Modification P229 Introduction of a Seasonal Zonal Transmission Losses Scheme Cost-Benefit Analysis

Report Annex: Additional Modelling using Alternative Beta Values

Report Version 1.0

A report for

ELEXON

by

London Economics in association with Ventyx

www.londecon.co.uk

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Annex 1 Additional Modelling: Alternative Beta Scenario

A1.1 Introduction

London Economics and Ventyx have been asked by Elexon to respond to a request by their Modification Group to an "alternative" proposal to P229, which provided for seasonal and zonal TLFs. The alternative is in essence similar to P229, but the seasonal/zonal TLFs are "scaled down" by an alternative scaling factor, or beta, which is less than the uniform 0.5 scaling factor used in P229. This report forms an annex to the report on P229 with the results for the 'alternative' scaling factor run for the reference scenario.

Within this section we present the modelling assumptions underlying this 'alternative' scenario and the resulting effects of changing the beta factor, the alternative scaling factor defined by the 'alternative'. Overall the results are consistent with those found in the reference scenario, although due to the assumptions of the modelling, the results are typically of a smaller magnitude as might be expected.

A1.2 Modelling assumptions

Under this alternative beta scenario, seasonal zonal TLF scaling factors have replaced the fixed 0.5 scaling factors used in the reference scenario. Beta scaling factors have been calculated for the purpose of this alternative scenario. One should note that this affects only the change case, i.e., the base case for this scenario is the same as for the reference scenario.

The seasonal zonal TLF scaling factors are calculated based on a Beta (β) scaling factor. The Beta factor is a system-wide measure based on a specified formula relating variable loss energy to maximum and weighted-average TLF values. Hourly Beta factors are calculated from the prior market year, then averaged across the hours of each season to arrive at the seasonal system-wide TLF scaling factor.

The modelling technique and process of computing evolved TLFs through successive simulations of market years is the same for both the reference and this alternative beta scenario.

As defined in the *'P229 Alternative draft solution 0 4'* document, the formulae for calculating the Beta values are as follows:[1]

$$\beta^{+}_{j} = \text{Min}(1, a * VL_j / [\ \text{Max}(TLF) * \Sigma^{+}(QM) - \Sigma^{+}(TLF*QM)\ ]\ )$$

$$\beta^{-}_{j} = \text{Min}(1, (1-a) * VL_j / [\ \text{Min}(TLF) * \Sigma^{-}(QM) - \Sigma^{-}(TLF*QM)\ ]\ )$$

Where:

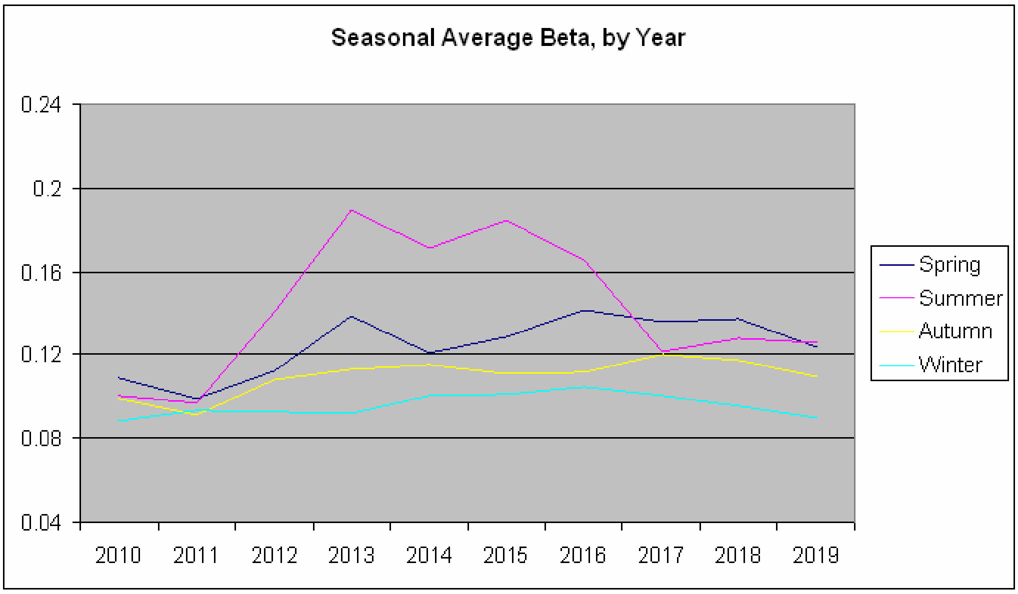
- a is the parameter (equal to 0.45) defined in Section T2.2.1(b) of the Code, which splits variable losses between generation and demand;
- VL_j is the level of Variable Losses in the Settlement Period;
- Max(TLF) and Min(TLF) are the maximum and minimum unscaled TLF values for any BM Unit in that period;
- $\Sigma+(QM)$ and $\Sigma-(QM)$ are the total metered volumes for BM Units in delivering and offtaking Trading Units respectively; and
- $\Sigma+(QM*TLF)$ and $\Sigma-(QM*TLF)$ are the sum of $QM_{ij}*TLF_{ij}$ over delivering and offtaking Trading Units respectively.

In modelling the system within the PROMOD simulation software, the formula components were available to calculate Beta on an hourly basis for the delivering and offtaking BM Units. Therefore, the betas used were the minimum betas across the β^{+}_{j} and β^{-}_{j} values in the settlement period.

A summary of the calculated beta values are presented in Figure A1-1. From this graph one can see the seasonal TLF scaling factors are anticipated in the range of 0.08 to 0.2, as compared to the fixed scaling factor of 0.5 in the reference scenario.

[1] It is noted that these values were first clarified with Elexon prior to implementation.

Figure A1-1: Beta Values - Alternative Beta Scenario



Source: LE/Ventyx

A1.3 Results from the Alternative Beta Scenario

A1.3.1 Overview of results

Table A1-1 shows the levels and differences for base and change case results[2] for the alternative scenario for major variables from the PROMOD modelling.

[2] The results are on a rolling 'full year' basis, i.e., 2011 is the full year starting in April according to the BSC calendar.

