordination due to insufficient interconnection capacities between individual control areas. The authors conclude that the European Commission, when ranking the options included into the 3rd Package directive (European Community 2009b), valued the cost-savings and right investment signals the most. They argue that the EC should proceed with efforts to finally accept and legally enforce a unique institutional form for TSOs as the coordination between the systems would certainly be more efficient if all the systems shared the same organizational rules. The important message from this group's works is that in different historic conditions different institutional settings may be most appropriate. They also, pretty much as the EC, consider the ITO arrangement the weakest as it comes to TSO task fulfillment in reformed power sector.

Brunekreeft (2008) performs a social cost-benefit analysis of the ownership unbundling with an emphasis on German TSOs. He studies three groups of potential effects across a few scenarios on welfare: (i) effects on market competition; (ii) effects on interconnection investments, and; (iii) effects on costs due to a loss of vertical synergies. He reports that: (1) In most scenarios the welfare change is positive but very small in a relative sense. (2) Effects on interconnection investments are surprisingly small, which is explained by the fact that, actually, vertically integrated utilities in countries which are either big importers or exporters need interconnectors, and therefore, they do not have an interest in stopping TSOs from building new ones. On the other hand, (3) Brunekreeft found the vertical synergy loss effects very small, too. All in all, the OU solution is found to have slightly positive welfare effects. The author makes no attempt to compare the OU with other arrangements.

Balmert and Brunekreeft (2009) try to analyze so-called "deep-ISO" variant of organization by posing the resolution of conflict between investment decision making and risk taking to the center of their attention. They argue that investment tendering (where private parties would be able to invest in transmission assets) would resolve this conflict. However, their conclusion is not really substantiated, and the question of private investments itself is too complex to be answered without much theoretical work or experience. This model is not yet clearly identified as a potential future canonic solution in other authors' works, either.

Bolle and Breitmoser (2006) compare ownership unbundling (OU) and legal unbundling (ITO) and conclude that legal unbundling leads to lower final electricity prices, i.e. to lower total costs in the system. However, one of the underlying assumptions of their model was that in legal unbundling setting double marginalization is completely avoided. Yet, it can be at least partially eliminated in cases of vertically unbundled systems, too, by designing multi-part tariffs. After all, the present EU law requires tariff separation as obligatory.

Nardi (2009) analyzes empirically effects of ownership unbundling on transmission capacity investment and quality of service by comparing on the one hand, countries with any kind of unbundling in place against the ones with no unbundling at all, and on the other, countries with ownership unbundling against all other countries. As regards capacity investments the OU seems superior to other arrangements. When it comes to quality of services, it turned out to be better in group of countries with any kind of unbundling than in those without it. However, the systems with OU seemed to be worse off than the others, although Nardi notes that this result was not statistically significant.

As regards criticism towards the European Commission's past attempts to pass the OU as the only legally allowed option, there certainly has not been a lack of journal papers, analyses, political manifests, and all sorts of public activities aimed against the EC's policy orientation. I will here pick only one author as a representative of this class. Thomas (2007 a,b,c,) analyzes, more-or-less, semantics of the EC's policy papers, working documents, press releases, and, finally, pieces of legislative acts, trying to prove his point that the Commission had not sufficiently investigated and attested the grounds for its political action aimed at obligatory ownership unbundling. However, there is a major blunder in such a view: the Commission was here merely a drafter of legislation. Had the European Parliament wanted to have the case scientifically or professionally *proved*, it would have certainly asked the Commission to produce some hard evidence. *But it had not*. And of course, the Parliament can pass a piece of legislation even (in a principal) on its whim, as long as the Treaty provisions are not breached. The *policy needs no proof.*

In contrast to such type of critiques, Pielow and Ehlers (2008) have a more constructive approach to the question of constitutional grouds for obligatory ownership unbundling. They analyze relevant provisions of constitutions of Germany, France and Netherlands, addressing the issue of basic freedoms of ownership and capital movement, although they never question the Commission's right of legislative initiative, nor the right to limit certain general freedoms when public interests are on stake. Certain countries may have some constitutional obstacles in that regard, however, the example of France show that these are basically not fundamental and that pragmatic solutions can be found. (For example, the French Constitution of 1958 requires public services to be supplied by publicly owned companies but it does not specify *which* are these services. This was the basis that made possible privatization of Gaz de France in 2004.)

There is an interesting piece of work on the relation between *corruption* and TSO unbundling. Van Koten and Ortmann (2008) provide an econometric analysis between Transparency International's *Corruption Perception Index* (CPI) and the level of unbundling modeled as a five-level variable. The main statistically significant conclusion is that lower degree of unbundling goes with lower CPI (i.e. higher perception of corruption). Moreover, newer EU member states have averagely lower level of unbundling. Interestingly, higher GDP per capita is associated with lower levels of unbundling. Although these results are quite intriguing, one can find some methodological problems here: First, the relation of CPI as a *perception* indicator and *true* level of corruption may be problematic in an international context as the same CPI may in the reality mean very different situations in different countries with considerably different relevant cultural features. Further, the GDP-unbundling relation may be affected by the fact that quite a few very large and high-GDP countries, like Germany and France, had at the time lower levels of unbundling.

Knyazeva, Knyazeva and Stiglitz (2009) do not engage specifically in electricity transmission industry at all (in fact, they analyze international telecommunications industry from 1987 to 1999 and check the plausibility of the results by

analyzing a multi-sector sample of European privatization deals from 1989 to 2006), but they investigate an aspect of *ownership change* influence on accessibility of external financing, which is (at least in my mind) *extremely important* since an alleged detrimental influence on financial positions of both former VIU and new TSO has been one of the *main arguments of ownership unbundling haters* in political arenas around Europe. In newer EU member states and candidate countries there have been attempts to stir up emotions in political arena around the "evil of privatization", too.

