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An Estimate of the Value of Lost Load for Ireland

Eimear Leahy and Richard S.J. Tol^{a,b,c}

Abstract: This paper estimates the value of short term lost load in the all island electricity market which includes the Republic of Ireland and Northern Ireland. The value of lost load, also known as the value of security of electricity supply, is inferred using a production function approach. Detailed electricity use data for the Republic of Ireland allows us to estimate the value of lost load by time of day, time of week and type of user. We find that the value of lost load is highest in the residential sector in both the Republic of Ireland and Northern Ireland. Our results can be used to advise policy decisions in the case of supply outages and to encourage optimum supply security. In the context of this study short term is taken to be a matter of hours rather than days or weeks.

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An Estimate of the Value of Lost Load for Ireland

1. Introduction

The value of lost load is the average willingness of electricity consumers to pay to avoid an additional period without power. In an efficient market, it should be equal to the wholesale peak price of electricity. The value of lost load would then affect decisions regarding investment in new generation capacity and closure of older, less efficient plants. Due to regulation in the Irish electricity market, customers cannot express their willingness to pay. Thus, the value of lost load has to be inferred.

It appears that peak and reserve capacity is undersupplied in Ireland (Lyons et al. 2007) and the possibility of supply shortages is real (Bazilian et al., 2006; Lyons et al., 2007; Malaguzzi Valeri and Tol, 2006), although the risk is smaller now due to the recession. As Ireland's electricity supply becomes increasingly variable, primarily because of the growing share of wind power in total power generation, capacity management and reward is extremely important. New forms of electricity demand, such as electric and hybrid vehicles, as well as increased interconnection will also lead to variability in demand and supply. An accurate and up to date assessment of the value of lost load is therefore essential to inform future planning.

This paper updates Tol (2007) which is the first and only published empirical estimate of the value of lost load for the Republic of Ireland. The main advantage of this paper is that access has now been provided to data on the time profile of electricity use per type of user in the Republic of Ireland. Whereas Tol (2007) assumed that the probability of a brown-out¹ is constant across consumer groups, we can now estimate which users would be hardest hit by such an event. We use this data to estimate the value of lost load in the Republic of Ireland between 2001 and 2008. We also estimate the value of lost load for Northern Ireland between 2000 and 2007. Thus, this paper constitutes a substantially refined estimate of the value of lost load in the all island market.

The value of lost load can be estimated in three ways. The first is that used by Beenstock et al. (1998) which relies on consumer surveys and is based on stated preferences. Since no Irish data of this kind exists, this method is unavailable to us.

¹ A brown-out is defined as a condition where the voltage supplied to the system falls below the specified operating range, but above zero volts. A black-out is a total loss of electrical power in a region.

Corwin and Miles (1978) estimated the value of lost load using cost estimates from previous supply outages. The underlying assumption is that the past and the future are similar, which is not appropriate for Ireland given the rapid economic and structural changes that have taken place. The third alternative, which is employed in this paper, is based on estimates of production functions. This approach relates electricity use to firm output, or in the case of households, the value of time spent on non paid work. Our methodology is discussed further in section 2.

In 2007 the regulatory authorities of the Single Electricity Market², the CER and NIAUR, set the value of lost load at €10/KWh based on the estimated peak price of planned electricity capacity (CER and NIAUR, 2007). The stated reasoning is rather unrealistic since it assumes that planned capacity will always equal desired capacity. The value has been re-estimated on an annual basis by using the previous year's value and adjusting it by applying the weighted average of the year-on-year increase in the Irish Harmonised Index of Consumer Prices (HICP) and the UK HICP.³ Using this method the value of lost load for 2010 is €10.27/KWh (CER and NIAUR, 2009).

The paper continues as follows. Section 2 presents the data and methods and Section 3 the results. Section 4 provides a discussion and Section 5 concludes.

2. Data and Methods

We follow the methodology of de Nooij et al. (2007), Tol (2007) and de Nooij et al. (2009) and estimate the value of lost load using the production function technique. The value of lost load can be derived by dividing Gross Value Added (GVA) (in €millions) in a specific sector by the amount of electricity (in GWh) used. This will give the value per KWh that this sector generates, roughly equal to the value that would be lost in the case of a brown-out.

For Northern Ireland, we assume that each sector's production function is linear and that companies are able to shift production within the year. Thus, the time at which the brown-out occurs is not important, but of course some production will be lost due to the brown-out. This assumption is a reasonable one for most activities. Another

² The Single Electricity Market is a joint electricity market between the Republic of Ireland and Northern Ireland.

