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Social cost-benefit analysis of electricity interconnector investment: A critical appraisal ☆

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ABSTRACT

This paper examines the economic analysis (social cost-benefit analysis) underlying two decisions to build an interconnector (NorNed and the East–West interconnector) in Europe. The main conclusion is that current interconnector and transmission investment decisions in Europe are unlikely to maximize social welfare. The arguments are as follows. (i) It is unclear how much demand for transmission capacity and interconnectors actually exists, and thus the benefits of investment are unclear. (ii) Both analyses underlying the investments studied are incorrect, to the point where, in one case, even the sign may be wrong. (iii) The main criticism concerns the fact that they do not take the resulting changes in generator investment plans into account and ignore the (potential) benefits of increased competition. (iv) Several smaller issues can be improved, such as the discount rate used. (v) Decisions at the European level are taken very differently, and approval may depend on which authority grants approval. (vi) Interconnector decisions receive the most attention, although most money goes to transmission investments. Two research recommendations for future improvements are formulated.

1. Introduction

Transmission and interconnection capacity between different markets or TSO regions should be increased and investment is insufficient according to many including the European Commission and the European TSO's (EC, 2007b, 2008b; ERGEG, 2009, p. 8; ENTSO-E 2010; see also ECF (2010) and PwC (2010)).[1] This new capacity should increase trade between cheap and expensive production areas, fight the market dominance of incumbents and increase competition, connect more renewable energy sources to the grid and increase security of supply (EC, 2007b, 2008b; ERGEG, 2009, p. 8). Consentec and Frontier Economics (2008, p. 7) estimate transmission investments needed to exceed €100 billion.[2] ENTSO-E (2010, p. 126) estimates the investment required up to 2020 to cost between €57 and €64 billion for about 42,100 km of new or refurbished network routes; this is about 14% of the total ENTSO-E transmission network of 300,000 km. About 25% of these new network routes will be new DC links, like the two cases studied here (ENTSO-E, 2010, p. 15). Given the vast amounts of investment at stake, careful decisions are necessary. Therefore, this paper focuses at two European cost-benefit analysis used to underpin actual investments, to test whether CBAs currently made are delivering efficient and adequate investments.

In a social cost-benefit analysis (CBA),[3] costs and benefits measure all differences in society with and without a project. Not only effects for the decision maker are included but also the externalities. This is done for all potentially good project alternatives. Methodologically there are two alternative methods: more limited cost-benefit calculations, and multi-criteria analysis (MCA).

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[1] EC (2007b) complained that not much investment is taking place. A similar statement holds for the US (see Joskow, 2005a). EC (2007a) gives several explanations why current low investment might mean underinvestment. However, several other explanations for low investments are possible without underinvestment: excessive investment prior to liberalization resulting lower required levels of investment now (Brennan, 2006; Moran, 2004) and calls for more investment may come from actors with an interest in building them (White et al., 2003).

[2] The absolute investments in transmission are large, but constitute only a relatively small fraction of the total cost of the electricity system (IEA 2002, p. 50). However, given the sharp rise in the cost of transmission investments, currently grid investment costs are comparable to generation assets on a rough per MW or MWh basis (see ENTSO-E 2010, p. 126.

[3] For an in-depth treatment of CBA see, for example Brent (2006), Eijgenraam et al. (2000) and EC (2008a).

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Sometimes, a cost-benefit calculation is made without including all of social costs and benefits; for example, in PJM the investment decision is based on reliability reasons or solely on congestion revenues in the case of market investment (see Joskow, 2005a, 2005b). This is unlikely to lead to socially optimal investment if external effects are important, or if both congestion and reliability benefit from a single investment.

In an MCA, projects are scored on various criteria, such as physical quantities, money and expert judgements. Weights are allocated to the criteria before the scores are combined into an overall rating for each project. The basis for the allocated weights is not always clear but often includes the preferences of policy makers or researchers involved. The double-counting of effects is more difficult to avoid than with a CBA because strict criteria for the inclusion of effects are lacking (Eijgenraam et al., 2000). An example of an MCA is the Baltic Energy Market Interconnection Plan (CESI, 2009). The criteria used are the benefit/cost ratio, where benefits refer only to market benefits and costs refer to investment costs, timing for the authorization and construction, and risks. Because it was impossible to determine the weights, CESI used equal weights. This has the drawback that relatively unimportant criteria or overlapping criteria (like the time required to realize a project, which is also included in the discounted value of the future benefits) are overrated.

The strength of a CBA is that all the effects need to be formulated precisely. A downside is that it is hard to determine how to use each factor in the CBA (such as the uncertainties related to quantifying the costs and benefits). MCA can deal with less strict criteria more easily. MCA and CBA both try to determine what the (physical) consequences of a specific project will be. While the MCA leaves it to the decision maker in dialog/debate with society to make the trade off, CBA tries to infer the weights by establishing how citizens make these trade-offs by expressing all effects in monetary terms. Therefore CBA is likely to get closer to answering the question of what happens to welfare than MCA. Therefore this article focuses on CBA.

