The European electricity transmission grid: toward a first best solution?

Fabio Domanico

Abstract

This article offers an analysis of the present framework for transmission grid in Europe and the results achieved with the liberalisation process. It underlines the importance of grid infrastructure investment within the European electricity sector in order to maintain and develop a secure electricity system toward the achievement of a “robust” transmission grid. In particular, the ownership arrangements of Transmission System Operators (TSOs) across Europe as well as the investments patterns of a sample of operators are studied in order to understand the effect of strategic behaviours coupled with regulatory imperfections. The role of regulation is hence investigated as a possible answer to the creation of a “robust” transmission grid which avoids risks such as blackout and anticompetitive behaviour.

Keywords: transmission grid; investments; regulation

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1. Introduction

Since liberalisation, the regulatory framework has mainly focused on competitive issues. However, consideration has also been given to the effects that the opening up and unbundling would have on other important features, such as the transmission grid. The grid infrastructure and the role of government are both important in the electricity industry. The sector, which is included in the group of network industries (sometime called infrastructure industries) is of vital importance for the economy of all countries. At the end of the 20th century different institutional changes took place in Europe, including privatisation and deregulation. Most of the literature has underlined the positive and negative aspects of this process, but less attention has been given to the role of the infrastructure, partly because of the high uncertainty characterising this segment. Moreover, regulation has been seen as a process in which the regulated firm has been able “to capture” the regulator. Different authors argue that deregulation and privatisation are the cure for X-inefficiency, and offers a better solution to this type of market failure through the introduction of competition. What will be the effects on investments and reliability in the future is an open debate. The issue will be discussed within this article.

The work aims at analysing European policy concerning the transmission network infrastructure with specific attention to the ownership arrangement of transmission system operators (TSOs) coupled with the incentives toward new investments in the grid itself.

Before starting the discussion, it is useful to recall the outages that occurred, mainly in Italy, Sweden, Denmark, UK in summer 2003 and in Germany in November 2006, and the negative spillovers for other countries. While these outages were due to different factors, such as technical and human errors, they focused attention on the insufficient electricity transmission infrastructure in Europe and the liberalisation policies. To create an internal electricity markets with the objective of achieving a fully liberalised market, it is essential to expand and rationalise the electricity transmission network. This does not always occur. In Europe, decisions on investments in inter-TSO or intra-TSO substantially diverge because of different political structures and organisations of Member States (Joskow, 2005a).

The increasing future demand for electricity and the need to maintain the existing infrastructures, require continuous investments. The European Commission calculated that Europe will need approximately €1 trillion in investments to meet the growing
energy demand in next 20 years (EC, 2006). Although it is difficult to assess the optimal level of investment needed to meet future demand, several authors have pointed to the problems likely to arise in the short term. The recent blackouts suggest that the need for new generation capacity and investments in transmission will be unavoidable in the next years. It is true that the market should determine the optimum level of investments, but any lack of incentives for market players in this particular sector could delay the creation of new capacity and interconnection, thus threatening the reliability of the system.

There are two main ways to enhance transmission capacity: upgrading the existing network or building new lines. The first option is easier in terms of costs, permissions and environmental issues, while the building of new transmission requires in-depth analysis prior to its being undertaken. Moreover, the discretion of TSOs on implementing reliability criteria have important effects on prices, congestion revenues (and rents), and incentives to invest. While on the one hand this discretional decision is essential to manage the network needs, on the other hand, it can affect final prices as well as incentives to invest in generation and transmission.

Also if public opinion is more aware of electricity prices, regulation should focus not only on the competitive field, but also on investments in network infrastructure. These are essential to guarantee long run competition, lower prices and enough power in the future. Moreover, any delay in investment may induce important welfare losses. Regulation, therefore, can play an important role in ensuring that the grid will work properly in the future. Changes in regulation can have important effects on changes in investment behaviour. The opening up to competition of some segments, can produce the familiar economics trade-off between allocative and dynamic efficiency (Guthrie and Videbeck, 2005).