³ The Irish HICP is given a weight of 2/3 and the UK HICP is given a weight of 1/3. Year on year increases are based on July estimates.

assumption is that the duration of the electricity outage does not matter. This is also reasonable as any brown-outs that could occur in Northern Ireland are likely to be for short periods. For households we define the value of lost load as the value of time spent on non paid work divided by electricity used. We assume that all activity stops when there is no electricity. Thus, an hour without electricity is an hour of time lost. This seems a generous assumption, but risk and annoyance are not taken into account. The value placed on time spent on non paid work varies with electricity use by time of day. Exelon (2007) shows that in the UK 44% of household electricity is used during the day, 35% in the evening, and 20% at night. For Northern Ireland we estimate the value of time spent at non paid work by day, evening and night for midweek days and weekend days.

Estimates of annual electricity use in Northern Ireland are taken from DECC (2008). NIAUR (2010) provides figures for household electricity use. However, estimates of electricity use in other sectors are not available. Instead, we allocate electricity use in these sectors using the appropriate UK and ROI shares. Thus, we have two estimates for the value of lost load in these sectors. GVA per sector data is taken from ONS (2009) and we convert these to constant prices (HM Treasury, 2010). Operating hours in the industrial and service sectors are taken from de Nooij et al. (2007). Estimates of the number of hours worked and average earnings are from the Annual Survey of Hours and Earnings (ASHE) 1999-2008 (ONS, 2010a). UK tax rates are taken from OECD (2009) while estimates of the number employed are taken from DETI (2010). Wages are adjusted for inflation using the Consumer Price Index for the UK (ONS, 2010b). The population of Northern Ireland is estimated by NISRA (2008).

With regard to the Republic of Ireland, ESBI (2009) has provided data on the electricity profiles of the residential, industrial and commercial sectors for each hour of 2001. We derive the proportion of electricity used by each sector at each hour and use it as a proxy for the proportion used by each sector in each hour in later years. Data on annual electricity use per sector are taken from SEAI (2009). For the industrial and commercial sectors, we estimate the annual average value of 1 KWh of electricity as before. Since we do not know the value added by the industrial and commercial sectors per day and hour, we cannot derive the value of lost load per time of day or year. However, we can estimate the total hourly value of electricity by multiplying the average value of 1 KWh of electricity by the amount of electricity used.

To evaluate lost load in the residential sector, we incorporate data from the 2005 Time Use in Ireland Survey (ESRI, 2005). Using this data we can assess the activities in which people are involved over two 24 hour periods; one midweek and the other weekend. For those who are not at home or at home but asleep, the cost of a brown-out is zero. For those who are working from home we assume that the opportunity cost of time spent on non paid work is equal to the average wage after tax. For those at home and neither working nor asleep, the opportunity cost of time spent on non paid work is equal to half of the average wage as in de Nooij et al. (2007) and Tol (2007). Thus, the opportunity cost varies throughout the day and between midweek and weekend days. As we have data on the profile of household electricity use, we can find hourly values of lost load by dividing the value of time spent on non paid work in that hour by the amount of electricity used.

Estimates of GVA per sector in constant prices are taken from CSO (2010). Population and labour force data are taken from GGDC (2010). Data on after tax non agricultural wages in constant prices⁴ are taken from the ESRI databank (Bergin and FitzGerald, 2009).

There are of course limitations associated with the use of production functions to estimate the value of lost load. One drawback is that additional assumptions are required such as rationality of economic agents and divisibility of goods and services. Also, production functions are usually estimated on an annual basis and thus may not be appropriate for estimating the impact of hourly electricity interruptions. We are unable to account for restart time in businesses after an outage or annoyance in households caused by a supply interruption.

3. Results

Figure 1 shows the value of lost load in Northern Ireland if power outages had occurred in 2007. The value of electricity to the industrial and commercial sectors varies depending on whether electricity use was allocated using ROI or NI shares. The use of ROI and UK shares result is a surprisingly similar value of lost load in the industrial sector. The value of lost load in the commercial sector varies depending on whether UK or ROI shares are used. This can be attributed to the higher share of

⁴ 2004=100

electricity use in the UK services sector relative to that of ROI. The value of lost load in the residential sector far outweighs that of the other sectors.