The conclusions of Knyazeva, Knyazeva and Stiglitz (2009) are: (i) Full privatization is more likely to happen in industries with weak performances; in states with higher fiscal deficits; in states with a legal system of non-French origin; and in larger and wealthier states. (ii) Access to external financing (bank crediting) has an important positive impact on future profits, investments and growth. (iii) Performance changes in years around the ownership change are not very sensitive to past financing limitations of public sector. (v) Company performances have better prospects to advance in the future if the privatization is done later due to the effect of "learning" an optimal privatization design in given circumstances in the sector. (vi) Maturity of capital market in a given state is important factor regarding success of privatization. (vii) Newly-privatized companies have higher information asymmetries (i.e. less reputation: they are less known to the business community). Since costs of debt are less sensitive to information than costs of equity, the access to bank loans is essential. Effects on operating performances are more evident in later years after privatization, though. (viii) Performances of privatized companies *are not better (nor worse)* than of the ones that stayed under state ownership. The lack of government guarantees can increase capital costs on grounds of higher risks, especially in early years following privatization. Effects of ownership change (or non-change) to company performances *were statistically equally insignificant* in both examined groups.

To sum up the conclusions stated above, and to translate them to the electricity transmi-ssion industry, *the ownership change itself is not all that important*, meaning that it cannot be used as a key argument *pro et contra* either of the TSO institutional arrangements. The arguments of state v. private ownership *are not that important, either*. What matters is the availability to external sources of capital, which is not especially related to the electricity transmission sector itself.

The last class of works I want to discuss here is pretty important, too. They shed light on the ownership unbundling subject from the standpoint of antitrust law, policy and jurisprudence, focusing on energy sector cases, see e.g. Willis and Hughes (2008), or Diathesopoulos (2010). A great importance of it stems from the fact that antitrust litigations have been one of the most powerful tools the Commission uses to enforce its policy goals in a less direct manner. Willis and Hughes (2008) conclude: (i) The Commission *does have a right* to order ownership unbundling in non-merger proceedings, too, as a structural measure in individual cases, after a thorough economic analysis, adhering to the principle of *proportionality* of the measure in relation to the nature and extent of the breach. (ii) The Commission is likely to be able to defeat any legal challenge based on arguments that it has infringed the European Convention on Human Rights (Council of Europe (1953), Protocol 1, Art. 1, the right of peaceful enjoyment of his/her possessions), Article 295 of the Treaty (European Community (2002), national property rights), or the principle of subsidiarity of Art. 1 of the Treaty, provided that the unbundling remedy is proportionate to the breach of the EC antitrust law, as the Commission has already won a number of cases in courts where it commanded divestiture as a structural remedy under Art. 82 of the Treaty. Further, there were cases in which the Commission acted under Art. 81 of the Treaty by approving firm's commitment to *voluntary measures* taken to avoid expensive, long lasting and risky litigations.

For example, on 26 Nov. 2008 the Commission adopted a decision on commitment addressed to E.ON for two *suspected* infringements of the EU antitrust law (manipulating the wholesale energy market by withholding, and buying system reserves favoring its affiliated generation plants). To avoid litigation, the E.ON had to commit to divest: (i) 5.000 MW of installed generation capacity; (ii) the high voltage grid together with the system operation activities. These were the first cases ever in which a company agreed to sell *very substantial* amount of assets to avoid antitrust proceedings the Commission intended to start, and this is a very good example how the Commission can use antitrust law to effectively propel its policy goals in electricity markets by, *inter alia*, ordering TSO divestiture as a *proportionate* structural remedy. It is worthy to mention that, regarding non-discriminatory ancillary service procurement, many today's integrated TSOs may as well face a similar situation shortly. A brief exposure of these two milestone antitrust cases can be found in Chauve *et al*. (2009).

### *3. IS THERE AN "OPTIMAL" TSO INSTITUTIONAL ARRANGEMENT?*

From the above literature review one can conclude probably one thing only: there is *no firm economic evidence* that either of the 3rd Package's canonic forms is "the best" from the social cost-benefit point of view. Moreover, the "old" arrangements themselves, like full vertical integration or legal unbundling within a VIU group, cannot be in a theoretically sound way regarded as neither "better" nor "worse" from these three. The reason for this lies in a fact that the TSO-related economic phenomena are too complex and dependant on too many variables, many of them being specific for a given electricity system with its unique inherited features, and that therefore they cannot be emulated by simple and comprehensive theoretic models. Complex models, on the other hand, cannot be employed because they

would require much wider statistical samples within each of the modeled structure, and longer time series than available.

Thus, my conclusion is that the very *organizational form* itself cannot be too important and it certainly cannot be *the* most important thing to take care of, provided each of the organizational settings is executed in a correct manner. But then, the problem is how to achieve this correctness itself.

When companies are totally independent, as in the OU case where former VIU and new TSO have different owners, all that is more-or-less important are normal strategic interactions between firms, requiring only a relatively mild ex-post control over possible collusive practices. An ISO arrangement requires more regulatory engagement, while ITO may pose truly big challenges before regulatory system as a whole. One of the main characteristics of the TSO design-related literature is that the analyses have been performed under an assumption of regulatory efficiency (i.e. optimality). Yet, this assumption might prove to be too strong. My personal impression is that most regulators cannot be deemed efficient. (Allow me to have such an impression as a former regulator.) Although there is not too much literature on this theme, there are works that illustrate this point. For example, Ugur (2009) concludes from his analysis of ex-ante and ex-post indicators of regulatory quality and their relationship with market outcomes in three liberalized network industries (telecoms, gas, and electricity) of the EU-15 countries that the design of European market institutions is *not* optimal and that it may be conducive to regulatory ineffectiveness or outright regulatory failure.