In terms of European market integration, we should recall that interconnection was originally built to ensure reliability, and not for trade purposes. Today, lack of interconnection hampers market integration, limits the consumer benefits from liberalisation and creates concerns in relation to the electricity system (Domanico, 2007).

The work is structured as follows. Section 2 discusses the achievements of the European regulatory framework. This is followed by an examination of ownership arrangements of TSOs across Europe and the investment patterns of a sample of operators indicating how different policy actions should be implemented in order to obtain a “robust” transmission grid. These policies can help in avoiding risks such as blackouts or unfair competition. The last section concludes.

2. The European regulatory framework for transmission

The definition of the (electricity) network depends on three elements: first, the existence of a group of nodes; secondly, the existence of (material or immaterial) connections among these nodes, in the case of electricity these are represented by the transmission (and distribution) lines; and thirdly, the existence of a (electricity) flood traversing the network. These three elements are essential to achieve the two transversal characteristics of a network: ubiquity and reversibility. Ubiquity refers to the flow being available at each node of the grid. Reversibility refs to the possibility to create different
connections and patterns, for example, by modifying and adding nodes (Gobbo, 2003). While these two elements are important for a proper network, they are to some extent limited within the European electricity industry. As we have seen flow availability (ubiquity) is sometimes diminished by congestion while reversibility is not always possible, for instance, because of difficulties in obtaining permits to build new transmission lines (EC, 2007a) or the absence of economic incentives to create a new infrastructure. Regulation should intervene in the case of achieving reversibility to establish the right incentives for investments.

The European Community has taken steps to deal with the electricity network issue. However, often regulation seems to follow rather than to anticipate or move in parallel with electricity network investments.

At the same time, the expansion and maintenance of national grids depends essentially on the development policies of each Member State, and the available budgets of TSOs. Some transmission operators already publish annual development plans for their national grids, and some include interconnection projects with other countries. The development of interconnection plans among Member States is organised in a coordinated way by the European Commission (DG TREN) as part of the TEN-E project, which is the major TSO transmission projects.

The EU framework on the liberalisation of the electricity sector has tended in the past to overlook investments in transmission and interconnections, setting basic rules that have not achieved the hoped for results. The first directive on the liberalisation process, Directive 96/92/EC, addressed various transmission issues, describing the segment as regulated and prescribing the unbundling of TSOs and their accounting separation from other market actors. While unbundling could have some negative effects in terms of investments coordination by increasing the risks in a project environment, the directive did not provide any rules concerning infrastructure investments.

The European Commission implemented a second package of measures - the second electricity Directive 2003/54/EC and the Regulation 1228/2003/EC – on the regulation of cross-border trade. While Directive 2003/54/EC guarantees better non-discriminatory access to the network, legal unbundling of TSOs in order to avoid cross subsidisation and discrimination between incumbents and new entrants, it does not include any provision for infrastructure investment, that is, investments that could have been delayed by the less than satisfactory results from unbundling and from the existing connection with incumbents.

This second package of measures includes Regulation 1228/2003/EC regarding cross-border trade in electricity. The legislative framework provides for different elements related to cross border investments, such as harmonised principles for tariffs and payments between TSOs and rules on congestion management in the network and the allocation of cross border capacity. This is the first European legislative framework to consider network investments in a specific way. It includes rules to provide incentives to private investment within the network and rules related to how the revenues of TSOs should be spent (e.g., in capacity allocation), including network investments\(^1\). Firms can

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\(^1\) Art. 6 states that: Any revenues resulting from the allocation of interconnection shall be used for one or more of the following purposes: (a) guaranteeing the actual availability of the allocated capacity; (b) network investments maintaining or increasing interconnection capacities; (c) as an income to be taken
obtain exemptions from these obligations if they demonstrate that revenues are being used for other investments that will enhance competition and would not otherwise have taken place. However, this exemption rule has not produced good results; at the time of writing only two exemptions had been requested (EC, 2007a).