Figure 1. The Value of Lost Load in NI 2007

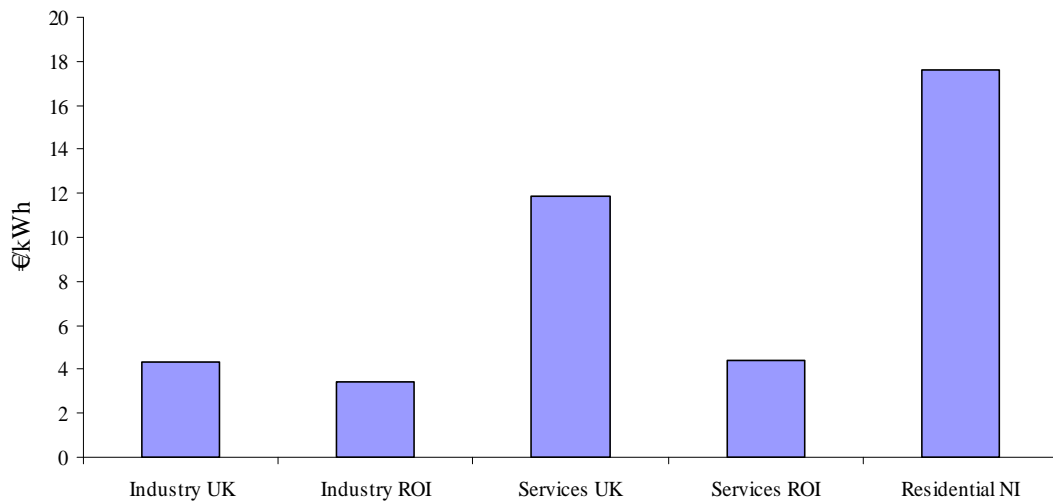
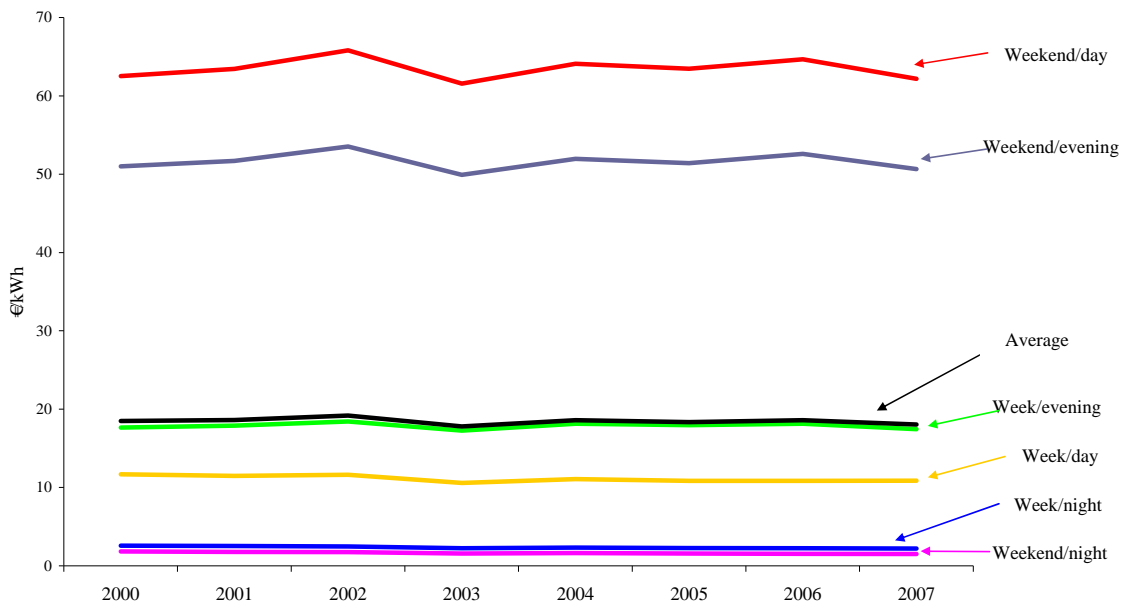


Figure 2 shows the value of lost load in Northern Ireland by time of day over the period 2000 to 2007.⁵ The value differs substantially between midweek and weekend days and by time of day. The value of lost electricity to industry is highest on midweek days between the hours of 8am and 6pm. For households, the value of electricity is highest at the weekends, especially during the day. Because the value of lost load is so much greater to households than it is to industry, we see that this pattern is repeated in the average results. As expected, the loss is lowest during the night both midweek and at the weekend.

⁵ We estimated these values using both ROI and NI electricity shares in the non residential sector and found that the results were very similar. This graph represents an average of the two results.

Figure 2. NI value of lost load by time of week and year (2000-2007)



With regard to the Republic of Ireland, the average value of lost load is highest in the residential sector. This happens because of the relatively high value which is placed on time spent at non paid work on both midweek and weekend days and evenings. The total value of hourly electricity is also much higher in the residential sector than it is in the industrial and commercial sectors. The total cost of a lost hour of electricity varies considerably by time of day, especially in the commercial and residential sectors.

