Institution: University of Birmingham

Unit of Assessment: C18 - Economics and Econometrics

Title of case study: Re-design of electricity transmission charges

1. Summary of the impact

The energy regulator, Ofgem, drew on research from the University of Birmingham when it instructed the electricity industry to re-design transmission charges that recover £1.6 billion per year. This instruction, issued in May 2012, was the culmination of Project TransmiT which Ofgem launched in September 2010. As part of TransmiT, Ofgem commissioned three teams of academics to consider whether changes to transmission prices were desirable and, if so, to recommend changes. One of these teams was from the Universities of Birmingham and Strathclyde. The changes introduced by Ofgem - which aimed to send more accurate signals of the cost of dealing with low-carbon electricity - were those recommended by the Birmingham and Strathclyde team. As a consequence, **the research has fundamentally shaped a significant change to the future of electricity pricing in Great Britain, affecting the costs incurred by the industry and the payments made by every consumer in the country.**

2. Underpinning research

Professor Richard Green was Professor of Energy Economics at the University of Birmingham from 1 July 2005 to 31 August 2011. One strand of his research concerned the best way to organise the electricity wholesale market in which generators sell power to the retailers ("suppliers" in the UK) who then sell it on to customers. One of the key challenges is that the location of the generator determines whether or not its output can safely be accepted onto the network (over-loading the lines can lead to a nation-wide blackout in the event of a failure) and also affects the proportion of the generated power that can be delivered to customers. A market mechanism known as *nodal pricing* has been adopted in several parts of the US to take account of these factors, allowing prices to vary across the power network to reflect the true marginal cost of meeting extra demand at each point. In Great Britain, most electricity trades ignore the generator's location on the network, but National Grid, the system operator, then has to adjust the output from particular generators to ensure that the physical constraints are met. These trades are limited to meeting those constraints and do not result in a fully optimal solution.

The research published in output 1 (R1; 2007) asked how important the failure to reach an optimal solution was. It used a techno-economic model of generation and transmission in England and Wales to calculate the dispatch of power stations, and the resulting prices, under different pricing rules. These included the current system, the "optimal" solution of nodal pricing, and hybrids under which either consumers or generators faced regionally differentiated prices. The research found that the welfare benefits from moving to the optimal nodal prices were equal to about 1 per cent of the wholesale market's turnover, that these came mostly from exposing consumers to the true marginal cost of their consumption, and that there were significant inter-regional welfare gains and losses. The benefits of giving generators alone a price signal were small.

Interdisciplinary research with electrical engineers from Strathclyde (R2; 2007) asked how sensitive the transmission charges used in Great Britain would be to different scenarios for the future evolution of electricity generation to 2020. The differences between scenarios were relatively small.

Another strand of research looked at the challenges of integrating renewables and the demands that this would place on the spot market mechanisms. Output 3 (R3; 2008) compared the generic wholesale market designs used in the US and in Europe, and concluded that the balance of advantage was swinging towards the US design, based on nodal pricing. Output 4 (R4; 2010) continued this work, quantifying the swings in demand and possible constraints on the England-Scotland border that the market would have to cope with in Great Britain.

The majority of the research was funded by the Engineering and Physical Sciences Research Council, under two Supergen Grants (details below). The Principal Investigator on both grants was Professor J McDonald (University of Strathclyde); Professor Green was a co-investigator, and was a workstream leader on the second project

3. References to the research

Research outputs:

R1) Green, R.J. (2007) 'Nodal pricing of electricity: how much does it cost to get it wrong?', *Journal of Regulatory Economics*, vol. 31, no.2, pp. 125-149 **[http://dx.doi.org/10.1007/s11149-006-9019-3]**

R2) Ault, G.W., I.M. Elders and R.J. Green (2007) 'Transmission use of system charges under future GB power system scenarios', *IEEE Transactions on Power Systems*, vol. 22, no. 4, pp. 1523-1531 **[http://dx.doi.org/10.1109/TPWRS.2007.907128]**

R3) Green, R.J. (2008) 'Electricity wholesale markets: designs now and in a low-carbon future', *Energy Journal*, vol. 29, special issue No. 2, pp. 95-124 **[http://dx.doi.org/10.5547/ISSN0195-6574-EJ-Vol29-NoSI2-6]**

R4) Green, R.J. (2010) 'Are the British electricity trading and transmission arrangements future-proof?', *Utilities Policy*, vol. 18, no. 4, pp 186-194 **[http://dx.doi.org/10.1016/j.jup.2010.06.002]**.

Grants:

(a) Green, R (PI) *GR/s28082/01 SUPERGEN - Future Network Technologies*, Sponsor: Engineering and Physical Sciences Research Council. October 2003 – September 2007, £3,419m (UoB allocation £80k).

(b) Green, R (PI) *EPSRC Project EP/E04011X/1 SUPERGEN 1 Renewal Coare - Flexnet: Renewal of the SUPERGEN Consortium on Future Network Technologies*, Sponsor: Engineering and Physical Sciences Research Council. October 2007 – March 2012, £6,876,795 (UoB allocation £336,845).