Table A1-1: Alternative Beta Scenario

	Reference Base	Reference Change	Change - Base	Change - Base	Reference Base	Reference Change	Change - Base	Change - Base
	Production Cost (Billion Pounds Sterling)	Production Cost (Billion Pounds Sterling)	Diff	% Diff	Transmission Losses (TWh)	Transmission Losses (TWh)	Diff (TWh)	% Diff
2011	6.97	6.97	-0.002	-0.04%	3.82	3.77	-0.05	-1.34%
2012	7.11	7.11	-0.003	-0.04%	3.73	3.64	-0.09	-2.32%
2013	7.38	7.38	-0.001	-0.02%	3.68	3.63	-0.05	-1.39%
2014	7.69	7.68	-0.001	-0.02%	3.63	3.56	-0.07	-1.93%
2015	8.38	8.38	-0.003	-0.03%	3.40	3.34	-0.06	-1.69%
2016	8.65	8.64	-0.001	-0.01%	3.50	3.47	-0.03	-0.85%
2017	8.98	8.98	-0.002	-0.02%	3.78	3.74	-0.05	-1.29%
2018	9.23	9.23	-0.004	-0.04%	3.84	3.76	-0.07	-1.91%
2019	9.70	9.70	-0.003	-0.03%	4.01	3.95	-0.07	-1.66%
2020	9.87	9.87	-0.003	-0.03%	4.13	4.07	-0.06	-1.46%

Source: LE/Ventyx

A1.3.2 Cost-Benefit Analysis

Table A1-2 presents the total benefits from the introduction of P229 for the alternative beta scenario.

The results of our analysis indicated that the total net benefit from the CBA for P229 under the alternative beta scenario was £76.0 million pounds (NOx and SOx included).

The figures are in constant 2009 GBP and the discount rate used is the real after tax WACC of 4.42%.

Table A1-2: CBA – Alternative Beta Scenario with NOx and SOx (£ millions)							
Year	**NOx Costs**	**SOx Costs**	**Production Cost Savings**	**Imp. Costs**	**Ongoing Costs**	**Annual Net-Cost Benefit**	**Discounted Net-Cost Benefit**
2011	£0.31	£1.31	£1.94	-£3.85	-£0.16	-£0.45	-£0.43
2012	£4.39	£7.68	£2.60	£0.00	-£0.16	£14.52	£13.29
2013	£3.11	£5.48	£1.97	£0.00	-£0.16	£10.41	£9.12
2014	£3.54	£7.13	£2.05	£0.00	-£0.16	£12.56	£10.53
2015	£3.98	£8.83	£1.32	£0.00	-£0.16	£13.97	£11.20
2016	£2.71	£4.24	£1.76	£0.00	-£0.16	£8.56	£6.57
2017	£2.25	£3.40	£2.04	£0.00	-£0.16	£7.53	£5.53
2018	£2.86	£4.54	£3.60	£0.00	-£0.16	£10.84	£7.61
2019	£1.98	£4.92	£2.66	£0.00	-£0.16	£9.40	£6.31
2020	£2.36	£5.12	£2.29	£0.00	-£0.16	£9.62	£6.18
Totals							**£75.90**
Discounted Demand Side-Benefits							**£0.09**
Total (including Discounted Demand-Side Benefits)							**£76.0**
Source: LE analysis of Ventyx Data							

Table A1-3 shows the total benefits from the introduction of P229 for the alternative beta scenario, excluding benefits associated with NOx and SOx.

The major benefits are from the production cost savings which are the results of the net reduction in losses and despatch costs. The results show a net benefit of £12.54 million.

The figures are in constant 2009 GBP and the discount rate used is the real after tax WACC of 4.42%.

Table A1-3: CBA – Alternative Beta Scenario without NOx and SOx (£ millions)					
Year	**Production Cost Savings**	**Imp. Costs**	**Ongoing Costs**	**Annual Net-Cost Benefit**	**Discounted Net-Cost Benefit**
2011	£1.94	-£3.85	-£0.16	-£2.07	-£1.98
2012	£2.60	£0.00	-£0.16	£2.44	£2.24
2013	£1.97	£0.00	-£0.16	£1.82	£1.59
2014	£2.05	£0.00	-£0.16	£1.89	£1.58
2015	£1.32	£0.00	-£0.16	£1.16	£0.93
2016	£1.76	£0.00	-£0.16	£1.60	£1.23
2017	£2.04	£0.00	-£0.16	£1.88	£1.38
2018	£3.60	£0.00	-£0.16	£3.44	£2.42
2019	£2.66	£0.00	-£0.16	£2.50	£1.68
2020	£2.29	£0.00	-£0.16	£2.14	£1.37
Totals					**£12.44**
Discounted Demand Side-Benefits					**£0.09**
Total (including Discounted Demand-Side Benefits)					**£12.54**
Source: LE analysis of Ventyx Data					

Thus, as one might expect given the reference scenario assumptions and results already studied, the results of the CBA for the alternative beta scenario indicate that there is a net benefit to the introduction to P229, vis-à-vis the alternative of leaving the system as it currently operates. This is true when one considers the impacts both including and excluding NOx and SOx. However, the impact of this alternative beta scenario is to reduce the overall size of the associated benefits, relative to the reference scenario.