Figure 3 shows the average value in 2008 of a lost hour to the industrial sector at different times of year. Note that figure 3 shows the value per hour rather than the value per KWh. The bars and lines represent midweek and weekend days respectively. The pattern is somewhat similar across seasons. The value of a lost hour is lowest between the hours of 16.00 and 18.00 in winter. This may be partly due to a lower demand for cooling at this time of year. The value of a lost hour is highest at 07.00 on midweek days all year round. At weekends, however, the value of a lost hour falls between 6am and 8am and between 3pm and 6pm. This pattern is repeated throughout the year. In general, the value of a lost hour is lower at weekends than it is midweek due to reduced activity on Saturdays and Sundays.

Figure 3. ROI Industry hourly value of electricity by season and time of week (2008)

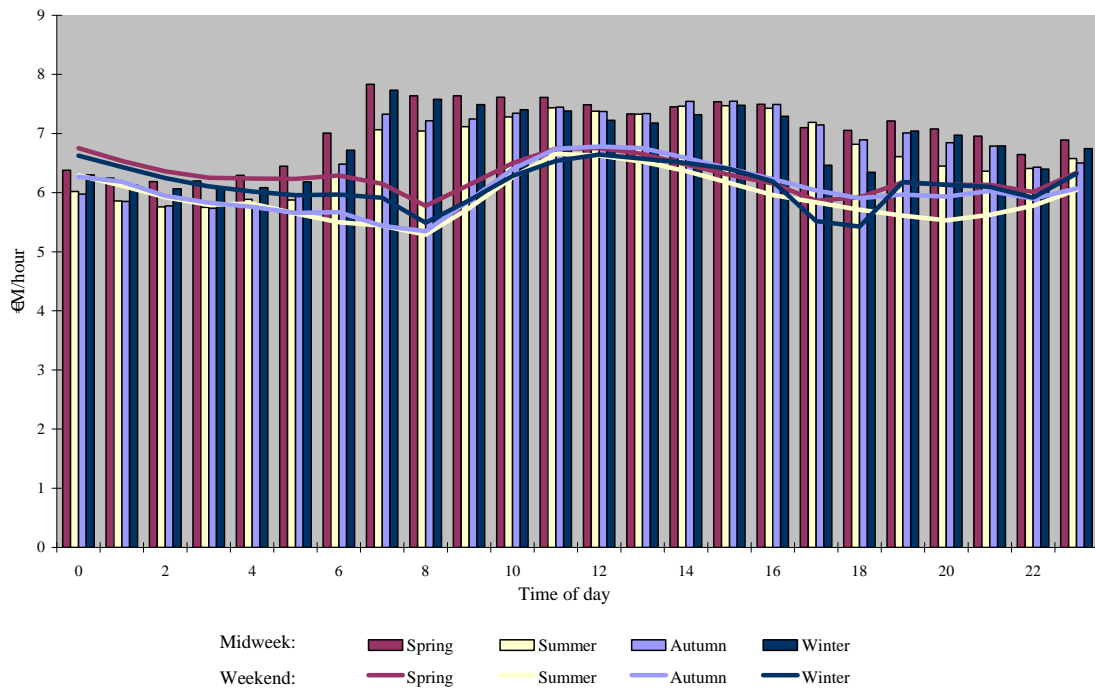


Figure 4 shows the average value in 2008 of a lost hour of electricity in the commercial sector at different times of year for midweek (represented by bars) and weekend (represented by lines) days. Again, figure 4 shows the value of electricity per hour rather than per KWh. Both midweek and weekend days follow a similar pattern. As expected, in each case, the loss is highest during standard business hours. The value can be as high as €17 million per hour. As the commercial sector represents all of the service industry and the public service, it is not surprising that the loss is lowest in summer when the demand for electricity is also low because of natural light.

Figure 4. ROI Commercial hourly value of electricity by season and time of week (2008)