The European Community has implemented two main mechanisms to promote investments in interconnection capacity between TSOs located in different control areas. The first is the Trans-European Energy Network Programme (TEN-E), which provides financial support for interconnection investments (Meeus et al., 2005). However, this programme does not represent large shares of investments in interconnection capacity (EC, 2004). Since 2006 a revision to this programme is attempting to boost new investments in the electricity sector and transmission grid, and enhance the participation of private capital. The amount of investment established for next years (2006-2010) for European electricity projects is around €4.8 billion.

The second mechanism derives from the actual framework for investments in interconnection included in the Regulation 1228/2003, as discussed above. Nevertheless, the last energy sector enquiry shows that most TSOs prefer to use the extra revenue from the reductions in network congestion, to reduce grid tariffs rather than to invest in interconnection capacity. This is a cosmetic solution that favours incumbents and makes the entrance of new actors more difficult.

Figure 1: EU15 TSOs Ownership and Reinvested Congestion Revenue (2001-2005)

Without real separation between the transmission and distributions network operators and the generators, incentives to invest in the cross border interconnection and the internal infrastructure will be scarce. In this sense, the second electricity Directive needs to be implemented, and in such a way as to guarantee a real separation of these segments. It is be necessary to change the provisions of Regulation 1228/2003 in order into account by regulatory authorities when approving the methodology for calculating network tariffs, and/or in assessing whether tariffs should be modified.

2 The programme usually co-finances interconnection projects up to 50% of the total cost of the investment.

to provide TSOs with the right incentives to increase network infrastructure investments. To confirm these statements, Figure 1 illustrates how during recent years TSOs subject to ownership unbundling have invested higher percentages of their congestion revenue in network infrastructure than have vertically integrated TSOs.

The first electricity package did not address the transmission issue. Other rules about security of supply are included in Regulation 1228/2003/EC and in Directive 2003/54/EC. However, the need for specific regulation in this area was satisfied with Directive 2005/89/EC on the electricity supply and infrastructure. Among its different provisions, it encourages Member States to implement apposite measures to guarantee a secure system. Transmission (and distribution) system operators need an appropriate and stable regulatory framework for investments in network infrastructure. Article 4 of Directive 2003/54/EC requires Member States to monitor and submit reports on the security of electricity supplies. The Directive 2005/89/EC goes a step further by indicating that these reports should cover short, medium and long-term factors relevant the secure supply of electricity including TSOs’ intention to invest in the network. The directive also indicates that there is a need to ensure sufficient transmission and generation reserve capacity for stable operation and underlines the importance of removing administrative barriers to investments in infrastructure and generation capacity.

Will these measures be sufficient to maintain a timely and appropriate level of investment? This is an open question. While this Directive will be implemented by end February 2008, it is too soon to discuss whether the results will be positive, that is whether it will be fully implemented by Member States, or whether implementation will be a formality as has been the case with other Directives. The next section looks at TSOs’ investment patterns for the past seven years. However this is not sufficient to indicate whether investment will be adequate to meet forecast demand. Perhaps the European Commission’s third package of measures for the sector (September 2007) gives a clear indication that ownership unbundling is the best solution and recommends that TSOs and regulators should be coordinated under the supervision of a European Energy Agency. The new proposal indicates that TSOs should publish medium term (ten year) investments plans. However, their publication will not assure the effectiveness of investments. The next section examines the different transmission ownership arrangements across Europe coupled with the new EC proposal.

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4 It obliges Member States to maintain a sufficient level of network security with transparent market rules. This directive will be implemented on February 2008 and the first monitoring report will be due in 2010.

5 Article 6 of the Directive requires Member States to establish a regulatory framework providing investment signals in transmission (and distribution) infrastructure for TSOs in order to meet forecast demand. Moreover, TSOs have to facilitate maintenance and renewal of networks as well as allowing merchant investments in interconnection in accordance with Regulation 1228/2003. Decisions regarding interconnections investments have to be undertaken with the close cooperation of the TSOs involved. The directive also requires TSOs to indicate investment plans for the next five years for transmission, including cross border interconnections (art. 7).
3. Transmission ownership arrangements in Europe: towards the first best solution?