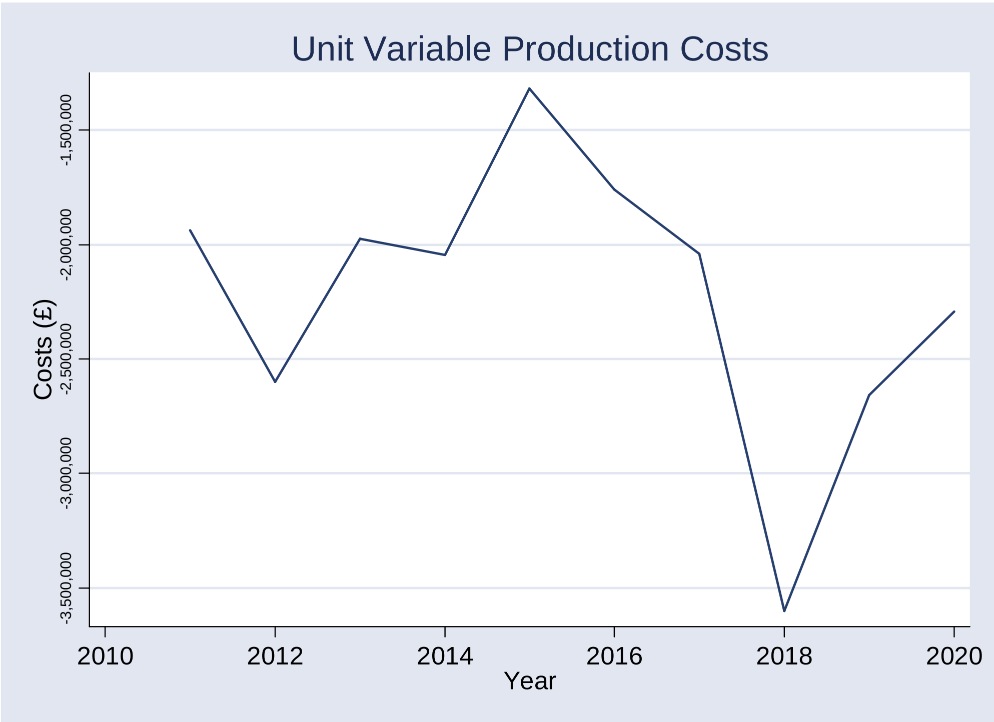
A1.3.3 Despatch costs

In the alternative beta scenario, one of the primary benefits of P229 derives from lower overall generation costs, as total system generation equals losses plus demand.

Figure A1-2 shows the difference between the base case (BAU) and the change case for total generation costs for the alternative beta scenario.

Firstly, one should note that relative to the base case of the alternative beta scenario there are significant savings in each year following the adoption of P229. Initially there is a substantial reduction in the first year, then the annual savings moderate over the period 2012-2014, they fall significantly in 2015, before once again starting to increase in the period to 2018. The largest savings are realised in 2018 before smoothing out of the series in 2019 and 2020 with average annual savings of approximately £2.5 million.

Figure A1-2: Unit Variable Production Costs – Alternative Beta Scenario

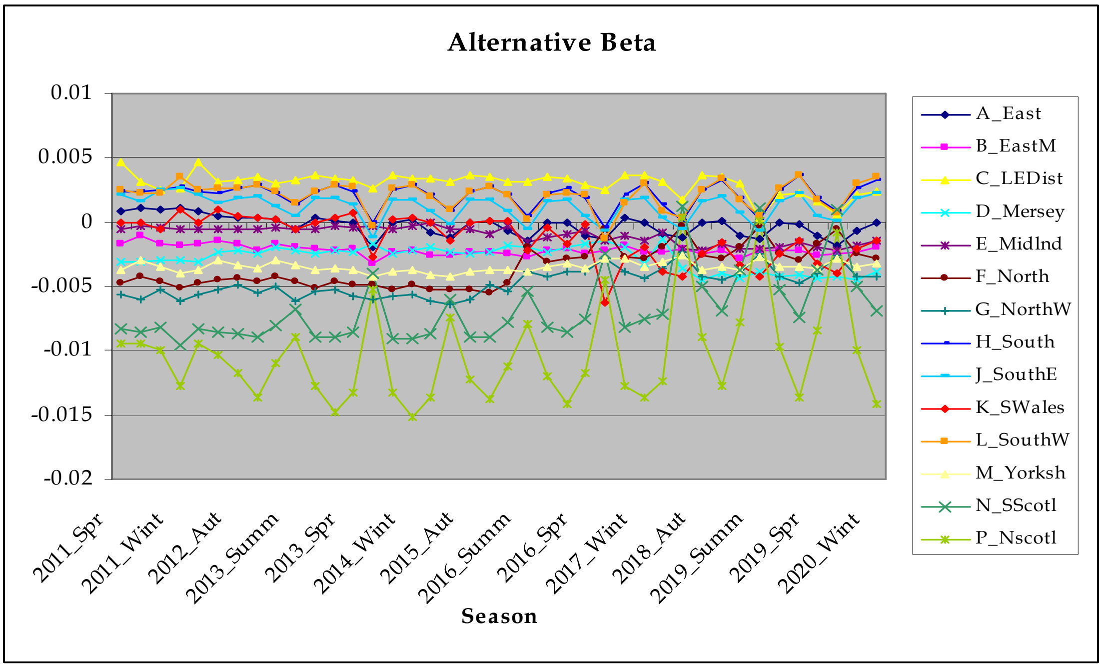


Source: LE/Ventyx

A1.3.4 Evolved TLFs

Figure A1-3 outlines the evolution of Beta adjusted TLFs, by zone, from the years 2011 to 2020 for the alternative beta scenario.

Figure A1-3: Alternative Beta Scenario



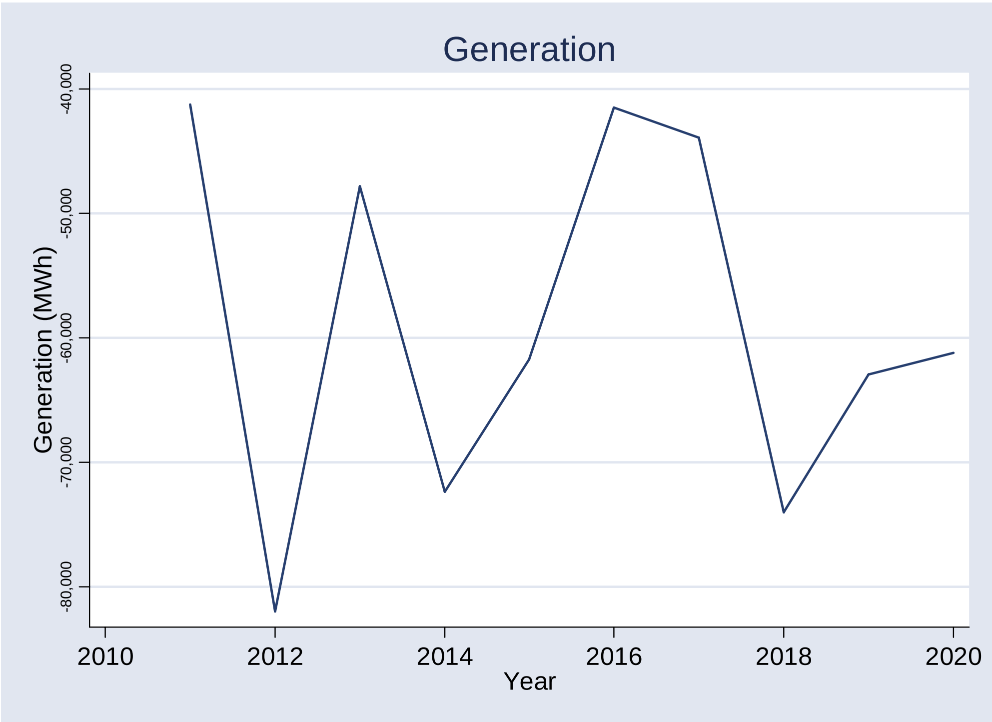
Source: LE/Ventyx

In general, the TLF values under this alternative beta scenario reflect the trends exhibited in the reference scenario. One of the noted differences is that the values are considerably smaller given the use of the beta scaling factor as opposed to a fixed factor of 0.5 (as in the reference scenario). Once again, most of the volatility within zones can be explained by changes between seasons for a given year and as before, the highest degree of volatility is observed in zones P and N.

