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Electricity Infrastructure & Security of Supply: Should EU Governments Invest in Transmission Capacity?

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This paper challenges the central premise that lack of investment is the main cause of increased transmission congestion in Europe (and North America) and instead proposes an alternative non-investment approach that would deliver a far quicker and cheaper solution than either the US or EU proposals. This alternative non-investment proposal addresses the real cause of transmission congestion which, in most cases, is that regulatory failures have resulted in significant interregional and intertemporal wholesale price differentials that artificially increase demand for transmission capacity far beyond what is available as traders attempt to exploit the arbitrage opportunities on offer. Instead of stimulating transmission investment, the regulatory focus should therefore be to i) reduce interregional price differences caused by the exercise of generator market power; ii) maximise the availability of existing transmission capacity by preventing vertical integration of generation and transmission capacity; and iii) implement market mechanisms to efficiently allocate scarce transmission capacity whenever constraints do occur. These objectives could be achieved by more aggressive and more widespread application of antitrust powers vested in US and EU competition authorities to force: i) mandatory divestment of mid-merit and peaking generating capacity by dominant incumbents; ii) divestment of vertically integrated transmission capacity iii) implementation of market to allocate transmission capacity when congestion occurs.

1. Background

The electricity transmission systems of Europe are the legacy of decades of investment by monopoly utilities directed by central planners and paid for by regulated tariffs. They were never built to support liberalised electricity markets nor deliver the sheer volume of trans-continental flows of bulk power that arbitrage trading activity has created. As a result, transmission systems

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have become increasingly congested, especially on cross-border routes. The European Commission, in the form of the Directorate General for Transport and Energy (DG TREN), believe that this has been caused by inadequate investment in new transmission capacity since electricity market liberalisation began[1]. Furthermore, if transmission congestion is not relieved by new investment they fear integration of regional wholesale markets will be prevented, competition inhibited, and system security threatened. This perception has been strongly, but mistakenly, reinforced by the blackouts that occurred in Europe and North America during summer 2003.

2. The Directive

To address the issue of transmission investment, DG TREN has proposed a new Directive on *Infrastructure and Security of Supply* to "promote investment in the European energy sector to both strengthen competition and help prevent the reoccurrence of blackouts" that will:

i. require Member States to have a clearly defined policy towards the supply - demand balance which allows for targets for reserve capacity to be set or alternatives such as demand side measures;
ii. require Member States to have defined standards relating to the security of the transmission and distribution networks;
iii. require that each transmission owner (TO)submits an (multi)annual investment strategy to its national regulator;
iv. require regulators to submit a summary of these investment programmes to the European Commission for consultation with the European Regulators Group on Electricity and Gas and with account having been taken of the Trans European Networks axes of priority European interest; and

[1] DG TREN commissioned a report in 2001 looking directly at this question in *Analysis of Electricity Network Capacities and Identification of Congestion* http://europa.eu.int/comm/energy/electricity/publications/index_en.htm and has also repeatedly highlighted cross-border congestion in its benchmarking of progress in *Implementation of the Internal Electricity and Gas Market http://europa.eu.int/comm/energy/electricity/benchmarking/index_en.htm*.

v. include a right for regulators to intervene to accelerate the completion of projects and, where necessary, to issue a call for tender on certain projects in the event that the TO is unable or unwilling to complete the projects concerned.

The broad conclusion that can be drawn from the proposed Directive and the package of documents that accompany it[2] is that DG TREN now believes the need for new transmission capacity investment is so critical that the application of capital subsidies by the European Commission and governments (and or Member States) is not only justified but, in extreme cases, the construction of that new capacity by DG TREN (and or Member States) itself may even be necessary if a TO organisation refuses to invest in it itself.