While Ugur's work is of a practical kind, which is very important for getting a picture on true regulatory quality around Europe, I can refer to two seminal theoretic works on regulation, too. Stigler (1971) formulates his famous theory of regulatory capture following an econometric analysis of *effectiveness* of regulation. Peltzman (1976) made a sort of generalization of Stigler's theory by modeling a regulator as an agent which tries to maximize *its own utility* (and *not* society's) by choosing certain equilibrium mix between popular and private political support. In an earlier work by Stigler and Friedland (1962) the effectiveness of electricity utility regulation throughout the USA in the pre-World war two time was studied. It was econometrically calculated how the explanatory variables (total population in cities larger than 25 thousand inhabitants; price of fuel; percentage of hydro generation; per capita state income; and dummy variable for presence of regulation in a state) influence average revenue per kilowatt-hour. Influence of regulation proved to be statistically insignificant in all analyzed years. Further, the relation between regulation and rate structure (the ratio between household and business tariffs) was studied. Finally, the effects of regulation on long term equity performance was investigated. In both cases regulation had statistically insignificant influence. (These findings certainly contributed to Stigler's theory of regulation of 1971.) Stigler and Friedland explained this, in essence, by informational asymmetry (in today's vocabulary).

I think not many economists today oppose to these basic theories and their more advanced later versions. Yet, for some reason, in many theoretical analyses regulatory system is being *assumed* efficient, while seemingly *it is not* by the *very nature* of regulatory process. Thus, it is methodologically problematic to assume regulation was perfect while at the same time regulatory imperfectness has been theoretically undisputed since decades.

Now, taking this basic fact into account may certainly change the otherwise hazy situation regarding the choice of optimal TSO institutional arrangement by making the models less dependant on regulation more desirable. It is well known that either total ownership unbundling or total vertical bundling are the settings least dependant on regulatory action. Since the 3rd Package *commands* vertical unbundling in one of the three canonic ways without vertical integration among them, obviously this leaves not much maneuvering space, at least not in countries where regulatory institutions are still considerably weak. Such countries are often characterized by a joint state ownership over the regulator, the VIU, and the system operator (either directly or indirectly), which may complicate relations between these agents (e.g. for the ITO case these relations would be: state-regulator; VIU-ITO, VIU-regulator and regulator-ITO) to a further level and make them look increasingly similar to a relation very clearly described in the Aesop's "The wolf and the lamb" fable. If a *political goal* is to have electricity transmission system operated independently of either generation or supply activities, and the European Parliament and Council made it a goal by adopting the 3rd Package, then, having in mind that a non-negligible degree of regulatory failure is by the nature quite probable, the full ownership unbundling would presumably fit best into this political framework. Thus, it is expected the EC would continue with pressure against the few remaining Europe's ITOs, probably through antitrust litigations, to achieve full ownership unbundling throughout the European space in just a few years period. It is worthy to note that American economists (and politicians) strongly favor wholly independent system operation, too (see e.g. Joskow, 2003). Given American tradition in policy pragmatism, as well as the fact that the whole idea of electricity market reform had originated in the USA, this is certainly something to take into account, too.

Unfortunately for politicians, theoretical economic analysis cannot provide a firm proof that either of the TSO models is "the best". If it could, there would be less debating over the issue. However, unfortunately for the EC's critics, the politicians successfully created a sufficient amount of political will needed to pass the legislation that clearly prefers the OU model. As the 3rd Package appeared in a democratic process, it is a demonstration of political will and thus does not have to be even economically justified, let alone proved. This is an elementary fact overlooked by quite a few authors, as I argued above.

## *4. THE ROLE OF TSOS IN ACHIEVING THE KEY ENERGY POLICY CHALLENGES*

### 4.1. Formulation of the policy problem

Energy mix problem in electricity generation becomes more and more important throughout the World for two main reasons: emissions of carbon dioxide, $CO_2$, should be lowered because of global warming concerns, and fossil fuels need to be gradually replaced by alternative available energy sources in next few decades as the fossil fuel reserves are limited. In electricity generation these two goals are to be achieved by two kinds of actions: implementing new generation plants that use renewable energy sources like wind, solar or geothermal power, and making industry and living less energy-intensive by all sorts of energy efficiency improvements, for instance investments in better thermal isolation of homes, fostering development of distributed generation aimed at lowering energy losses in networks (at some expense in generation efficiency, though), producing better electrical machinery that would spend less energy for the same functionality, etc.

Today about fourteen percents of primary energy within the EU area comes from renewables. The European Community adopted a policy of reaching twenty percents of total energy consumption from renewable sources until 2020. This policy has been turned into law: the Renewables directive (European Community, 2009a) sets out this goal as a firm obligation for the EU and also specifies individual national targets which took into account specifics of each member state.

By reading this directive and other policy stuff from multiple governmental and non-governmental sources one can encounter in the media, one can easily get an impression that policies are now more or less clearly articulated: the society *wants* green energy because people *want* to live in a cleaner environment and they *do not want* to be too dependent on petrol once the reserves are near exhaustion and prices skyrocket. But, my cynical question is: *do they want to pay for this*? It seems not. There is no need to run massive polls just to find out what *the people* think about it. One just needs to look at all these policy statements and accompanied legal acts, because what politicians speak and write is what they assume (in most occasions correctly) the people want to hear. So, everyone talks more or less about *state subsidies* in one form or the other, that would attract investors in (still uncompetitive, see e.g. Joskow (2010)) renewable sources of electricity. No one talks about real economics relevant for adoption of substantial quantities of new renewable generators into an existing system within relatively short time.

While acknowledging a need to create strong driving force for the process of "greening" the electricity system to *start* successfully, one should probably think of the self-evident need to create a sustainable system for the long run, too. In other words, the fact that today's technology does not allow for full competitiveness of renewable sources as compared to classical ones *does not automatically remove* the need to gradually create a situation in which renewable sources would be able to compete *in normal free electricity markets* with minimized state intervention. This may not be achievable instantly, though.

Thus, in my mind the main *political* goal in the electricity sector for the decades to come should be as follows: The renewable sources *must* eventually become an integral part of free electricity markets, and they *must* be subjected to the same market forces and price incentives. This is a precondition for the transition from fossil fuel-dominated system to a green one. I fear that governments will gradually introduce a great deal of market distortions by sustaining unreasonable subsidy schemes for a long time. Although I cannot dispute the need for a state intervention in the beginning of the process, there is a question of how well it has been thought through and are the mechanisms for government's pull-out in place or at least envisaged.