A1.3.5 Generation

Figure A1-4 presents the impact on generation from the introduction of P229 as modelled by the differences in aggregate generation between the change case and the base case for generation for the alternative beta scenario.

Figure A1-4: Generation – Alternative Beta Scenario



Source: LE/Ventyx

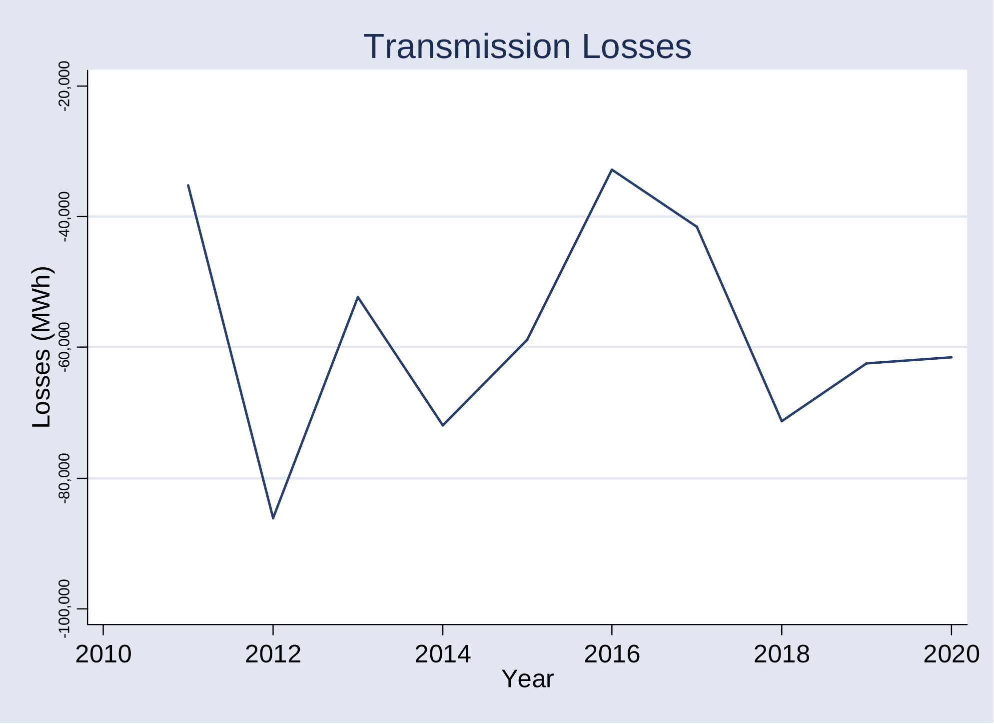
Under the alternative beta scenario, the introduction of P229 is expected to lead to a reduction in total generation in each year of the study. The trend exhibited by this graph is broadly similar to that in the reference scenario, although just as with the TLF values, the scale of the reductions are significantly less.

The trends in this graph correlate well with the trend exhibited in Figure A1-2 (unit variable production costs).

A1.3.6 Losses

Figure A1-5 charts the savings (change case minus base case) expected to accrue as a result of a reduction in transmission losses from the modelled introduction of P229 for the alternative beta scenario.

Figure A1-5: Transmission Losses – Alternative Beta Scenario



Source: LE/Ventyx

The results show that there are expected loss savings on an annual basis of varying degrees and equating to over 80GWh at the peak in 2012. Once again the trend is broadly similar to that exhibited in the modelling of the reference scenario; however, the scale of the reduction in losses is significantly smaller under this scenario.

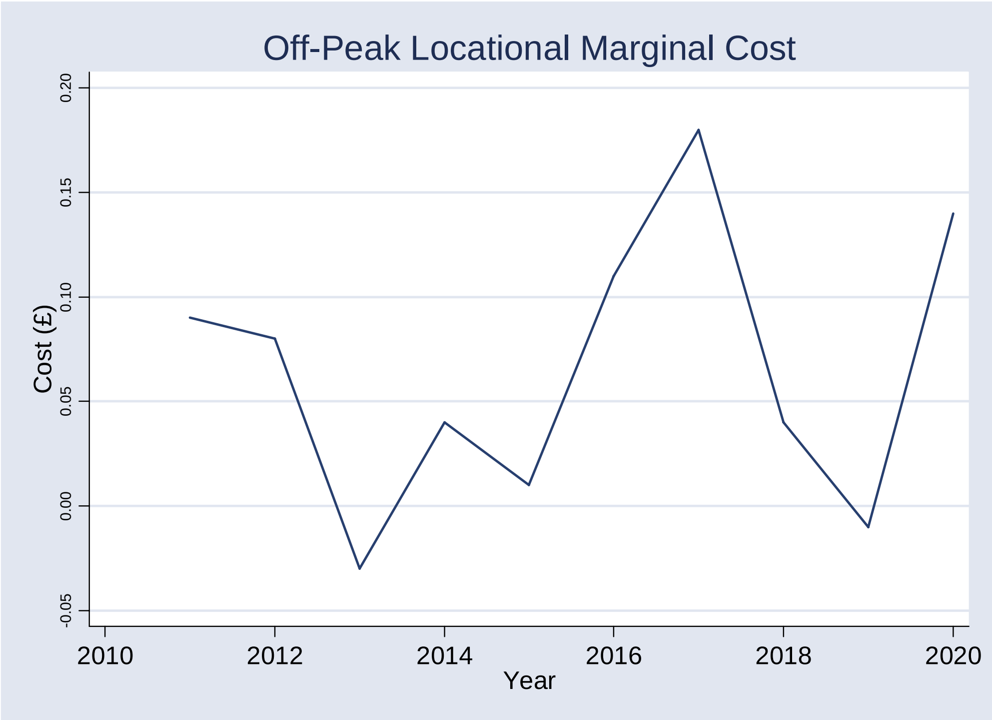
Similarly, the pattern of transmission losses largely mimics the pattern of production cost savings (and reduced generation), indicating that production cost savings are being driven by loss reductions.