3. An alternative non-investment solution

Throughout the transmission investment policy deliberations in DG TREN there is a rather pertinent question that has not been asked let alone answered: what could be done to reduce demand for transmission capacity? If demand for transmission capacity could be reduced so that it never, or at least only intermittently, reached the limit of existing available capacity, then it follows that there would be little or no need for new investment. The question of whether or not DG TREN (and or Member State governments) should be planning, funding and constructing new transmission lines would therefore never arise. It is such an obvious alternative solution that it is hard to fathom why so little effort has been put into analysing it. The remainder of this paper therefore addresses this gap in current thinking by proposing an alternative *non-investment* solution that shifts the regulatory focus to:

i. reducing interregional price differences caused by the exercise of generator market power;
ii. maximising the availability of existing transmission capacity by preventing vertical integration of generation and transmission capacity; and

[2] Go to http://www.europa.eu.int/comm/energy/electricity/infrastructure/com_proposal_2003_en.htm to review proposed Directive and supporting package of documents.

iii. implementing market mechanisms that efficiently allocate scarce transmission capacity whenever constraints do occur.

The *non-investment* solution rests on the assumption that the real cause of transmission congestion is that regulatory failures have resulted in significant interregional and intertemporal wholesale price differences that artificially increase demand for transmission capacity far beyond what is available. Electricity market liberalisation has allowed traders to enter the wholesale electricity market who are quite legitimately seeking to exploit market inefficiencies (arbitrage opportunities) by buying large quantities of power from low cost locations and selling it at profit in high priced locations. The larger the locational price differentials, the greater the likelihood that the existing transmission system capacity will be overwhelmed.

For the avoidance of doubt, the focus here is on congestion that is occurring above and beyond what would naturally be expected due, for example, to regular diurnal and seasonal swings in demand between regions or temporary unexpected outages of power plants and transmission lines. A 'normal' level of congestion has always occurred in transmission networks and as their operation is not fundamentally changed at the electrical engineering level by the market liberalisation process this will continue to be the case.

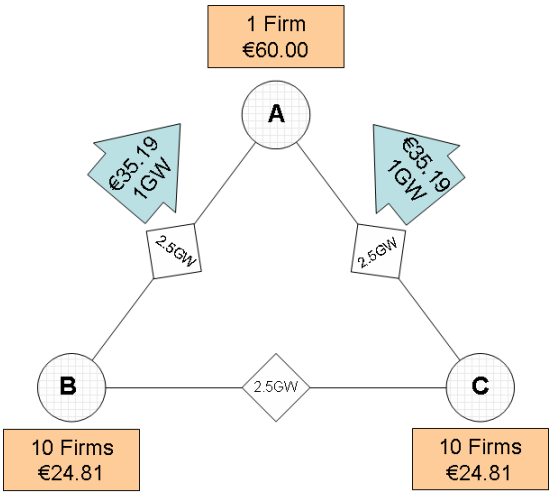
4. Causes of Congestion

A schematic representation of a cross-border wholesale electricity market is shown in Figure 1 which contains three countries with their national transmission grids linked together by three cross-border transmission lines. Though this is a dramatic simplification of the European electricity market, the prices, outputs and power flows show why congestion is growing on cross-border transmission routes in Europe.

Country A has a monopoly generator and country B and C each have a fragmented industry structure made up of ten generators. The physical cross-border import/export transmission capacity for each country is 5 gigawatts (GW), divided equally (2.5GW) between the two transmission routes connecting each country to its neighbours. It is further assumed that the

monopolist in country A also owns and operates the grid in that country and has determined that import capacity on lines A—C and A—B must be restricted to 2GW (i.e. 1GW on each route) in order to maintain stability on its national grid. Meanwhile the national grids in country B and country C are each owned and operated by an independent TO that has no interest in generation capacity or supplying customers. The line B—C is jointly owned and operated by these two independent TO organisations. The incumbent monopoly utility in country A jointly owns and operates lines A—C and A—B with the respective TO in country C and country B. All other factors are identical in each country with a short run marginal cost of €20/MW and available generating capacity in each country is sufficient to supply up to 80GW. Demand (D) declines linearly with price according to the formula 100 – D.