4. Details of the impact

The electricity industry in Great Britain is regulated by the Office of Gas and Electricity Markets, Ofgem. Ofgem has to set limits on the overall level of the prices charged for electricity transmission and distribution to consumers, and to approve the methodology by which the particular prices paid by each system user are set. Ofgem (or strictly speaking, its governing Gas and Electricity Markets Authority) is also responsible for approving or denying changes to the rules of the British Electricity Transmission and Trading Arrangements, which interact with the prices set by the transmission companies to determine the overall cost of buying power.

Ofgem drew on research findings of the University of Birmingham when it instructed the electricity industry to re-design transmission charges that recover £1.6 billion per year. This is a very significant impact because of the geographical structure of supply of and demand for electricity.

Electricity typically flows from the north to the south of Great Britain, and the flows have been greatest at the times of maximum demand. To reflect the costs that these flows impose, transmission tariffs have been based on the capacity of generators and are higher for generators in the north than in the south. This imposes relatively high costs (per unit of output) on renewable generators in Scotland and northern England, which generate less per unit of capacity than most other power stations, potentially raising the subsidy they require to break even.

Ofgem started Project TransmiT in 2010 to review whether these charging arrangements would remain fit for purpose as the proportion of low-carbon generation increased through 2020 and beyond. There was extensive industry consultation, and three teams of academics were engaged to consider whether changes to transmission prices were desirable and, if so, to recommend changes. A fourth team produced a report on whether transmission prices should be used to promote low-carbon generation; another team academic peer-reviewed the reports (source 3 below).

Professor Green was recruited as the sole economist in one of the teams on account of his extensive reputation among policy-makers in this area (source 4); for instance, he had been a Specialist Advisor to the House of Commons Trade and Industry Committee for two reports in 2003 and 2004. On this team, he worked alongside four engineers from the University of Strathclyde. Professor Green played a crucial role in the team's work through evaluating the economic impact of several alternative methodologies considered in their report (source 1). The team recommended improvements to the current charging methodology; in particular that charges per unit of electricity generated should be introduced alongside the existing (but reduced) charges for generating capacity. The intention was to send an approximate signal of the costs imposed by distant generators at off-peak times but to avoid proposing radical changes that might not be politically implementable (such concerns were discussed in R3 above). The other two academic reports proposed the radical change of introducing a system of nodal pricing as used in the US electricity markets (source 2, which includes references to R1 above). All the draft reports were presented to Ofgem at a meeting in March 2011 and published after responding to feedback from the regulator.

The regulator rejected nodal pricing as it would have involved changes to energy trading as well as to transmission pricing (source 5). Instead, it favoured the approach of improving the current system that was recommended by the Birmingham-Strathclyde team (source 6). Following further analysis, National Grid has now been directed to develop charging proposals along these lines (source 7). This includes explicit consideration of charges per unit of output (as recommended in source 1); much of the industry analysis had been of charges per MW of capacity that would be linked to the generator's load factor, and hence mathematically equivalent to charges per unit of output.

The research has thus fundamentally shaped a significant change to the future of electricity pricing in Great Britain, affecting the costs incurred by the industry and the payments made by every consumer in the country. These "Transmission Network Use of System" charges amounted to £1.58 billion in 2009/10 (source 1, pp 23-24). Ofgem are still working to quantify the benefits from the changes, but their broad conclusion is that "cost reflectivity drives more efficient decisions by market participants and policy makers which creates value for consumers" (source 6, page 5); this is the key theme which was expanded and quantified in the research presented in section 2 of this case study.

5. Sources to corroborate the impact

1. Bell, K, R.J. Green, I. Kockar, G. Ault and J. McDonald (2011) *Academic Review of Transmission Charging Arrangements - Universities of Strathclyde and Birmingham* Academic Report Commissioned by Ofgemhttp://www.ofgem.gov.uk/Networks/Trans/PT/WF/Documents1/Project_TransmiT_final%20report_Strath_Birm.pdf
2. Newbery, D. (2011) *High level principles for guiding GB transmission charging and some of the practical problems of transition to an enduring regime* Academic Report Commissioned by Ofgemhttp://www.ofgem.gov.uk/Networks/Trans/PT/WF/Documents1/2011_April_22_David%20Newbery%20Report.pdf
3. Ekins, P. (2011) *Project TransmiT - A Peer Review of Commissioned Academic Analysis* Peer Review Commissioned by Ofgemhttp://www.ofgem.gov.uk/Networks/Trans/PT/WF/Documents1/Paul%20Ekins%20final%20report.pdf
4. Corroborating statement from Senior Partner, Smarter Grids and Transmission: Ofgem, 12 March 2013 held by the University
5. Ofgem (2011a) *Project TransmiT: approach to electricity transmission charging work*, Reference Number 73/11 http://www.ofgem.gov.uk/Networks/Trans/PT/Documents1/110527_TransmiT_charging_letter.pdf
6. Ofgem (2011b) *Electricity transmission charging: assessment of options for change* reference 188/11

http://www.ofgem.gov.uk/Networks/Trans/PT/Documents1/Project%20TransmiT%20Dec11.pdf

7. Ofgem (2012) *Electricity transmission charging arrangements: Significant Code Review conclusions* reference 65/12 http://www.ofgem.gov.uk/Networks/Trans/PT/Documents1/TransmiT%20SCR%20conclusion%20document.pdf