A1.3.7 Wholesale prices

To show the pattern of wholesale price changes, we consider the average annual wholesale prices as measured by the locational marginal costs (LMPs) from PROMOD. The prices are the load weighted average LMPs by season.

The following two graphs present the results for peak and off-peak price periods (peak being set to 0800-2000 for Dec to March, 0600-2000 for June to Sept, and 0700-2000 for April, May, and Oct).

Figure A1-6: Off-Peak Locational Marginal Cost – Alternative Beta Scenario

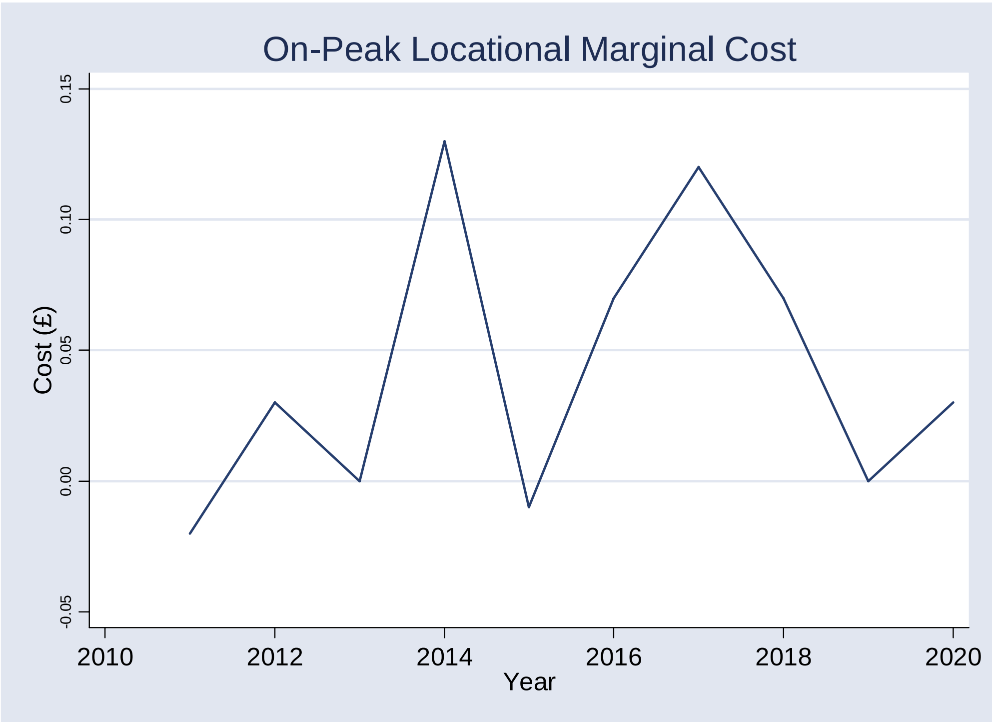


Source: LE/Ventyx

Figure A1-6 shows the difference between the competitive off-peak LMPs in the change case minus the base case for the alternative beta scenario. In general, the LMPs are higher under the change case, where the P229-alternative has been adopted.

The results show a modest increase in off-peak prices over the study period. The differences between scenarios fluctuate from a saving of approximately 2.5p in 2013 to an increase of 17.5p in 2017. Once again, the overall trends mimic those observed in relation to the reference scenario and as previously noted for other outcomes under this scenario, the relative magnitude of the changes are consistently smaller than those observed in the reference scenario.

Figure A1-7: On-Peak Locational Marginal Cost – Alternative Beta Scenario



Source: LE/Ventyx

Figure A1-7 presents the differentials between the competitive on-peak LMPs in the change case minus the base case for the high price scenario. The intuition is the same that, in general, the competitive LMPs are higher for the change case, although it is noted that there are some years where on-peak LMP is found to fall below the reference (base) case value, as with off-peak LMP. However in these years, as well as all other years, the differences are relatively small ranging from a saving of approximately 2p to an increase of approximately 13p.

A1.3.8 Distributional impacts in CBA from P229

Table A1-4 presents the distribution impacts and transfers, across zones, for the alternative beta scenario. The results indicate that there will be potential transfers for generators and suppliers in each of the regions. The magnitude of transfers in each region has been calculated from the 2011 system modelling data.

Table A1-4: Estimate of the distributional impacts and potential transfers – Alternative Beta Scenario

Zone	Demand (TWh)	Supplier TLM	Transfers (£m)	Generation (TWh)	Generator TLM	Transfers (£m)	Net Transfers (£m)
North Scotland	6	0.997	2.04	2	0.983	-0.72	1.32
South Scotland	20	0.999	5.71	35	0.985	-8.15	-2.44
North West	22	1.002	3.95	18	0.988	-2.05	1.89
Northern	16	1.003	2.25	8	0.989	-0.60	1.65
Yorkshire	22	1.004	2.05	51	0.990	-1.72	0.33
Merseyside	13	1.004	0.92	17	0.991	-0.22	0.70
East Midlands	24	1.006	0.51	62	0.992	2.32	2.83
Midlands	26	1.007	-0.63	8	0.993	0.64	0.00
South Wales	11	1.007	-0.45	18	0.994	1.85	1.40
Eastern	30	1.008	-2.28	12	0.994	1.58	-0.70
South East	18	1.009	-2.26	17	0.996	3.15	0.89
South West	16	1.010	-2.15	14	0.996	2.80	0.65
Southern	33	1.010	-4.61	5	0.996	1.08	-3.52
London	29	1.011	-5.04	0	0.997	0.04	-5.01

Source: LE/Ventyx

On the demand side (suppliers), the results estimate that suppliers/consumers in Scotland and Northern England may receive benefits of approximately £16 million.

On the generation side, generators in Scotland and the North of England are estimated to lose approximately £13.2 million while southern generators are expected to benefit by a similar amount.