It is well known that the electricity industry has specific characteristics. However, it seems that sometimes this uniqueness is not considered by policymakers. For instance, regulation continues to be necessary in segments opened up to competition.

Liberalisation, privatisation and deregulation are all needed to reduce government influence, to foster market competition and to lead decisions driven by profit in network industries. However, in the electricity industry this can lead to conflicting priorities and effects by generating oligopolies or monopolies with the aim of exploiting market power. In more competitive environments there is a need to ensure reliability of service and to prevent anticompetitive behaviours deriving from market power (Wu et al., 2006). At the same time, in a competitive scenario, investments in transmission (and generation) are generally undertaken only if profitable (Auer and Haas, 2006). This is one of the main reasons why transmission (and distribution) should be regulated and unbundled from generation and supply, enabling open and non-discriminatory access for all market actors.

In terms of investments in network infrastructure, it is important to stress that the way TSOs are organised influences the incentives for investments. From the multitude of transmission ownership arrangements that exist, there are three that are more relevant for the discussion at European level. The first type is where the TSO is fully vertically integrated in the generation and retail sectors, sometimes with only a functional separation. Then it is necessary to have strong regulation, particularly in relation to non-discriminatory access and prices, and investment decisions. Conflicts of interest with other segments make regulatory activity indispensable to maintain some degree of competitiveness. In Germany, the absence of real unbundling following liberalisation, has allowed utilities to make more profit from the grid than from their generation business (Auer and Haas, 2006). It is no coincidence that it is difficult to find data on investment in transmission by TSOs in Germany.

A second type of organisation model is the fully ownership unbundling, where the operator both owns and manages the infrastructure, is completely independent from the other segments of the industry, and focuses on transmission management. There is no conflict of interest here. This system has been adopted in England and Wales, Spain, New Zealand and Italy.

Thirdly, there is the Independent System Operator (ISO), where the operator is separated from the other segments of the industry, but does not own the transmission facilities and is not responsible for investments. The ISO is responsible for programming, managing the dispatch of power, the allocation of scarce capacity, interconnections, etc… The generators own the network, but are subject to regulation to ensure separation. From an economic point of view, this model raises regulation costs and introduces the risk of capture or partial influence by generators on the transmission strategies. This system has been implemented in Scotland, for the network managed by the National Grid, in Italy (for few years) and in the PJM region in the US (Joskow, 2005a).

Before discussing the advantages and disadvantages of different ownership arrangements and related European policy, it should be pointed out that unbundling of
TSOs from generators will always imply higher levels of technical coordination among these players. Technical aggregation should be maintained and strengthened: it is necessary to guarantee that the electricity market works properly to reduce the risks of blackouts (Auer and Haas, 2006).

Full integration of TSOs with generation companies, although it guarantees higher levels of coordination, does not provide incentives for investment (see Figure 1) and can open the way to abuses of market power. The single independent system operator can manage the network or control zones of more than owner without any conflict of interest. However, a higher degree of regulatory effort is required and to some extent this does not guarantee that the generator’s investment decisions will be completely independent (Joskow, 2005a). Nevertheless it is politically acceptable and it can represent a step towards full unbundling of the network infrastructure. In theory, the fully ownership unbundling model represents the first best solution. Moreover, practical experience indicates that this model generates efficient results, although the implementation of such a model can be politically difficult to achieve (Joskow, 2005b).