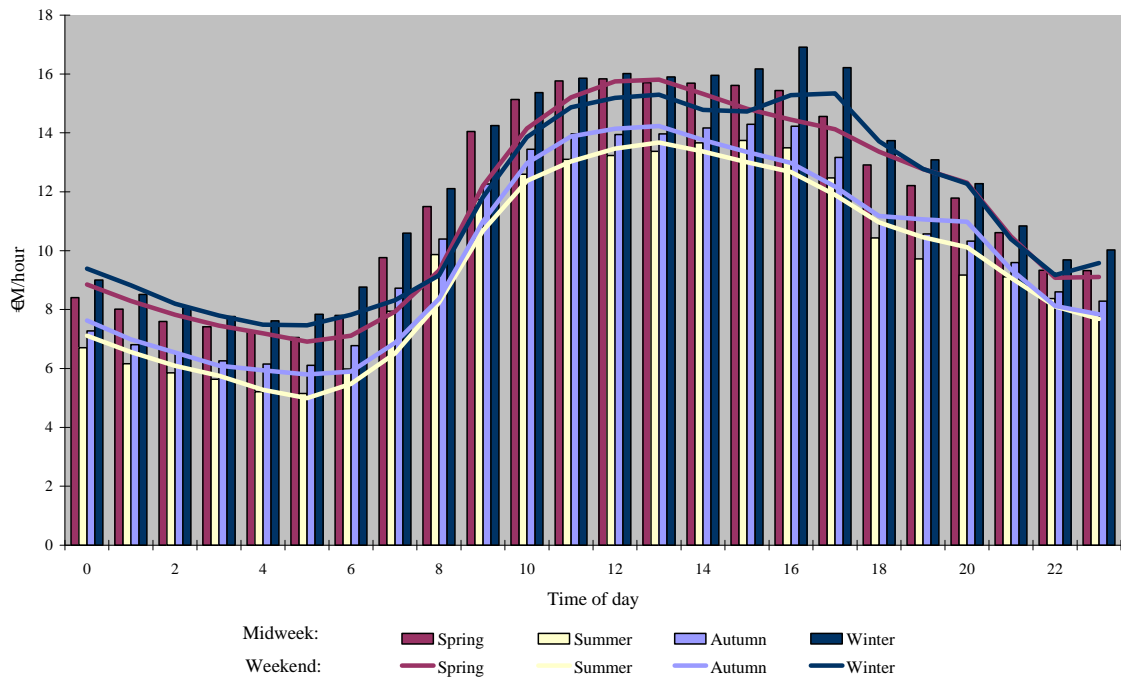


Figure 5 shows the value of a lost unit of electricity in households in 2008. Unlike figures 3 and 4, figure 5 shows the value of lost load. The bars, which represent midweek days, show that the value of lost load is low during the night and increases substantially between the hours of 5am and 7am. It then remains relatively steady until evening time, mainly driven by the fact that the value of time spent on non paid work is low and stable between 8-9am and 17-18pm when most people are at work. On midweek days, in the evening time, the value is highest in summer and lowest in winter. Although electricity use is highest in winter, electricity is valued in terms of time spent on non paid work and thus the amount people are willing to pay per unit of electricity falls.⁶ However, the hourly value of electricity will remain high in winter. The continuous lines represent the value of lost load at weekends. Again, the value is lowest during the night and increases between the hours of 5am and 8am. From midday onwards, the value varies by season. At 20.00 on weekend evenings in summer, the value of lost load reaches an average of €1/KWh when most people are at home but

⁶ Because the value of lost load is defined as loss of time spent on non paid work divided by electricity use, the overall value people are willing to pay for a lost unit of electricity will fall when electricity use, the denominator, increases.

not asleep. For the most part, the value of lost load on weekend days exceeds that of midweek days.

Figure 5. Household value of lost load by season and time of week in ROI (2008)