Figure 1: Cross-border Congestion



Under these circumstances the monopoly generator at country A sets a monopoly price of €60.00 and prefers to reduce its output by 2GW in order to accommodate imports from generators in country B and C. The price in country B and C is €24.81, which is just above the €20.00 short run marginal cost of production, because the fragmented industry structure combined with the capacity of the transmission line B—C means that the wholesale market in these two countries effectively operates as a single market populated by 20 generating firms which have little opportunity to exercise market power. Given the price differential between country A and that of B or C there is a significant economic incentive to export from the low priced location in countries B and C to the high priced location in country A.

Generators in countries B and C will each sell 1GW of output to country A and export it over cross-border lines. In practice, the 1GW output at B will flow 2/3 along line B→A and 1/3 along B→ C→A. Likewise, the output at C will flow 2/3 along line C→A and 1/3 along C→ B→A. The flows on line B—C, will net to zero and the marginal value of transmission capacity on that route will be zero because the line is uncongested. However, lines B→A and C→A will be carrying a flow of 1GW and therefore running at the limit defined by the utility in country A. Although operating below their physical capacity limit these lines will therefore be operationally congested with the marginal value of transmission capacity on each line equal to €35.19, which is just the difference between the monopoly price at A and the near competitive price at B or C. Generators at B or C who are exporting to A will only receive €24.81 net revenue, not the €60.00 price on offer at A, because they will have to pay the entire €35.19 of transmission charges to the owners of the transmission assets.

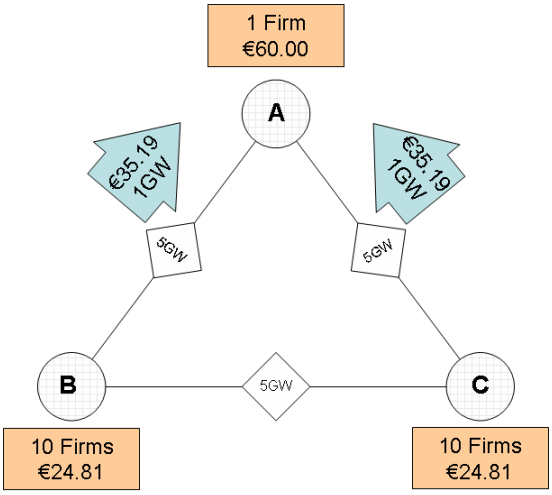
This scenario therefore contains all of the elements of the European cross-border wholesale electricity market. Wide price differentials between countries mean some transmission routes are heavily congested while others are not congested at all. The industry structure in some countries is defined by monopoly national utilities with vertical control over national grids and generation capacity and joint control with neighbouring utilities of cross-border import/export routes. In other countries, a fragmented generation industry exists with transmission capacity operated independently by an independent fully regulated TO. The net result is that wholesale electricity in country A costs almost three times what it does in B and or C. Though this outcome is the product of a simplified model it therefore echoes much of the empirical reality of wholesale electricity market issues facing policy makers in Europe in 2004.

5. Mandatory Investment

The proposal made by DG TREN and apparently agreed by Member States, is to resolve transmission congestion, promote wholesale competition and create an IEM by increasing cross-border transmission capacity to 10% of peak load. Figure 2 shows what the impact would be if national governments in each of the three countries agreed to pay for the installation of an extra 2.5GW of cross-border transmission on each cross-border route, a doubling of existing capacity.

Assuming all other conditions stay the same, the net result will be no change in output, prices or flows because the vertically integrated monopoly utility in country A can still limit actual flows on B→A and C→A to 1GW on each line in order to preserve grid stability. Given the informational advantage it has over the true operational status of its own national network it is impossible to say whether import capacity is being deliberately restricted to inhibit competitive entry from country B or C or whether there really is a national grid constraint in country A. Regardless of what the true reason for the constraint is the entire investment of public money would be wasted unless the incumbent utility at A can be persuaded to relieve the constraint and increase import capacity into country A.

Figure 2: Investment Solution



The crucial regulatory issue that this outcome hangs upon is the dominance of the generating monopoly position (horizontal integration) reinforced by its control over the transmission network (vertical integration) of the incumbent utility in country A.