In addition to the transfer analysis, we present results in the change in generation predicted by zone for this scenario in Table A1-5. This is the difference between the base generation level in the reference scenario (i.e. the base case for the alternative beta scenario) and the change generation in the alternative beta scenario.[3] As the results of the distributional analysis indicate, zones in the North of GB are expected to lose generation while zones in the South are expected to produce more. This result reflects that observed for the reference scenario, although again the magnitude of the difference is reduced under this scenario.

Table A1-5: Change in Generation by Zone, Alternative Beta Scenario (GWh)

Zone	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Eastern	46	150	54	114	120	116	306	297	-139	2
East Midlands	46	79	-97	-375	-86	165	479	401	533	563
London	26	24	59	40	52	59	104	110	99	103
Merseyside	-35	-21	-138	58	106	-161	-128	-474	-501	-489
Midlands	0	-11	-23	2	-3	9	18	-190	-43	-18
Northern	0	-14	3	0	0	0	-200	-204	-97	-132
North West	0	0	0	0	0	0	0	0	0	0
Southern	327	425	616	606	480	536	471	477	340	339
South East	45	161	43	41	-61	-216	-148	-110	50	63
South Wales	-65	-81	-137	-201	-265	-99	-381	-182	-340	-339
South West	115	940	598	687	730	633	341	595	719	524
Yorkshire	-496	-764	-633	-446	-600	-725	-489	-737	-510	-642
South Scotland	-32	-947	-340	-563	-495	-338	-354	-15	-112	-5
North Scotland	-20	-24	-54	-35	-40	-21	-62	-42	-62	-30

Source: LE analysis of Ventyx Data

[3] Importantly, the change in generation for all scenarios measures the difference between change and base generation within each scenario. Unlike all other scenarios considered, the base generation for this scenario is also the base level generation for the reference case, therefore it is possible to compare the impact of P229 with a fixed factor and alternative beta factor adjustment to the TLFs. For all other scenarios, the analysis of the difference is only within scenario, and not relevant for extensions to comparison with the reference scenario.

A1.3.9 Impacts on the transmission system

The data presented in Table A1-6 presents the annual percentage differences in total line flows between the base case and the change case for the alternative beta scenario. The data outline the percentage changes in total line flows, across time, for three different voltage levels.

Table A1-6: Alternative Beta - (%) Change Annual Line Flows

Voltage (KV)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
132	-0.04%	0.24%	-0.07%	-0.08%	-0.11%	-0.02%	-0.12%	-0.13%	-0.09%	-0.07%	-0.09%
275	-0.34%	-0.86%	-0.23%	-0.27%	-0.33%	-0.11%	-0.33%	-0.70%	-0.59%	-0.70%	-1.07%
400	-1.01%	-2.02%	-1.39%	-1.65%	-1.65%	-1.44%	-1.22%	-2.02%	-1.75%	-1.69%	-2.77%

Source: LE/Ventyx

In each year and for each voltage type, the model is predicting small but significant reductions in line flows. This is consistent with the aggregate effect of P229, which is to reduce overall line losses.

In addition, the pattern of flow reductions is higher on the higher voltage lines. This is as expected, since typically the higher voltage lines would be the lines transporting power over long distances. This also confirms the conclusion that P229 is predicted to have little impact on 132kV lines and connected users. (Note: 2011 and 2021 are partial calendar years).

Once again it is noted that these results are consistent with the reference scenario, although smaller in magnitude.

A1.3.10 Congestion

Table A1-7 outlines the annual number of hours with congestion in the base case and the change case and the differences between the two cases for the years 2011 to 2020, under the alternative beta scenario.

Table A1-7: Annual hours with congestion – Alternative Beta

Year	Base	Change	Diff	Diff (%)
2011	261	249	-12	-4.60%
2012	737	796	59	8.01%
2013	839	807	-32	-3.81%
2014	1,207	1,151	-56	-4.64%
2015	1,546	1,548	2	0.13%
2016	2,257	2,211	-46	-2.04%
2017	296	284	-12	-4.05%
2018	198	202	4	2.02%
2019	338	343	5	1.48%
2020	387	386	-1	-0.26%

Source: LE/Ventyx

In terms of total number of hours, both the base and change case follow a similar pattern; rising steadily until 2016, falling significantly in 2017 and beginning to rise again in 2019. In approximately half of the years contained in the study, a reduction in the number of hours of congestion is anticipated, although the difference in the number of hours in each year is relatively small.

A1.3.11 Impact on demand

The demand side impacts arising from the adoption of P229 under this alternative beta scenario, relative to the base case, is estimated to be just £0.09m.

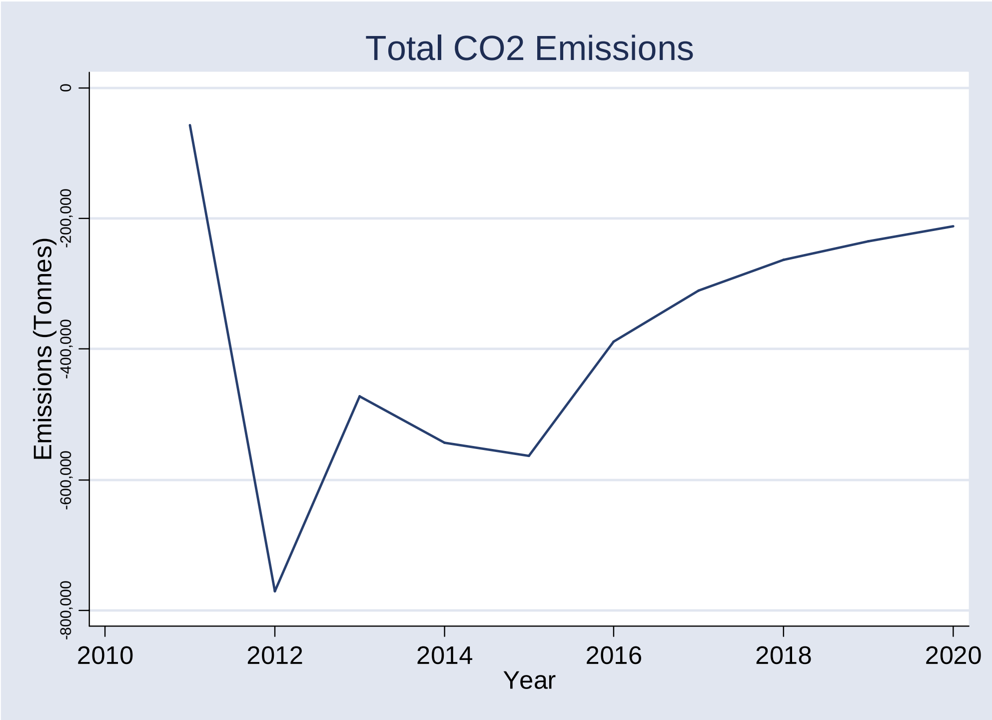
A1.3.12 Environmental impacts emissions

The environmental impacts are assumed to be primarily made up of CO_2 emissions changes, and SOx and NOx emissions changes. There may be other emissions such as mercury, soot, ash, and particulates, but these have not been modelled.