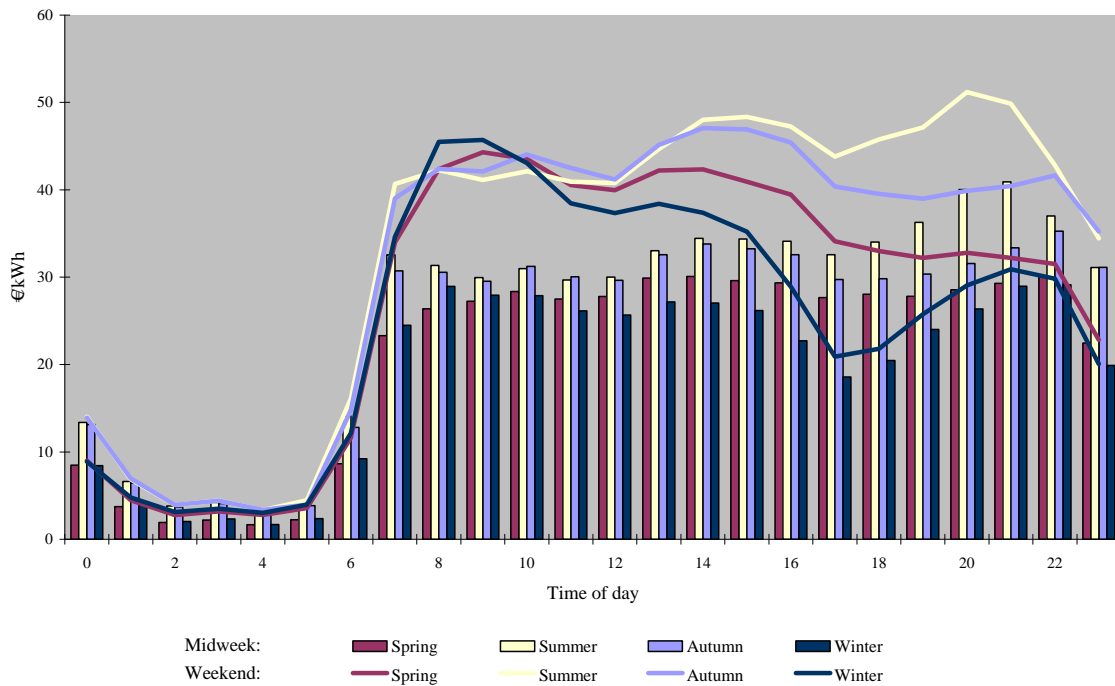
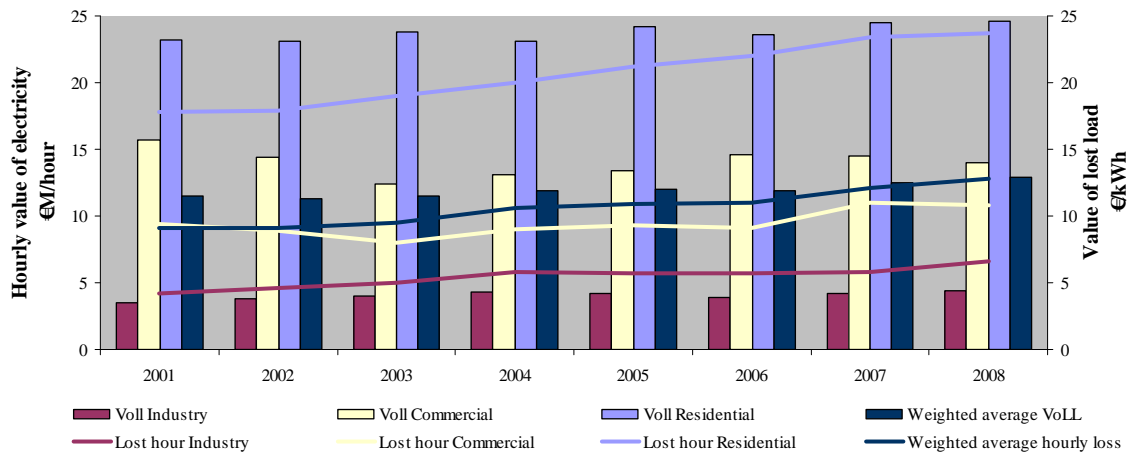


Figure 6 shows the evolution of the value of electricity over time for both the hourly value (€hr) and the value of lost load (€KWh). The total value of a lost hour of electricity to all three sectors (indicated by the lines on the chart) increased between 2001 and 2008. We estimate the cumulative annual growth rates in the value of a lost hour of electricity in the industrial, commercial and residential sectors as being 6.7%, 1.9% and 4.2% respectively. The bars (and secondary axis) on the chart show the average value of losing 1 KWh of electricity in each of the sectors. The residential values increased only slightly over the period (by 0.8%). This trend is largely due to the stabilisation of wage taxes and saturation of the employment ratio. The industrial value of lost load increased over the period as GVA outgrew electricity use in this sector, however, the commercial value decreased slightly.

Figure 6. Hourly value of electricity and value of lost load in ROI 2001-2008



4. Discussion

4.1. Current capacity regulations

On 1st November 2007 the trading of wholesale electricity in the Republic of Ireland and Northern Ireland began on an all-island basis. In this Single Electricity Market (SEM) all electricity generated in or imported into Ireland must be sold into a common pool and all electricity for consumption in Ireland or export to other countries must be purchased from the pool. The SEM replaces the old system in which a central planner would specify a level of capacity (for example, by estimating expected demand plus a reserve margin) thought sufficient to meet a defined standard for system reliability. The aim of the SEM is to allow market forces to ensure that adequate capacity is built in an efficient and timely manner. It is hoped that this will lower prices in the long run. The market operates on pool arrangements whereby all suppliers pay and generators receive the same System Marginal Price.⁷ Generators also receive capacity payments, which are based on annually determined fixed amounts and are ultimately paid for by consumers. The aim of such payments is to increase certainty of revenues, encourage investment and ensure that capacity is made available when it is required. The benefit for generators is that if they make plant available when capacity margins are tight, revenues can be earned which are greater than the short run costs. The level of payments is based on estimates of the tightness of the market and the cost of new

⁷ The system marginal price is determined by the bid price of the marginal dispatched plant and all dispatched plants receive this price. Dispatched plants are chosen on the basis that all plants are stacked according to their bid, from the cheapest to the most expensive. The cheapest plants that are needed to match demand in each half hour are dispatched.

peaking capacity. Since this system has been implemented availability of plants has increased slightly in the Republic of Ireland.