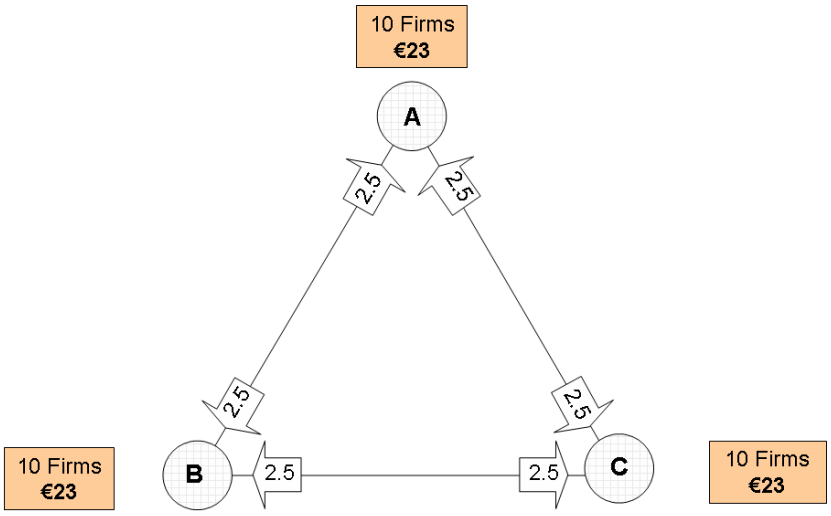
6. Mandatory Divestment

Figure 3 shows how the market power of the incumbent utility in country A could be curtailed without requiring massive new investment in cross-border transmission capacity. In this case, it is assumed that regulatory intervention not only forces divestment of transmission to an independent TO but also that the generating capacity is divested to 10 new generating firms. This creates an industry structure in country A that is identical to that of country B and C. The size of

these competing generating firms is now small enough to ensure that if any one of them were to attempt to raise prices significantly above the perfectly competitive level then they would lose the entirety of their market share either to incumbents in its own country or to imports from elsewhere.

The first effect is that the divestment effectively creates a single market containing 30 generators where each is free to sell electricity in any country, including its own, which means that prices are now slightly lower in country B and C than per previous and dramatically lower in country A. The second effect is that there are no flows on any transmission line and congestion has completely disappeared. This is because identical industry structures in each country have rendered prices equal in every location. The incentive to move power from low priced country B and C to high price country A to exploit arbitrage opportunities has been eliminated. Indeed if any party signed a contract to transmit electricity in either direction then all other parties would have an incentive to sign exactly equal and opposite contracts and be rewarded by receiving exactly the value of transmission losses saved. The transmission congestion revenue is zero and there is no incentive to invest in incremental interconnector capacity between any pair of countries. This is a strong indicator that no investor, including DG TREN or national governments, would consider building new transmission capacity.