### 4.2. Economic challenges in front of the generation-transmission half of the system

In this section I will concentrate on issues specific for generation and transmission, for they will shape the future of transmission business probably more intensely than those related to distribution and supply of final customers (although there are things that deserve more attention, like the question of system operation with distributed generation, once it becomes widespread). The main assumption is that the biggest challenge in front of transmission business is how to adopt a large sum of new (intermittent) renewable sources in relatively short time in an economically viable fashion and yet, not jeopardize security of electricity supply. In that context, issues relevant for transmission and for generation are often inseparable.

Transmission networks as they are today had been built mostly to meet different type of requirements than the emerging ones. Historically, the grids had been planned to enable transmission of energy from domestic generation plants to domestic consumers (mostly on national level), aiming at electrical self-sufficiency. Cross-border capacities had been built for technical purposes (security of network operation) and they usually had been too small to be able to carry significant energy flows. System reserves had been planned and built to satisfy the regulation needs of electricity system mostly comprised of easily dispatchable fossil fuel-fired, nuclear, and hydro plants on the production side, and quite predictable load and prediction tools appropriate for relatively slow-changing load profile on the consumption side.

The greenification of the electricity system, combined with market reform, brings more complex challenges in front of networks and their operators. As regards market reform, transmission systems are expected to become more interconnected to allow for serious energy transfers across national borders. This is, for example, in line with the European electricity sector policy (see European Community, 2009 b and c). However, execution of the policy goes together with many practical problems and possible misunderstandings. One of the most prominent blunders is that every cross-border congestion is by definition bad and that it must be rooted out at any cost, as it apparently follows from European Community (2009c). Another very popular blunder is that new interconnectors would solve all the problems regarding free electricity trade, as they are needed to compensate for large-scale unevenness of generation plant geographical distribution and, maybe more important, growing unevenness of geographical distribution of large wind generation plants across the internal European market. At the same time, the problem of insufficient capacities for ancillary services, especially secondary and tertiary regulation, which are necessary to have to enable larger penetration of intermittent renewables, is being constantly undervalued. (I cannot actually prove this, nor can I quite understand *why* this happens all the time. This is my personal impression, a very strong one, though, I fetched while taking part in quite a few politically driven processes run by the European Commission or Energy Community Secretariat).

Although challenges that TSOs face in the greenification process may seem technical in their nature, they are not. In fact, there are huge *business challenges* that will soon need to be efficiently managed by TSOs. When, for instance, operators say that they are getting a hard time when they have to operate the system with a substantial percentage of wind power production, this usually does not mean that they do not know how to run it, but rather that they do not have sufficient resources. As regards congestion management, it is solvable with still relatively cheap investments in transmission lines. However, the problem with regulation (i.e. technical balancing that needs to occur beyond "real time" market balancing, in *truly* real time, often in an automatic way) does not go away with energy transferred through the transmission lines. It remains within the "domestic" system which must bear the burden of regulation.

Appropriate ancillary services may be provided by certain technological types of "classical" power plants, only. It is widely known that fast (secondary) regulation may be provided basically by hydro plants with reservoirs, or with pumped water storages, or otherwise by natural gas-fired plants, provided the latter are connected to a gas transmission system which is balanced both market-wise ("real time") and physically (*true* real time). (Note that in the latter case in fact the gas transmission system regulates the electricity system, therefore, the gas grid must be able of compensating large-scale and fast variability in gas consumption.)

Thus, the increase in regulation capability of the power system is inevitably associated with hefty investments in the *classical generation* sector, and as everyone knows, by the currently prevailing political will the generation industry must be *unbundled* from the transmission business, leaving TSOs essentially helpless when it comes to new regulation plant investments. Since that is so, *the one and only way* to make increase in regulation capability possible is to make the regulation power plant investments lucrative for potential investors. This is equivalent to say that the society *must commit* to free electricity market mechanisms and give up the state intervention in the electricity sector, which has been there in many different forms since the very early days of the system development. Or, yet another equivalent form of the same statement could read: *people will eventually have to start paying for the true economic costs* of energy production and supply. Since electricity demand is growing and the primary energy prices are growing, too, it is inevitable that final energy prices will eventually have to keep rising no matter what.

I have recently tried to study an often encountered and quite peculiar relation between politics and policy in electricity sector (Sabolić and Grčić, 2010). Based on the sample of the South-East Europe (SEE) countries and their electricity companies, it turned out that, as a rule, the governments of these countries, contrary to an opinion widely spread among electricity market researchers, see e.g. Pollitt (2007c), *do not subsidize* their utilities. Instead, they force them, mostly by managerial control, to keep the retail electricity prices, especially for domestic users, as low as possible for as long as possible (I will be calling this type of policy ALAP to avoid the lengthy expression). Clearly, this can hardly be anything else but a pure populism, although I can have some understanding for the governments in transition countries which have to deal with much wider and deeper scope of social changes than the governments in "ordinary" and stable societies do.

Serious problems with ALAP-like policy making occurs if it lasts for too long (in quite a few countries of the SEE it has been there virtually since decades) and if there is no political "exit strategy". An another problem is, as I see it, that the ALAP club is not limited exclusively to the SEE, nor to a more widely defined set of former socialist countries. When it comes to the management of transition from today's classical electricity system to a future greener one, I suspect the ALAP virus threatens the "free economy" world, too, in the form of uncritically designed state subsidies directed towards the green sources. (However, *a primordial* version of ALAP logic – a systematic avoidance of pollution externality costs – that had been here since the beginning of the electricity system, actually lead to the need for these subsidies.) The sector policies vary considerably across the European space and across the World. I have no problems with subsidies aimed at successful start-up of the process, but there must be a clear policy on how to eventually get out of these schemes.