A1.3.13 CO_2 emissions

Figure A1-8 presents the total change in tonnes of CO_2 emissions from the modelled alternative beta scenario; the results are again the change case minus the base case.

Figure A1-8: Total CO_2 Emissions – Alternative Beta Scenario



Source: LE/Ventyx

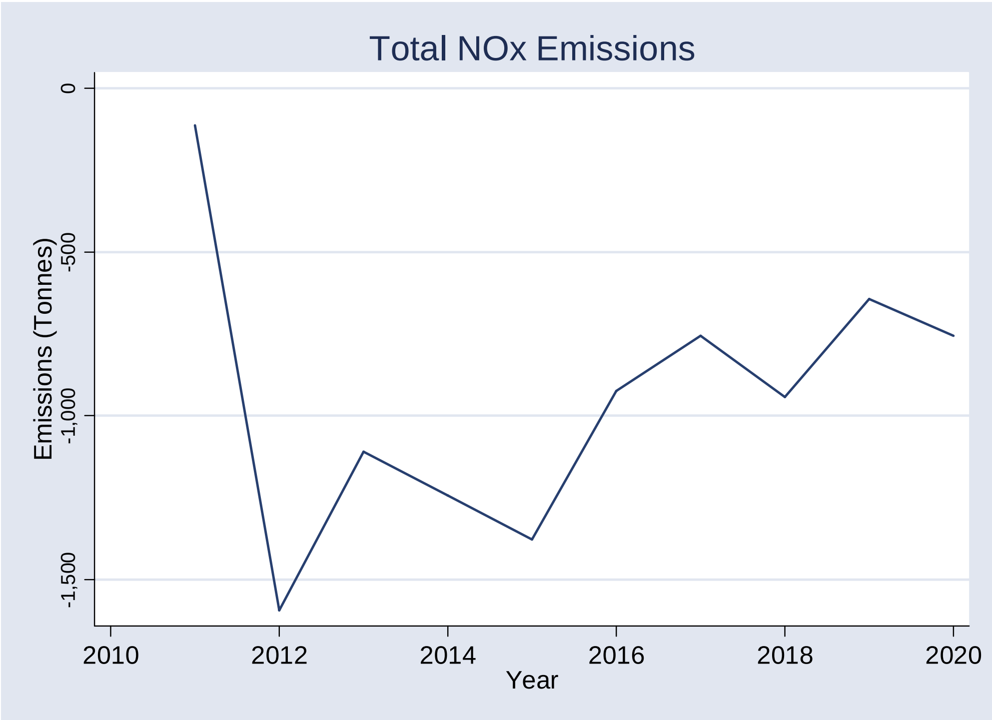
The results indicate a reduction in CO_2 emissions in each year of the study, following the introduction of P229, relative to the base case. The trend of the reductions mimic those of the reference scenario, however, the magnitude of the reductions are smaller. This is consistent with all of the results considered so far for the alternative beta scenario, relative to the reference scenario.

A1.3.14 SOx and NOx emissions

Emissions for sulphur and nitrogen oxides (SOx and NOx) form some of the most important emissions from the production of electric power, the primary damage from these emissions being acid rain.

Figure A1-9 presents the change case minus the base case for NOx Emissions in tonnes, under the alternative beta scenario.

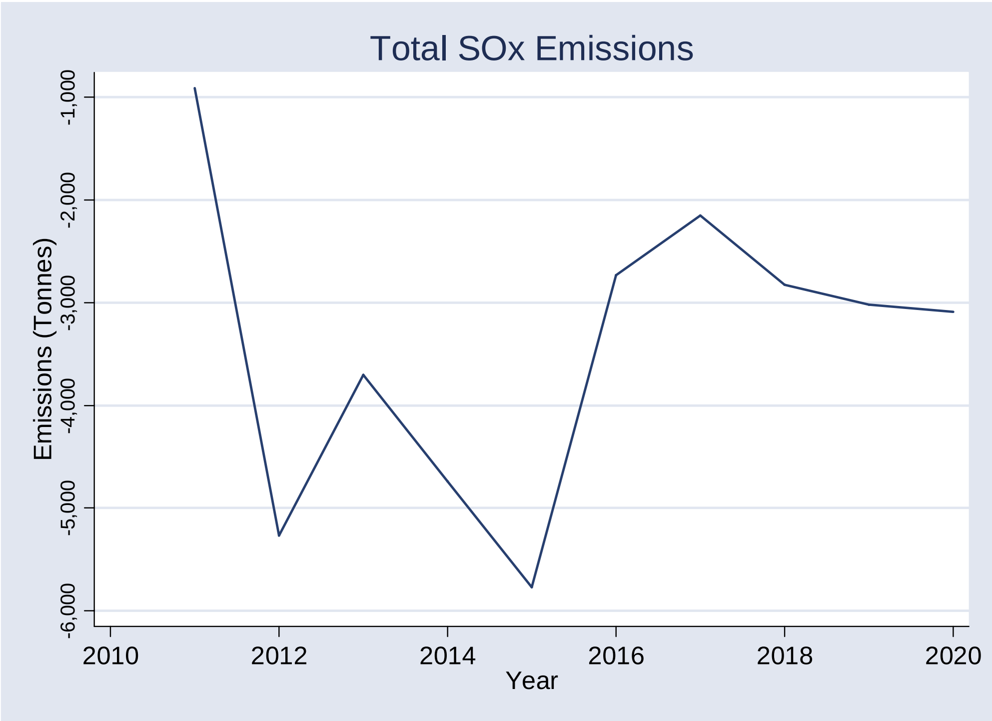
Figure A1-9: Total NOx Emissions – Alternative Beta Scenario



Source: LE/Ventyx

The results of this analysis indicate that the adoption of P229 is anticipated to reduce the annual level of NOx emissions vis-à-vis maintenance of the status quo. This result is consistent with the results found up to this point for the alternative beta scenario. The trends of the overall results are broadly consistent with that of the reference scenario, although the magnitude of the effects is smaller. This summary discussion is similarly relevant for SOx emissions, the results of which can be seen in Figure A1-10.