Current dispatchable capacity stands at approximately 7,000 MW. At times of high demand, surplus capacity is currently about 800MW (Eirgrid, 2009). However, forced outages among a small number of ageing generation units could sharply increase the risk of shortages if they were to coincide with peak winter demand (Malaguzzi Valeri and Tol, 2006). Continued increases in demand (although the recession resulted in decreased demand last year) and planned retirement of old plant have increased the need for investment in new plants over the coming years. According to the energy forecasts of SEAI (Walker et al., 2009), electricity demand is set to increase by 12% between 2008 and 2020.⁸ The growing importance of wind generation in the SEM suggests that the system will need more mid-merit and peaking capacity to help meet system reliability goals in future. Peaking plants can be switched on and off relatively easily due to the relatively high level of variable costs to fixed costs that they face. Thus, these plants can be used to meet fluctuating demand. Base load plants, on the other hand, face relatively high fixed costs to variable costs and so, it is most efficient to use them in a continuous way. Mid-merit plants generally produce electricity for several hours at a time but can be shut down and restarted on a daily basis.

4.2. The implications of using the estimated value of lost load

The value placed on lost load should be used to assist decisions regarding investment in new capacity and closure of older, less efficient plants in order to meet the desired supply security. Capacity management is increasingly important as electricity supply and demand become more variable. In Ireland, the growing share of wind power in total generation means that supply is already less predictable than it used to be. The expected growth in interconnection, electric and hybrid vehicles, and smart appliances will further complicate capacity management.

Our results show that the weighted average value of lost load in ROI is €12.9/KWh. This indicates that the €10/KWh set by CER & NIAUR is too low for short term loss of load (several hours). The average value of lost load in Northern Ireland in 2007 was

⁸ Despite forecasted decreases in demand between 2008 and 2012, the average annual growth rate for both electricity and total energy is estimated to be 0.9% between 2008 and 2020.

€4/KWh for the industrial sector, €3/KWh for the commercial sector and €18/KWh for the residential sector. In contrast, in the Republic of Ireland in 2008, the average value of lost load was around €4/KWh for the industrial sector, €4/KWh for the commercial sector and €24.6/KWh for households. The residential value is an average, brought down by the very low values which occur during the night. It can reach values over €60/KWh, usually at weekends when most people are at home. Between the hours of 18.00 and 21.00 on midweek days, when brown-outs are most likely, hourly values of electricity are at their highest; between €41 million and €45 million. In 2008, peak electricity demand occurred at 17.00 on 15th December. At this time, the average value of lost load was €5.2/KWh but it was even higher at €35/KWh between 08.00 and 09.00 that day. Thus, the peak value of lost load and peak electricity demand do not occur simultaneously. This opens some opportunities for peak shifting to minimise the damage of brown-outs.

The estimate for Northern Ireland suffers from a lack of detailed data on residential electricity use and time use. The average VoLL we have estimated for NI may be an overestimate, as the incorporation of detailed data on residential electricity use for the Republic of Ireland has resulted in a downward revision of the weighted average value of lost load compared to that estimated by Tol (2007).

At present, during a brown-out, it is policy to shut off electricity in residential areas first, and in industrial estates later. As the value of lost load is highest in the residential sector, in both Northern Ireland and in the Republic of Ireland (during the relevant hours), this policy may be reconsidered. However, the decision as to which sector will be subject to rationing should depend on the day and time at which the shortage occurs. During the hours of 1am and 6am the value of a lost hour of electricity in the industrial and commercial sectors is much higher than it is in the residential sector.

5. Conclusion

In this paper, we use a simple version of the production function approach to estimate the short term value of lost load in Northern Ireland for the period 2000-2007 and in the Republic of Ireland for the period 2001-2008.

These results come with a number of caveats. More detailed data on electricity use per type of user in Northern Ireland would enable us to deliver more accurate results. It would be good to test the validity of our results based on the production function

approach with estimates based on contingent valuation and contingent choice methods as well as with estimates based on observed black-outs. Our estimates are valid only for short interruptions of the power supply. Longer interruptions, while much more unlikely, may well be disproportionately damaging. All this is deferred to future research.

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References

Bazilian, M., O'Leary, F., O'Gallachoir, B., Howley, M., 2006. Security of Supply in Ireland. Sustainable Energy Ireland, Cork.

Beenstock, M., Goldin, E., Haitovsky, Y., 1998. Response Bias in a Conjoint Analysis of Power Outages. *Energy Economics*, 20, 135-156.

Bergin, A., FitzGerald, J., 2009. The ESRI Data Bank. Economic and Social Research Institute, Dublin.