Table 1: Unbundling Arrangements in Europe

<table>
<thead>
<tr>
<th>Member States</th>
<th>2001</th>
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<tbody>
<tr>
<td>Austria</td>
<td>legal</td>
<td>legal</td>
<td>Czech Republic</td>
<td>ownership</td>
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<tr>
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<td>legal</td>
<td>Finland</td>
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<tr>
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<td>Hungary</td>
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<tr>
<td>Estonia</td>
<td>legal</td>
<td>legal</td>
<td>Italy</td>
<td>legal</td>
<td>ownership</td>
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<tr>
<td>France</td>
<td>functional</td>
<td>legal</td>
<td>Lithuania</td>
<td>ownership</td>
<td>ownership</td>
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<td>Germany</td>
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<td>Netherlands</td>
<td>legal</td>
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</tr>
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<td>ownership</td>
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<tr>
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<td>Spain</td>
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<tr>
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<td>Sweden</td>
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<td>Slovakia</td>
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<td>UK</td>
<td>ownership</td>
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Source: Energy Sector Inquiry (EC, 2007a)

The new proposal for a third package of measures to promote competition and reduce distortion within the European electricity sector clearly indicates the essential need for the effective unbundling of TSOs from the interests of generators and suppliers. Greater unbundling would better guarantee indiscriminate access and would avoid the strategic use of network infrastructure investments (Baarsma et. al., 2007). Lack of investments can keep new entrants (including RES actors) out of the generator segment, it can help to maintain high congestion revenue flows for TSOs and it preserves the market power of generators (Wu et al., 2006).

Errore. L’origine riferimento non è stata trovata. shows the changes in unbundling arrangements of main European Member States, indicating how different countries are still implementing a legal separation, which when not effective, resembles the vertical integration model along with all its disadvantages. The new EC proposal indicates that the fully ownership unbundling model is the best solution and the ISO model as the second best solution. Once again, there is the risk of a well designed regulatory
framework having poor results in terms of its implementation in the Member State countries.

The role of regulator is limited to an extent, because of the asymmetry of information in the system. In the case of not full unbundling this can generate disproportionate advantages for generator incumbents, and reduce the reliability of the system. When the new actors are renewable electricity producers, the new entrants of the future, this becomes even more relevant.

Ownership unbundling has led to increased levels of infrastructure investments in countries such as Italy and Spain, where this structure has been implemented since 2003 (see Figure 3). In Germany, however, vertically integrated companies have demonstrated lower levels of investment, at least prior to the 2006 blackouts (see Figure 2). Another example of the advantages deriving from ownership unbundling is the percentage of investments in interconnection (see Figure 2).

![Figure 2: Investments of all German TSOs Compared to National Electricity Consumption (2000-2006)](image)

*Source: own elaboration on data EC, 2007b*

Taking account of the difficulties of and opposition to ownership unbundling in Member States such as Germany and France, the EC proposal also makes provision for ISOs. This would allow the companies to retain their network assets, while management would become the responsibility of the ISO. However, this solution has some problems. It will require detailed and stronger regulation with continuous monitoring in the presence of information asymmetries. Moreover, some kind of coordinate mechanisms would be needed in order to decide about investments within the grid infrastructure.

A first European experiences of the ISO solution is the Scottish electricity system, managed by the National Grid. This is a small market, surrounded by ownership unbundled operators in neighbouring zones [and hence preventing cross border matters] and enjoys strong regulation and continuous monitoring through OFGEM, to protect against discriminatory investments. Italy is another such example, but inefficiencies and
other difficulties led to the establishment in 2003 of an ownership unbundling operator, Terna\(^6\) (EC, 2007b).

In sum, European policy needs to be more consistent. There should be unambiguous and clear signals related to ownership unbundled transmission operators in all Member States. The second best solution (ISO) should be considered as a temporary arrangement prior to implementation of the full ownership unbundling model. In Germany, for instance, a single ISO managing all the national network would have avoided the 2006 blackouts.

We next analyse investments in network infrastructure in order to understand their pattern within Europe as well as likely risks of underinvestment in the future.

4. TSOs’ investment paths within the EU

TSOs are not only responsible for the real-time balancing of electricity generation and load, they also have other important roles including the provision of signals in the case of system inadequacy in the short and long term. This signalling should promote new investment in national as well as cross border network infrastructures. There are several elements that are acting as disincentives for new investment. For instance, while internal investments are required for reasons of reliability, interconnection investments are only subject to economic considerations, such as project cost opportunity including the decreases in revenue of diminishing congestion. The aim of this section is to analyse the investments paths of some European TSOs.