The only way to get rid of state subsidies is to make new renewable sources *economically competitive with classical ones*. Technology development can bring renewables still closer to classical plants regarding overall long run incremental costs, on the one hand. On the other, enormous externality costs of pollution, which are still largely avoided, should be paid for by the industry. Naturally, these new costs ($CO_2$ emission costs being the most famous of them all) will be transferred towards the final customers, and again, they will have to start paying. The fact that fossil-fuel generation is still considerably cheaper than the renewable one is merely a consequence of long-lasting avoidance of bearing the true costs of pollution, which is a variant of ALAP policy obviously not restricted neither to the developing countries, nor to the Third World. It is spread all over the Globe, and these costs, that have been systematically avoided, would have to be borne by future generations.

By saying that the renewable sources must become competitive to classical ones (as soon as possible) I mean that at the end of the day *the energy generated from renewable sources must be traded normally, just like the energy from any of the classical sources*. I think this is essential.

For example, one day (I hope soon), the renewable sources *will have to* start planning their production realistically on a day-ahead basis, or in the real-time market should there be one available, just like everybody else, and pay for the misbalance they cause, because that is the only way for them and every other market participant to receive *correct price signals*. Otherwise, as long as wrong planning cost wind plant owners (and/or anybody else) nothing, they would get no price signal that would stimulate them to do something about their quality of planning (i.e. investing in prognosis tools). In countries where renewable generators are not responsible for misbalance (like in Croatia, for example), they can simply put zero into their plans, leaving the system operator in difficulties with planning of regulation reserves.

One of the problems still encountered in most of transition countries is avoidance of market integration. The governments seem to have a feeling they would preserve "energy independency" by avoiding connection with neighboring systems (however myopic this attitude is). There is much ideology involved in such an irrational approach and I suspect sometimes it serves for purely daily-political needs. Market integration is something related closely to the TSOs as they provide infrastructure (in the widest sense of the word) for electricity markets. Note that the ALAP pricing is possible only if the country's electricity sector is separated from external markets. The larger the degree of separation, the better. Integration with neighboring markets would inevitably lead to an adoption of somebody else's rules of the game, narrowing the maneuver space for the domestic government to set them how it wants. But, to formally (legally) allow integration is by itself a clear sign of political will to abandon unnecessary state intervention. A big exception would be if two or more states decided to integrate their systems under old non-market rules, but I am not sure if this would be possible at all because, as we all know from Tolstoy, "*Happy families are all alike; every unhappy family is unhappy in its own way.*" Market rules in countries with economically viable electricity markets are founded on quite similar principles and thus compatible with relatively small adjustments. However, the rules of the game in countries where states plan and run electricity markets are often uniquely distorted, each in its own way. It is hardly imaginable someone could adjust them all to function together properly. And of course, the question is what would be the point of such an endeavor.

It is important to note that an ALAP country cannot isolate its electricity market absolutely. Because ALAP policy inevitably leads to import dependence (as there is no long run profits which would otherwise enable necessary investments), governments must allow for substantial imports of electricity far beyond the scope of purely technical exchanges between network operators. In this way domestic utilities must enter into rather "normal" trade relations with foreign partners at least as wholesale buyers. To compensate for the lack of investments in generation, utilities are usually allowed to invest in substantial interconnection capacities with neighboring systems because it is way cheaper to build e.g. a 100 km interconnector with 2.000 MVA capacity than a small power plant of 100 MW in any technology one might think of. This is one of the main reasons why utilities in ALAP countries tend to secure their import capabilities by investing in transmission interconnections more than what is usual in countries where there are normal pricing signals for generation investments.

Transmission system operation shows certain *externalities*: the bigger a control area centrally operated, the lower the unit costs of providing system services, and vice versa. As described above, ALAP policy leads to "electricity isolationism" which in turn leads to a reluctance to take part in mutual usage of certain system services although economic logic would suggest opposite. This is a paradox: to make ALAP pricing possible, the governments maintain separation from neighboring markets. However, due to this separation system services become more expensive, and what is more important, generation investments may as well become *less competitive*. Therefore, a part of costs incurred by system operator's defection from participating in wider area system operation are being shifted to somebody else (either suppliers or generators), with an increase in final electricity price as a consequence.

One of the problems encountered in small power systems is the *night load minimum* (e.g. Croatian system with about 3.100 MW of peak load can be considered small; the night minimum is about 1.400 MW). At least all coal-fired and nuclear plants (if any) have to fit into this modest range. Moreover, recent strong political and legislative trends give advantage in network access to renewable sources (European Community, 2009a). Thus, in quite a few countries large wind farms already have preferential treatment as compared to fossil fuel and nuclear plants. In such circumstances it is not hard to imagine a situation where a larger new plant (say, 800 MW coal-fired, or 1.000 MW

nuclear) would be simply too large to be "squeezed" into a tight generation schedule unless shipping a substantial percentage of produced electricity abroad, especially during the night.

For that reason, investors in large (and usually more efficient) generation units would be forced to ship the excess energy abroad, especially during the night time. This can increase investment risks tremendously as selling an energy nobody needs may lower its prices considerably (even to negative values, as several times during 2009 on the German market). If there is no coupling with the foreign markets to sell, the investor would have to bear risks of cross-border charges, too. All these risks diminish as the market is bigger (with more players and more energy to exchange), i.e. more liquid. Connecting to international markets increases liquidity, decreases risks, and usually enables usage of various financial hedging devices.

Further, there occurs a question of *system reserves*, especially the tertiary reserve. A system operator has an obligation to keep available as much tertiary reserve capacity as big the largest generator inside its control area is. Suppose an investor wants to build a new 1.000 MW nuclear plant with a single generator in a control area with e.g. 3.100 MW peak load. Let the largest existing generator in such a system have 300 MW of installed power. Thus, local system operator has to keep 300 MW of tertiary reserve. After new nuclear plant is built, the operator would have to get additional 700 MW of tertiary reserve.