CER and NIAUR, 2007. The Value of Lost Load, the Market Price Cap and the Market Price Floor -- A Response and Decision Paper. Commission for Electricity Regulation and Northern Ireland Authority for Utility Regulation, Dublin.

CER and NIAUR, 2009. The Value of Lost Load in 2010 Decision Paper. Commission for Electricity Regulation and Northern Ireland Authority for Utility Regulation, Dublin.

Corwin, J., Miles, W., 1978. Impact Assessment of the 1977 New York City Blackout. US Department of Energy, Washington, DC.

CSO, 2010. National Accounts. Central Statistics Office, <http://www.cso.ie/statistics/nationalacc.htm>.

de Nooij, M., Koopmans, C., Bijvoet, C., 2007. The value of supply security: The costs of power interruptions: Economic input for damage reduction and investment in networks. *Energy Economics*, 29, 277-295.

de Nooij, M., Lieshout, R., Koopmans, C., 2009. Optimal blackouts: Empirical results on reducing the social cost of electricity outages through efficient regional rationing. *Energy Economics*, 31, 342-347.

DECC, 2008. Sub National Electricity Figures. Department of Energy and Climate Change,
<http://www.decc.gov.uk/en/content/cms/statistics/publications/ecuk/ecuk.aspx>.

DETI, 2010. Employment Statistics. Department of Enterprise, Trade and Investment,
<http://www.detini.gov.uk/deti-stats-index/stats-labour-market/stats-labour-market-employment.htm>.

Eirgrid, 2009. Generation Adequacy Report 2010-2016. Eirgrid,
<http://www.eirgrid.com/media/Generation%20Adequacy%20Report%202010-2016.pdf>

Elexon, 2007. Load Profiles and their Use in Electricity Settlement. Elexon,
http://www.elexon.co.uk/documents/Participating_in_the_Market/Market_Guidance_-_Industry_Helpdesk_faqs/Load_Profiles.pdf.

ESBI, 2009. Electricity Profiles 2001. ESB International, www.esbi.ie.

ESRI, 2005. Irish National Time Use Survey 2005. Economic and Social Research Institute, www.esri.ie.

GGDC, 2010. Total Economy Database. Groningen Growth and Development Centre,
<http://www.ggdc.net>.

HM Treasury, 2010. GDP Deflators. Her Majesty's Treasury, http://www.hm-treasury.gov.uk/d/gdp_deflators.xls.

Lyons, S., Fitz Gerald, J., McCarthy, D., Malaguzzi Valeri, L., Tol, R.S.J., 2007. Preserving Electricity Market Efficiency while Closing Ireland's Capacity Gap. Quarterly Economic Commentary, Autumn, 62-82.

Malaguzzi Valeri, L., Tol, R.S.J., 2006. Electricity Shortages in Ireland: Probability and Consequences. Quarterly Economic Review, Winter, 1-7.

NIAUR, 2010. Electricity. The Northern Ireland Authority for Utility Regulation, <http://www.niaur.gov.uk/electricity>.

NISRA, 2008. Demography. Northern Ireland Statistics and Research Agency, [http://www.nisra.gov.uk/archive/demography/population/midyear/NI_Home_Pop_5yrbds\(1961-2008\).xls](http://www.nisra.gov.uk/archive/demography/population/midyear/NI_Home_Pop_5yrbds(1961-2008).xls).

OECD, 2009. Taxing Wages 2008. Organisation for Economic Co-operation and Development, Paris.

ONS, 2009. NUTS1 GVA (1989-2008) Data. Office for National Statistics, http://www.statistics.gov.uk/downloads/theme_economy/CRC2008ALL.pdf.

ONS, 2010a. ASHE Results. Office for National Statistics, <http://www.statistics.gov.uk/statBase/product.asp?vlnk=13101>.

ONS, 2010b. Consumer Price Indices. Office for National Statistics, <http://www.statistics.gov.uk/statbase/Product.asp?vlnk=868>

SEAI, 2009. Energy Balance Statistics, Sustainable Energy Authority of Ireland, <http://www.cso.ie/px/sei/database/SEI/Energy%20Balance%20Statistics/Energy%20Balance%20Statistics.asp>

Tol, R.S.J., 2007. The Value of Lost Load, in: O'Leary, F., Bazilian, M., Howley, M., O'Gallachoir, B. (Eds.), Security of Supply in Ireland 2007 Report, Sustainable Energy Ireland, Cork, pp. 63-66.

Walker, N., Scheer, J., Clancy, M., Ó Gallachóir, B., 2009. Energy Forecasts for Ireland to 2020. Sustainable Energy Ireland, Cork.

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