There are various problems in locating data on TSOs in Europe. Despite regulations, the main TSOs do not publish investment plans for their own networks. Regulation should be made more effective in order to mitigate this information asymmetry between TSOs and regulators. Although several directives, including the new EC proposal (EC, 2007b), require TSOs to publish their future investment plans, this does not ensure that investments will be undertaken. Also, it is difficult to establish the right level of transmission investments.

The comparison of these data is also difficult. Some TSOs manage all their national transmission networks (e.g., France, Italy and Spain), others manage only parts of them. In Germany, for example, there are four main transmission operators. At the same time, most operators manage both the transmission network and the distribution infrastructure. This makes comparison even more difficult. To compare investments, we also need to consider the lengths of the lines. But again, these vary across Member States and depend on the geographical conformation of the territory as well as of the voltage definition of the transmission network. There is no common definition for a transmission network, it depends on the network voltage.

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\(6\) After privatisation in 1999, Terna has constantly reduced its investments in network infrastructure, starting from €306 million in 1998 and arriving to €163 in 2002
shows the development of the lines of major transmission operators within Europe. While in the UK this definition includes lines up to 265 kV, in France it includes lines from 380kV to 63kW. The US definition starts from 65 kV lines (Joskow, 2005b). This seemingly small difference in network transmissions is significant in terms of understanding the difficulties related to comparing such elements as congestion costs, losses, and investment levels in different European countries. It is relevant for comparing amounts of investment by TSOs, and establishing a yardstick related to competition.

Figure 3: Investment Path Major EU Electricity TSOs (2000-2006)

Source: Own elaboration based on annual reports companies

Figure 3 shows an overview of the transmission investment patterns for a sample of transmission network operators within Europe. While this figure does not provide a complete picture for Europe, it can be taken as a good indicator of European investment paths. The companies operating in the different countries, represent significant areas of territory and population numbers across Europe. Although data for the Scottish and Southern TSOs are not available before 2003, some general conclusions can be drawn. It seems that transmission investments do not follow a constant pattern. This can generate important congestion problems within control zones and national networks. The data confirm that in the past national regulators have not paid sufficient attention to transmission issues, but, like TSOs, seem to have become more aware of them following the recent blackouts. In fact, it appears that in recent years companies have been undertaking increasing levels of investment. However, this does not mean that they are sufficient to meet all present and future infrastructural needs in a constant path of increasing demand.
Intuitively, the investment path should to some extent depend also on national consumption patterns. It is therefore useful to compare investments and consumption paths. This comparison enables some conclusions about the nature of investment and the possibility that markets can establish appropriate incentives for new investments in transmission networks. Figure 4 shows this contraposition between company investments and national electricity consumptions. While the figures do not provide information about the right level of investments and it is obvious that this depends on other factors as well, we could argue that in some countries, such as Italy, Spain, France, Germany (concerning E.On) and UK, investments in the past have not always
followed the pattern of constantly increasing consumption. As already analyzed in section 5, the ownership unbundling arrangements implemented in Italy (after 2003) and Spain has led to increased level of infrastructural investments compared to other Member States.

National network infrastructures have a superior level of capillarity respect to interconnection transmissions, however congestion occurs not only at the borders. Furthermore, there are cases where interconnection investments have only shifted the congestion problem from one network to another, but have not solved the problem. In a pattern of increasing electricity demand within the enlarged European Union\(^7\), blackouts have been experienced frequently caused by weak interconnection links, insufficient coordination between TSOs, and insufficient electricity production as well as infrastructural problems. The European Union needs to overcome the limitations of still fragmented national networks. The new European Commission proposal includes rules for more integration, coordination and sharing of information among operators. However, only time will tell whether it will be effective.

5. Conclusions

Since last decades European energy policy has developed in a dynamic manner. While once it was settled by individual national governments, EC policy is aimed at making it more homogenous. In 2004 the EU increased in size which added further complexity to the sector.