For example, the price of one megawatt of imported tertiary reserve Slovenian operator ELES has been paying during last several years ranged from about 17 k€ to 62 k€ (see www.eles.si). The lot was only 145 MW big. Even under the same conditions 700 MW would cost from about 12 M€ to 44 M€ a year more than before. However, unit prices for such a big lot would certainly be even higher. Sooner or later the TSO and regulator would pop up with an idea to introduce a *G*-component of the transmission tariff aimed at penalizing big generators which incur them additional substantial costs.

It is self understood that in a bigger system it would be much easier and cheaper to obtain larger sums of tertiary reserve *and* the problem of the generator unit size would not be that drastic as in small systems. These are the reasons why it is economically better for system operators *themselves* to be a part of a larger system. Generators would benefit, too, because diseconomies of running in a small system would naturally decrease. Or, to put it simpler: *system operation* exhibits economies of scale. Transmission system operators and electricity system as a whole profit from including more control areas into a centrally operated system. Therefore, state policies should foster mergers of control areas beyond national borders instead of discouraging them. Yet, at least regarding this point, European states have not shown too much rationality, so that exploiting the system operations economies of scale like in the USA still seems decades far away when it comes to the EU or Europe in a wider sense.

Regarding European policy towards ancillary services *trade*, apparently there is none. Otherwise, if anybody took care about this important detail, the European Commission would not effectively prevent cross-border trade of non-dispatchable services as it did in the Regulation on network access for the cross-border exchange (European Community, 2009c). Since the cross-border capacity allocation rules are based on forwardly traded scheduled capacities (except for the remaining capacities available for intra-day (real-time) allocations), and since capacity reservation is forbidden (except for technical purposes related strictly to security of system operation) they apparently prevent non-schedulable services, such as reserve power, to be traded over national borders, although ancillary service trade is obviously useful and beneficial.

The question of competitiveness of renewable sources is not by any means simple nor one-dimensional. In Joskow (2010) the author argues that the currently used methods of comparison, the levelised cost being the most frequent one, do not produce realistic results in comparing classical with renewable technologies, and make the green technologies look more attractive in an economic sense than they realistically are. The levelised cost methods sum all the capital and operating costs during the plant's life cycle and divide it by the quantity of energy it will produce in this time span. The idea of the calculation is to enable comparison between total long-run production cost per unit of generated electricity. Joskow shows that, since such studies have an underlying assumption that the economic value of the energy produced in all types of plants is the same, the results are misleading.

Electricity can take a number o marketable forms, so one cannot speak about the electricity as a single product. Instead, one can think of separate energy and reserve power markets such as base-load, peak-load, night base load, day base load, spinning reserve, secondary regulation, tertiary reserve, island operation, black start, etc. (for more information see Stoft, 2000). In this context, as an approximation Joskow identifies two main groups of generating plants: dispatchable and non-dispatchable. While dispatchable plants can easily adjust their generation power to a desired level that is derived from economic dispatching and system security criteria, the non-dispatchable cannot. In other words, dispatchable generators can work (and make money) when ever needed, while the others cannot. If by a political force the non-dispatchable sources were given a legally established precedence in network access, they would incur additional costs of system regulation. In any case, the energy produced in non-dispatchable generators has significantly lower economic value. For this reason, more accurate models for comparison of concurrent electricity generation projects will have to be developed. Regarding only the renewable electricity technologies, geothermal plants are the nearest to the goal of being competitive with coal, combined-cycle natural gas, or nuclear plants, and

this is because of their inherently dispatchable character. Wind farm technology is probably the next in line, while solar thermal and especially solar photovoltaic technologies will have to wait longer to become truly competitive (Joskow, 2010).

The economic factors that will certainly help renewable technologies to become competitive in time even without state subsidies are as follows: (i) the hydro potentials will eventually become mostly utilized, so there will be no significant potentials for further construction of hydro plants; as power consumption will inevitably increase, these natural resources will gradually become more and more scarce; (ii) the prices of fossil fuels (oil, natural gas, coal) will inevitably keep increasing for their reserves will gradually come to their ends (though, coal reserves will probably last quite longer than gas and oil); (iii) the carbon emission reductions will become tighter in time as a consequence of increased political determination to significantly slow down the pace of human-induced global warming; therefore, the prices of carbon emission rights (or their tradable financial derivatives, to be more precise) will also keep increasing; (iv) in order to combat increasing carbon emission prices the companies might start investing in carbon capture and sequestration technologies (should they become truly efficient with affordable prices); this will be just another manifestation of carbon emission reduction costs which will additionally burden both capital and operating costs (since these technologies increase fuel consumption, which in turn may also contribute to further fuel costs increases, too).

From today's standpoint it is hard to tell when the above listed costs will become significant enough to draw true normalized costs of renewable and classical electricity sources nearer to each other. However, one should note that it is not only a drop in renewable plant costs that will happen – rather, it is an increase in classical plant costs, too.

## *5. CONCLUSIONS – WHITHER TRANSMISSION BUSINESS?*

To sum up the considerations dwelled upon in the previous sections, I think that *the most important strategic challenge* before transmission system operators is adoption of large-scale renewable sources, many of them with intermittent characteristics, into transmission systems. All other problems seem to be far more modest and less important.

This assumes the systems must be upgraded both in the physical domain and in the domain of the system operation philosophy. The networks must not pose (unnecessary) barriers to the power system greenification, however the technical problems may be challenging, especially in view of preservation of system security levels already reached.

Regarding physical upgrades, the new transmission systems must become able of evacuation of considerable amounts of energy from many new renewable generating plants. They have to become able of transferring large-scale energy flows between macroscopic geographical areas with uneven distribution of new renewable plants. Nevertheless, this is "merely" a problem of network investments which may prove to be still relatively modest (in the developed and near-developed countries).

