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The benefits of integrating European electricity markets

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HIGHLIGHTS

- The benefits from day-ahead market coupling are €1 bn/yr.
- Intra-day and balancing benefits add a further €1.3 bn/yr.
- Total benefits including removing unscheduled flows could be €3.4 bn/yr.
- Sharing balancing and reserves is high priority.
- Rewarding interconnectors for all services reduces barriers to expansion.

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ABSTRACT

The European Commission's Target Electricity Model (TEM) aims to integrate EU electricity markets. This paper estimates the potential benefit of coupling interconnectors to increase the efficiency of trading day-ahead, intra-day and balancing services across borders. Further gains are possible by eliminating unscheduled flows and avoiding the curtailment of renewables with better market design. In the short run the gains could be as high as €3.9 billion/yr, more than 100% of the current gains from trade. About one-quarter of this total comes from day-ahead coupling and another third from shared balancing. If shared balancing is so valuable, completing the TEM becomes more urgent, and regulators should ensure these gains are paid to interconnectors to make the needed investment in the cross-border links more commercially profitable.

1. Introduction

The European Union is, by the end of 2015, part way through the process of further integrating EU electricity markets by rolling out the Target Electricity Model (TEM). Most Member States have effectively implemented the TEM at the day-ahead stage, and by the end of 2014 the share of market coupling had risen from 60% in 2010 to 86% (ACER, 2015, p15). The harder intra-day allocation and shared balancing is still work in progress and not expected before the end of 2017. A key part of the TEM is improving the efficiency of cross-border trade over interconnectors. If that leads to a material increase in benefits, then two policy implications follow. First, these gains need to be reflected in payments to the infrastructure providing these services. In some cases, notably cross-border balancing, this does not yet happen. Second, if payments to interconnectors are materially increased, the commercial profitability of, and hence pressure to build, more interconnection will also increase and help meet the European Commission's ambitious targets for cross-border links.

The materiality of the gains from integration is also important as the required market reforms are costly in terms of changing software and market operations, and certainly run into tens of millions of euros for each Member State. As an example, when Britain replaced the centrally dispatched Electricity Pool by an energy-only market (NETA) in 2001, the UK's National Audit Office estimated “that market participants could incur total costs of up to £580 million in implementing NETA over the first 5 years, and

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then operating costs of £30 million a year" (NAO, 2003).

It is therefore timely to measure the benefits of market integration to judge whether the enterprise is worthwhile, whether it is so beneficial that it should be completed more rapidly despite the difficulties, and whether it materially affects the profitability of investment in interconnectors. If, as argued here, the benefits are indeed large – several billions of euros per annum – then it becomes more urgent to accelerate the last difficult parts of the TEM, particularly sharing balancing services and reserves across borders and ensuring that potential interconnector investors see these gains reflected in profits and press for more and faster interconnections.

The TEM is part of the wider *Third Internal Energy Market Package* that came into force in 2011 with among other objectives "… to urgently upgrade Europe's networks, interconnecting them at the continental level, in particular to integrate renewable energy sources."[1] To press for continued and faster market integration DG ENER commissioned the authors to estimate the benefits of integrating electricity (and gas) markets (Newbery et al., 2013).

This paper sets out the methods used in that report and extends the results, using additional data published by ACER (2014a, b, 2015) that was collected in response to our report. This paper adds to ACER's estimates by extrapolating ACER's partial coverage to the EU-28, using later data where this corrects earlier estimates (e.g. for unscheduled flows), but attempting to measure the pre-coupling situation. Although these are necessarily somewhat speculative, they identify more clearly the sources of major potential integration gains, although they do not include additional gains from the resulting increased competition. Where appropriate we compare our estimates with ACER's estimates, but while ACER's annual market reports are directed at monitoring progress across a wide range of topics (such as retail competition and the gas markets) our aim here is to step back and assess the integration benefits of the TEM as it applies to wholesale electricity markets.