The role of regulation has changed over time, with a clear shift toward privatisation and liberalisation. In particular, the introduction of competition in the generation segment and European policy aimed at a fully liberalised Internal Market has led to regulatory spillovers in the transmission segment of the industry, where features such as unbundling have been introduced.

At the same time, policy making in relation to transmission investments have changed. There is currently important debate over the development of the Internal Market and the role of investments in the transmission segment. However, elements such as congestion, price differences across Europe, and blackout risks are introducing other issues into the debate, such as the benefits of a reliable system versus the achievement of European electricity policy goals.

In the past, progressive policy development toward liberalisation has not taken account of its effects on the European transmission grid and its capacity to ensure reliability. Actions are needed to provide incentives for the building of more transmission capacity and to ensure coordination between TSOs and regulators across Europe. In particular way, economic investments should be boosted more efficiently to reduce congestion with the ultimate aim of lowering prices and improving the reliability of the system. A

\(^7\) Based on baseline assumptions, electricity demand in EU15 is expected to expand by 1.5% per year in the period 2000-2030 (TEN-E guidelines, document available at: http://eurlex.europa.eu/LexUriServ/site/en/oj/2006/ce124/ce12420060525en00780080.pdf
number of different actions are needed to align the interests of private investors with the interests of the community.

In terms of network infrastructure investment, the analysis shows that TSOs have not always been consistent and increases in demand have not been matched by increased investment. There has been an increasing level of investment, but some of this has merely compensated for past under-investment. There is no guarantee that the present levels of investment will be sufficient to cover future electricity needs.

The examination of a sample of TSOs in Europe demonstrates that investments have not always followed an increasing trend. This is confirmed by examination of the recent investment patterns of TSOs. Furthermore, the implementation of unbundling ownership arrangements, as has occurred in Spain, has reinforced the pattern of continuous investment, compared to the position in other countries of Europe.

It is difficult to foresee whether the current investments in network infrastructure are sufficient to cover future needs. However, based on the evidence in this work it would seem that companies are aware of the strategic importance of the infrastructure. Based on our sample, it can be argued that, after the opening of competition in the generation segment and the unbundling of natural monopolies across Europe, transmission investments have decreased more in countries where effective separation has not been fully implemented, such as Germany and France. Moreover, investments did not follow the same trend as electricity consumptions. This cannot be ascribed to past overcapacity, because the networks of most European countries show internal congestion (EC, 2007a).

The European infrastructure has a number of weaknesses. Firstly, internal congestion and a weak interconnection infrastructure between Member States (Finon et al., 2004) have led to the creation of different markets for electricity within Europe with persisting price differences (Neely and Goulding, 2005). Second, the enlargement of the EU is leading to ever greater complexity and instability in the network system. There is a need for more coordination. Third, utility privatisation has not created an environment that attracts investment in network infrastructure, and actions such as ownership unbundling and new mechanisms to provide incentives for merchant investments are needed. An orientation towards profit for the TSOs would create problems of loop investments.

There are various policies that should be promoted in the transmission segment in order to benefit more from liberalisation and maintain a reliable system, in addition to ownership unbundling. First, it is essential to increase internal and cross border network transmission capacity also providing other direct incentives. Second, better regulation is needed to improve merchant investments in transmission and to provide incentives for locational signals. Third, there is a need to enhance the level of coordination management among TSOs as well as regulators.

Differently than in past, today the European Commission seems to be aware of the key role of the transmission infrastructure in the achievement of EU energy policy. The creation of an efficient European market for energy requires improvements in the infrastructure. For instance, the so called SmartGrid programmes are aimed at developing technologies to enable an accessible, reliable, flexible and economic future electricity network for Europe (Coll-Mayor et al., 2007). A reliable grid will improve security and quality of supply. The new EC proposal and new package of measure for the European electricity industry is focussing on unbundling, coordination among
European TSOs and regulators, effective medium term investments plans and the establishment of the new European agency to take on specific tasks. If successful, this regulatory framework would solve some of the problems in the European transmission infrastructure.