Yet, the policy ideas of building a ubiquitous copper-plate network, which are very present these days around Europe (but not in ever more rational USA), are dangerous and detrimental as their actual implementation would direct billions of Euros in the wrong direction. The networks do not have to be congestion-free all the time. Congestion can be efficiently managed. Eliminating congestion would drastically increase transmission system costs at the expense of customers. There has to be a rational equilibrium between congestion rents and transmission investment costs. One should achieve a rational development of both international and intra-national networks to foster both security of supply and electricity trade.

The main problem with large-scale (and relatively quick) renewable generation integration, besides occasional substantial network congestions, is the apparent lack of ancillary services. The renewable generation's intermittency will drastically increase demand for ancillary services. Transmission systems operators are virtually sole users of such services. Yet, since they have to be unbundled from the formerly vertically integrated utilities, and since, being relatively small in comparison to a whole power system, they do not have too large investment potentials for building their own regulation plants, they will have to keep relying on generation companies to provide them with sufficient reserve capacities.

Currently prevailing logic of pushing the excess renewable energy (i.e. when the winds are high in the northern parts of Europe) to somebody else (to the "hard" electricity system), selling it away even for negative prices (i.e. paying to somebody to consume it), and counting on the "hard" system's help when there is a (sudden) lack of generation from intermittent sources, is not sustainable. System is "hard" when disturbances are small relative to the total generation actively working on the grid. However, it is not hard when disturbances grow to substantial portions of totally engaged generation. Therefore, to stress it again, building new power lines is simply not enough. Very substantial new classical generation plants, technologically able of providing ancillary services, would have to be built shortly. That is, unless people will be tolerant to considerably more frequent power outages.

Out of similar reasons, the trade of ancillary services, however useful it may be in particular cases, will not compensate for the general and ever-growing lack of them. It is not too smart for a transmission operator to rely on purchasing system reserves in neighbor countries as they will start introducing large-scale intermittent renewable

sources, too, pushed by a force of supra-nationally EU-driven policy. Basically, each (relatively larger-scale) geographical area would probably have to have sufficient ancillary services supplied mostly from itself.

Generators able of providing system reserves must be paid enough to keep them financially interested in doing so. Therefore, clear market conditions must be established and each electricity service must be paid its real economic value. Unfortunately, public policies in still many countries prevent development of self-sustainable electricity markets, and the market integration even in the European Union does not go as well as ambitiously planned.

Of course, what can make problems with system reserves somewhat less stringent, is developing and implementing tools for prognosis of production from intermittent sources, making them effectively less intermittent. Gaining experience from actual operation with growing portion of such sources active on the grid counts in this category, too. Yet, the prognosis tools have their natural limitations. They may relax demand for ancillary services to a certain extent, but I believe more in firm physical reserves than flimsy software tools. They may be quite useful, yet they cannot be errorless. Nevertheless, this question is too complicated to be analyzed here in more depth. I am just mentioning it to illustrate the fact that transmission business will inevitably ask for more active ever-lasting learning how to run system which will soon become far less predictable in any possible way.

All the questions tangled above have their financial side. Transmission operation is a regulated business which must be sufficiently funded to be able to fulfill its tasks. It seems that increased need for ancillary services would put operators to a financial stress because the society (and regulators, too) would probably expect transmission tariffs not to increase (too much). Therefore, there will be pressures to reduce costs related to firm assets and labor, to make more room for additional costs associated with real-time system running. However, a combination of higher percentage of intermittent generators and lower asset-related spending could bring system reliability (i.e. short-term security of supply) nearer to a dangerous level. This in turn could pose new organizational challenges before management structures of the operators.

Regarding the economics of power system related to the process of system greenification, which has a profound influence on transmission business, the main policy goal should be to abandon the philosophy of subsidies towards the "green" sources as soon as possible. Renewable generation definitely must become an integral part of free electricity market. While the subsidies are justified in the beginning of the greenification, so that the process can successfully start after many decades of ignoring the externality costs related to environmental pollution, which made clean energy sources uncompetitive in comparison with the "classical" ones, once the levelised costs of the two become comparable the renewable sources will have to assume a role in normal power markets, which includes forward trades, real-time (spot) market settlements (called *balancing*), including balance responsibility measured by normal spot prices, *and* bearing costs according to future *G*-tariffs in proportion to the identifiable costs they incur to the system. In other words, one day renewable sources must become just another generation plants offering their products and services on organized or non-organized markets, following the same market rules, and receiving the same price signals, as anybody else.

Regarding the above mentioned *G*-tariffs, I believe they will have to be consequently applied as it is not economically efficient to socialize costs which are incurred by identifiable energy producers across all final customers. Instead, *G*-tariffs may be a proper vehicle to transmit certain long-term price signals to generators, providing them with financial incentives for more rational investment decisions. Obviously, transmission operators would then have to design appropriately structured *G*-tariffs in cooperation with regulators.

Finally, as I already argued, it is economically more efficient to run larger systems. The benefits for both sides, generation and transmission, are clearly recognizable. Political ideology of the European Union aims at fulfillment of the unified internal market doctrine, or at least at formation of a few wide regional markets across the European space. Political forces should never be neglected when it is about energy. They are often more efficient (in a pragmatic sense) than any other ones (e.g. market forces) as politics can provide short-cuts towards industry-wide restructuring processes that would otherwise take much more time to develop out of purely internal reasons. Moreover, politicians can, by a miracle of a democratic process, often come to more rational solutions than economists, probably because the democratic process inevitably leads to an extreme reduction of policy choice problem, narrowing the decision space to only a few choices. For a good illustration on how in fact weak arguments are needed to proclaim something a public interest and subsequently proliferate profound policies and make them a law in quite a short time, refer to Nardi (2009). Therefore, given an obvious political direction assumed by the European Commission, transmission operators and country governments should probably start thinking of super-national system operation. Political split among Europe countries about this particular question was probably the most important factor that prevented European electricity market(s) from developing to a more advanced levels as for example in quite a few wide regions in the United States. My guess is that it may take about fifteen years or so for the Europeans to reach a critical mass of political will to do it. (However, this is merely my speculation based on nothing really firm.)