Electricity market integration under the TEM couples cross-border interconnectors so that all electricity is (moderately) efficiently allocated across the EU by a single auction platform, Euphemia (Pan-European Hybrid Electricity Market Integration Algorithm).[2] By mid-2014 the day-ahead coupling objective had been achieved from Finland to Portugal, including Great Britain. Coupling means that wholesale electricity prices should be equalized across boundaries unless the interconnector is constrained, in which case prices can diverge but the interconnector should be fully utilized. Before market coupling, capacity on interconnectors was sold before the day-ahead markets opened, and traders had to predict the price differences across interconnectors and bid for that capacity. Traders faced the risk that on the day the trade would no longer be profitable, in which case the option to flow power would be abandoned and the interconnector would be under-used, or, worse, the power would flow from the high price to the low price zone.

The EU electricity market has an installed capacity of 948 GW in 2012, an annual production of 3010 TWh in 2014 and trade between Member States in 2011 of 315 TWh/yr, about the EU target of 10% traded power. If its average value is €50/MWh, production would be worth about €150 billion/yr. If the average value of capacity is €500/kW,[3] the installed capacity would be valued at some €500 billion. As part of the argument for closer integration, "the Commission estimated that about €200 billion of investment would be needed by 2020 in energy infrastructure Europe-wide."[4] Given these large sums, a small improvement in efficiency could amount to a large absolute sum of money.

The Section 2 summarizes existing estimates of the benefits of market integration. Section 3 sets out the methods for their estimation, Section 4 presents the data and calculates the arbitrage gains from market coupling, Section 4 gives estimates if the other benefits of integration, and Section 5 concludes.

2. Estimating the benefits of market integration

The two main methods of computing the potential benefits of market integration are to build a simulation model of the relevant area (ideally, the whole EU, normally some region) and compare the results with and without market coupling, as in some of the studies listed below and one used in this paper (described in Pudjianto et al. (2014)), or to examine individual interconnectors before and after reforms. The first runs into the problem that it is challenging to replicate flows and generation even with a greatly simplified representation, particularly in the presence of market power (Neuhoff et al., 2005). The second runs into the usual problems that other factors (e.g. fuel prices) also change over the period studied and general equilibrium/network effects are ignored. The first of these objections is partially allayed as these factors will likely affect prices at both ends of the interconnector, and the benefits depend on differences across the borders. The second is more serious in meshed networks and much less of a problem with links to isolated systems (e.g. to GB, Spain), but still has to be addressed by estimating possible price impacts.

Most of the following studies use the simulation approach, where estimating the benefits of more efficient electricity market integration has attracted intermittent attention in different jurisdictions and for a variety of reasons.[5] Neuhoff et al. (2011) explored the benefits of the most efficient form of market integration via nodal pricing (as in PJM[6]) but including a large volume (125 GW) of predicted future wind connection. They found savings of 1.1–3.6% of variable operating costs. If variable (mainly fuel) costs are roughly half total wholesale market value then the gains from full integration would be 0.6–1.8% of wholesale market value. Leuthold et al. (2005) simulated the benefits of adding 8 GW of offshore wind to Germany and moving to nodal pricing, estimating that gains of 0.6–1.3% came just from a move to nodal pricing and an additional 1% would come from nodally pricing the additional wind.

One important study comparing before and after over a wide region is that of Mansur and White (2009), although their study is the more ambitious one of comparing different market designs, not just the benefits of market integration, but moving from bilateral trading to simultaneous market dispatch and clearing. They compared monthly prices before and after a bilaterally cleared zone joined PJM's nodally priced market area to estimate reductions in price spreads, and estimated welfare gains in the same way that this paper does. They found incremental gains of $3.6 million/GW capacity, which if applied to the EU with 950 GW

[1] ⟨http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1441631107710&uri=URISERV:180202_1⟩.

[2] See PCR (2016) for a description of the algorithm and its workings.

[3] The cost of a new Combined Cycle Gas Turbine is about €1000/kW. New coal-fired stations cost around €1800/kW, about the same as on-shore wind. Nuclear power and off-shore wind are more than twice these amounts. While existing stations are old and largely written down, their lower-carbon replacements are likely to be more costly than the €1000/kW, partly because more capacity will be needed to deliver reliability.

[4] ⟨http://www.europarl.europa.eu/atyourservice/en/displayFtu.html?ftuId=FTU_5.7.2.html⟩.

[5] A fuller literature review is provided in Newbery et al. (2013).

[6] Originally the Pennsylvania-New Jersey-Maryland interconnection, since expanded considerably.