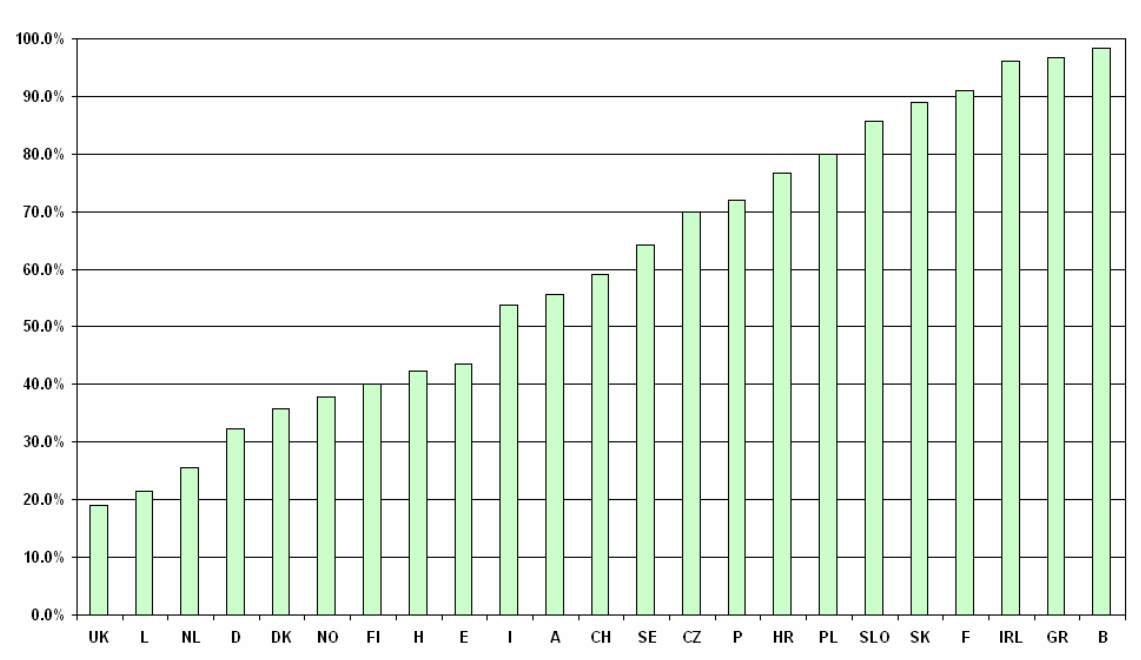
Figure 3: Divestment Solution



Empirical observation of generation sector concentration in the European market reveals that few countries have a competitive industry structure. Figure 4 shows the net generation output share of the largest generator in each country as a % of net national generation output in 23 European countries. To assess the likely competitive effect of horizontal industry concentration competition authorities typically use measures such as the Herfindahl-Hirschman Index (HHI) which is calculated by summing the squared market shares of firms in an industry with a maximum of 10,000 for a monopoly and zero for a perfectly competitive industry. The US Department of Justice Horizontal Merger Guidelines use benchmark HHI levels to categorise the competitiveness of different industry structures as follows:

i. HHI <1,000 are defined as unconcentrated markets and unlikely to have adverse competitive effects;
ii. HHI 1,000<>1,800 are defined as moderately concentrated but further mergers producing a change of 100 HHI points or more in such a market are likely to have adverse competitive consequences;
iii. HHI > 1,800 are regarded as highly concentrated markets and mergers producing a change of 50 HHI points or more in such a market are likely to have adverse competition consequences.

Figure 4: Net Generation Share of Net National Consumption by Largest Generator in 2002



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Although the HHI is only a very approximate gauge of the impact of industry concentration, by this definition, any country where a single firm controls 40% or more of the generation output share has a highly concentrated wholesale electricity market. In 17 of the 23 countries represented the largest generator has a market share of 40% or more. Of the remaining 6, Luxembourg is effectively subsumed into the French and Belgian market because of its small size, both of which are near generation monopolies. Norway, Germany and Denmark are effectively dominated by two or three competitors each with shares in the 30% range so also fall into the definition of highly concentrated markets. The Netherlands has 4 competing generators so would fall into the moderately concentrated range were it not for the fact that Electrabel, a near monopolist in Belgium, has merged with the largest of those generators and effectively controls the availability of cross-border transmission capacity into the Netherlands. That leaves only the UK as a relatively unconcentrated market in 2002, although mergers during 2003 have made that market slightly more concentrated since then.

6. Conclusion

The results from the analysis above and the empirically observed concentration of the generation sector in the European wholesale electricity market reveal that without a significant regulatory intervention that restructures the generation sector in virtually every European country to create a fragmented generation sector, there is little prospect of a competitive IEM emerging from the liberalisation process. Under these circumstances, and as much of the transmission capacity is either still in the hands of private incumbent utilities or is held by the state within the same monopoly holding company, the chances of cross-border transmission investment being able to force open these markets to any significant extent is nil. Mandatory generation and transmission divestment from dominant incumbent European utilities appears to be the only realistic way that DG TREN can achieve its vision of an integrated fully competitive IEM.