Finally, I will just briefly mention that transmission system operation business will be increasingly influenced from the distribution/supply half of the power system, too. Distributed generation may certainly pose additional challenges in

front of both transmission and distribution operators. However, it was not my intention to go into that area, so I am going to leave it to some future opportunity.

## *6. REFERENCES*


[1] Balmert, D., Brunekreeft, G.: Unbundling, Deep ISO and Network Investment, Jacobs University Bremen, Discussion paper DP 2009-07, Sept. 2009.

[2] Brunekreeft, G.: Ownership Unbundling in Electricity Markets – A Social Cost Benefit Analysis of the German TSOs, Jacobs University Bremen, Discussion paper DP 2008-05, Aug. 2008.

[3] Chauve, P., Godfried, M., Kovács, K., Langus, G., Nagy, K. and Siebert, S.: The E.ON Electricity Cases: an Antitrust Decision With Structural Remedies, Competition Policy Newsletter, No. 1/2009, pp. 51-54.

[4] Council of Europe: The Convention for the Protection of Human Rights and Fundamental Freedoms, 1953.

[5] Diathesopoulos, M.D.: From Energy Sector Inquiry to Recent Antitrust Decisions in European Energy Markets: Competition Law as Means to Implement Sector Regulation, University of Cambridge, Faculty of Law, Working paper, July 2010.

[6] European Community: Consolidated Version of the Treaty Establishing the European Community, Official Journal of the European Union, C 325/33, 24 Dec. 2002.

[7] European Community: Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, Official Journal of the European Union, L140 of 5 June 2009, pp. 16-62.

[8] European Community: Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC, Official Journal of the European Union, L211 of 14 Aug. 2009, pp. 55-93.

[9] European Community: Regulation (EC) No. 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003, Official Journal of the European Union, L211 of 14 Aug. 2009, pp. 15-35.

[10] Glachant, J.-M., Rious, V.: A Typical Case of Weak Institutional Complementarity in Institution Building: The Design of Transmission Network Monopoly In Competitive Electricity Markets, Proceedings of the 11th Annual ISNIE Conference, Reykjavik, Iceland, June 2007.

[11] Joskow, P.: Electricity Sector Restructuring and Competition: Lessons Learned, Cuadernos de economía, Vol. 40, pp. 548-558, 2003.

[12] Joskow, P.: Comparing the Costs of Intermittent and Dispatchable Electricity Generating Technologies, Center for Energy and Environmental Policy Research, MIT, Discussion Paper, No. 10-13, Sept. 2010.

[13] Knyazeva, A., Knyazeva, D., Stiglitz, J.: Ownership Changes and Access to External Financing, Journal of Banking & Finance, Vol. 33, pp. 1804-1816, Elsevier, 2009.

[14] Leveque, F., Glachant, J.-M., Saguan, M., De Muizon, G.: How to Rationalize the Debate About 'EU Energy Third Package'? – Revisiting Criteria to Compare Electricity Transmission Organizations, European University Institute, Florence, RSCAS Working paper 2009/15.

[15] Nardi, P.: Transmission Network Unbundling and Grid Investments: Evidence from the UCTE Countries; Universita Boconi Milano, Working paper, 2009.

[16] Pielow, J.-C., Ehlers, E.: Ownership Unbundling and Constitutional Conflict: A Typical German Debate, European Review of Energy Markets, Vol. 2, No. 3, pp 55-88, European Energy Institute, May 2008.

[17] Peltzman, S.:Towards a More General Theory of Regulation, Journal of Law and Economics, Vol. 19, No. 2, pp. 211-240, 1976.

[18] Pollitt, M.: The Arguments For and Against Ownership Unbundling of Energy Transmission Networks, ESRC Electricity Policy Research Group, University of Cambridge, 2007.

[19] Pollitt, M.: Ownership Unbundling of Energy Networks, Intereconomics, pp. 292-296, Nov/Dec. 2007.

[20] Pollitt, M.: Evaluating the evidence on electricity reform: lessons for the South East Europe (SEE) market, http://www.dspace.cam.ac.uk/bitstream/1810/195425/1/0756&EPRG0725.pdf [Accessed 27.1.2011], 2007.

[21] Sabolić, D., Grčić, B.: Electricity Sector Reform in South-East European Countries in Transition, Post-Communist Economies, Vol. 22, pp. 367-385, 2010.

[22] Stigler, G.J.: The Theory of Economic Regulation, The Bell Journal of Economics and Management Science, Vol. 2, No. 1, pp. 3-21, 1971.

[23] Stigler, G.J., Friedland, C.: What Can Regulators Regulate? The Case of Electricity, Journal of Law and Economics, Vol. 5, pp. 1-16, Oct. 1962.

[24] Stoft, S.: Power System Economics: Designing Markets for Electricity, Wiley-Interscience & IEEE, 2000.

[25] Thomas, S.: A Critique of the European Commission's Impact Assessment on the Legislative Package for Electricity and Gas, The University of Greenwich, Public Services International Research Unit, Nov. 2007.

[26] Thomas, S.: Unbundling of Electricity Transmission Networks: Analysis of the European Commission's Position, The University of Greenwich, Public Services International Research Unit, Apr. 2007.

[27] Thomas, S.: A Critique of the European Commission's Evidence of the Need for Ownership Unbundling of Energy Networks, The University of Greenwich, Public Services International Research Unit, July. 2007.

[28] Ugur, M.: Regulatory quality and performance in EU network industries: evidence on telecommunications, gas and electricity, Journal of Public Policy, Vol. 29, No. 3, pp. 347-370, 2009.

[29] Van Koten, S., Ortmann, A.: The Unbundling Regime for Electricity Utilities in the EU: A Case of Legislative and Regulatory Capture?, Energy Economics, Vol. 30, No. 6, pp. 3128-3140, 2008.

[30] Willis, P., Hughes, P.: Structural Remedies in Article 82 Energy Cases, The Competition Law Review, Vol. 4, Issue 2, pp. 147-174, July 2008.