A CBA also seems to be in line with ERGEG and ENTSO-E policy. The European Regulators' Group for Electricity and Gas (ERGEG 2010, p. 2) uses several criteria to judge the work of ENTSO-E on the desirability of new transmission capacity. ERGEG uses technical criteria (including a thermal criterion, stability criterion, voltage and reactive power criteria and short-circuit criterion) and several economic criteria to assess the social welfare arising from possible investment. The socio-economic evaluation should include a CBA, which should include investment costs, project risk analysis, change in losses and possible synergies and dependencies between the projects. It also includes socio-economic criteria such as: the exchange of ancillary services; the value of a more integrated market, for example by managing price differentials effectively across congested areas; the improved welfare of end-customers within the European market; the risk and costs of energy and/or power shortages (security of supply) and generation optimization (generation according to the merit order). How these various criteria should be weighted is not specified. ENTSO-E (2010, pp. 16–17) states that TSOs must use the following four criteria to evaluate investments in new transmission projects. (i) The investment should maintain or improve current high reliability to which end-users are accustomed. (ii) Investment should positively address social welfare. To this aim, cost-benefit analyses are undertaken by TSOs for every transmission project. (iii) New technological advances are taken into account. (iv) Grid planning should anticipate long-run perspectives beyond the following 10 years. This is an analysis of CBAs as mentioned by ENTSO-E under (ii).

This paper focuses at two large investments to increase interconnection capacity. However, capacity can also increase because of smaller measures, like changes in the operation, the allocation mechanism, congestion management,[4] the relaxation of reliability standards and investment in IT systems or small investment (see Hirst, 2000; Joskow, 2005b, p. 14; Léautier and Thelen, 2009, p. 131; Turvey, 2006; Kirschen and Stribac, 2004). Some of the objectives of more interconnection (i.e. more competition between generators) can also be reached with other measures like favouring entry (Küpper et al., 2009), or breaking up the largest companies (Tanaka, 2009). Although it is important for a CBA also to include low-cost solutions, this article does not discuss this in more detail. To illustrate its importance two examples follow. In 2004 capacity worth almost €50 million was not utilized on the Dutch–German border, almost half the total value of this interconnector capacity (EC, 2007a, p. 185). Under-using and misusing of the UK–France interconnector amounted to €289 million from 2002 to 2005 (Bunn and Zachmann, 2010). The importance of improving the use of existing interconnectors has been seen and improvements are underway. For example, market coupling between Belgium, the Netherlands and France reduced congestion: the percentage of time the prices between the Netherlands and France differed fell from 90% to 37% after market coupling in 2007 was established (see ERGEG, 2009, p. 16, Küpper et al., 2009).

In a CBA, all costs and benefits are relevant. The costs include investment costs, operational and maintenance costs, environmental impact, real options, the impact on electricity loss and other system costs (frequency control, spinning reserve and other ancillary services costs). The costs mainly follow directly from calculations made by engineers. On the benefit side, two benefits stand out: efficiency benefits and security of supply benefits (or reliability benefits).[5]

Efficiency benefits, including trade and competition benefits, can arise from investing in interconnection and transmission because an extended network increases the possibilities for trade and competition between generators. In the short run, this can increase allocative efficiency (the electricity goes to the consumer with the greatest willingness to pay; redistribution cannot improve welfare) and productive efficiency (the same electricity cannot be made at a lower cost by having some producers produce more and others less). Allocative and productive efficiency also include the absence of mark-ups over the marginal cost based on market power, since these mark-ups distort the optimal allocation of goods among consumers, of production among producers and the optimal quantity produced. More competition may also reduce x-inefficiency (where firms could produce at a lower cost than they actually do)[6] and it may influence dynamic efficiency (through investments in R&D and new technologies).

Increase in reliability is often the main reason behind grid investments (Joskow, 2005b). Valuing increased reliability requires (i) an estimate of the increase of reliability (e.g. the decrease in MWH of electricity not delivered due to interruptions) and (ii) a valuation of increased reliability (difficult, but possible, see de Nooij et al., 2007). Often a distinction is made between investments necessary to maintain reliability (by meeting certain engineering

[4] For congestion management at borders, see Kristiansen (2007), Turvey (2006) and Consentec and Frontier Economics (2004).

[5] For a more in-depth discussion of all costs and benefits, see the next two sections; de Nooij (2010), Turvey (2006) and Malaguzzi Valeri (2009).

[6] X-inefficiency (Leibenstein, 1966) can result from workers or management putting in substandard levels of effort, from misdirected effort, imperfect rationality and from markets that are not perfectly competitive. Leibenstein argued that gains of improved x-efficiency are likely to far exceed gains from improving allocative and productive efficiency. X-inefficiency is a departure from strict neo-classical economics, and as such is subject to criticism, see Stigler (1976) and Leibenstein's response (1978). Frantz (2007) gives an overview of studies that quantify x-inefficiency.