Figure A1-10: Total SOx Emissions – Alternative Beta Scenario



Source: LE/Ventyx

A1.4 Conclusions

Given the changes made to the beta factors under this scenario, seasonal zonal TLF scaling factors were found to be in the range of 0.08 to 0.2, as compared to the fixed scaling factor of 0.5 for the reference scenario. The smaller effective TLFs resulting from the seasonal zonal TLF scaling factors amount to weaker signals for re-despatch in the modelling to respond to the approximated marginal system loss impacts. The effect of this is the imposition of reductions on the benefits that can be gained through reducing those losses.

Therefore, as one might expect, the results for this scenario were smaller overall savings in system cost and smaller reduction in system losses and smaller emissions reductions, resulting in smaller net benefits.

Naturally, as there was a trade-off between benefits and distributive impacts, the alternative scenario implies that the net impacts on demand and the net impacts on individual suppliers or generators will also be reduced. The weighing of the balance between efficiency and distribution still exists, but the alternative scenario provides an additional 'option' to the menu of approaches, one where less efficiency is predicted but less redistribution is predicted as well. Overall, the size of the tradeoffs are similar and, very broadly, are proportional with the size of the beta reductions.

Annex 2 Comparison of Results

Table A2.1: Overview of P229 Impacts

		Year									
	Scenario	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Generation (GWh)	**Reference**	-210	-307	-205	-214	-197	-134	-138	-217	-252	-282
	High Gas	-151	-219	-214	-217	-194	-118	-155	-215	-333	-381
	Low Gas	-71	-104	-72	-112	-89	-64	-25	-69	-86	-102
	Wind	-227	-312	-207	-226	-192	-134	-147	-217	-261	-277
	Volatility	-173	-330	-151	-162	-205	-97	-94	-172	-141	-243
	Nuclear	-210	-307	-205	-214	-197	-132	-86	-95	-111	-179
	Alt Beta	-41	-82	-48	-72	-62	-42	-44	-74	-63	-61
Transmission Losses (GWh)	**Reference**	-203	-308	-202	-212	-195	-121	-133	-211	-245	-282
	High Gas	-157	-226	-214	-217	-194	-119	-156	-217	-329	-378
	Low Gas	-69	-101	-88	-111	-89	-61	-24	-72	-85	-103
	Wind	-220	-313	-202	-223	-183	-118	-141	-221	-264	-276
	Volatility	-175	-328	-147	-165	-201	-89	-92	-172	-136	-244
	Nuclear	-203	-308	-202	-212	-195	-120	-87	-93	-103	-159
	Alt Beta	-35	-86	-52	-72	-59	-33	-42	-71	-62	-61
Production Cost Savings (£million)	**Reference**	6.87	7.09	6.4	5	3.72	4.82	3.63	8.98	8.49	10.63
	High Gas	7.87	13.26	10.82	9	5.12	5.53	12.16	18.3	20.31	34.59
	Low Gas	2.31	2.15	-1.03	1.01	0.2	0.87	-0.18	2.21	2.77	1.53
	Wind	7.41	7.32	6.75	6.88	5.3	4.55	4.45	8.59	10.63	11.54
	Volatility	7.93	7.83	2.6	7.37	1.97	0.74	3.25	14.21	1.48	19.75
	Nuclear	6.87	7.09	6.4	5	3.72	4.75	1.97	2.74	5.94	10.62
	Alt Beta	-1.94	-2.60	-1.97	-2.05	-1.32	-1.76	-2.04	-3.60	-2.66	-2.29
NOx Reduction (kt)	**Reference**	1.65	6.95	3.87	3.34	4.27	2.79	3.04	2.42	2.6	2.84
	High Gas	-0.99	-2.94	-2.36	-2.32	-2.58	-0.72	-1.5	-1.99	-1.59	-3.53
	Low Gas	0.7	2.24	-0.49	-0.21	0.07	1.77	3.44	4.91	3.58	2.73
	Wind	1.8	7	3.67	2.96	3.73	2.68	2.79	2.69	2.17	2.2
	Volatility	-0.78	7.54	3.22	-0.21	6.02	3.66	0.07	-2.19	4.58	-1.46
	Nuclear	1.65	6.95	3.87	3.34	4.27	2.79	3.2	2.18	-0.1	2.01
	Alt Beta	0.11	1.59	1.11	1.24	1.38	0.92	0.76	0.94	0.64	0.76

	Scenario	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
SOx Reduction (kt)	**Reference**	7.41	25.86	11.79	12.73	17.13	10.23	8.5	9.69	10.74	8.4
	High Gas	-2.13	-4.73	-4.34	-5.35	-5.54	-3.3	-6.05	-6.56	-7.03	-15.44
	Low Gas	3.2	8.78	-2.49	0.22	-0.84	3.4	0.56	3.96	4	2.29
	Wind	8.1	26.07	11.58	11.31	14.75	8.99	7.37	11.11	8.23	5.53
	Volatility	-2.14	28.11	12.71	-1.11	17.05	11.14	-2.78	-7.91	12.61	-7.36
	Nuclear	7.41	25.86	11.79	12.73	17.13	10.28	9.79	5.94	-5.36	-8.27
	Alt Beta	0.91	5.27	3.70	4.74	5.77	2.73	2.15	2.83	3.02	3.09
CO_2 Reduction (kt)	**Reference**	885	3,257	1,511	1,458	1,848	1,153	1,205	782	948	818
	High Gas	67	-25	22	13	22	32	-151	-426	-301	-1,043
	Low Gas	590	1,071	208	321	258	479	787	845	624	470
	Wind	967	3,254	1,426	1,350	1,619	1,058	1,090	907	808	635
	Volatility	158	3,531	1,622	58	3,046	1,536	-219	-578	1,784	-556
	Nuclear	885	3,257	1,511	1,458	1,848	1,149	1,310	601	-347	-295
	Alt Beta	57	770	473	543	564	388	311	264	235	212
Off Peak LMP (£)	**Reference**	0.18	0.38	0.06	0.15	0.15	0.29	0.4	0.39	0.19	0.51
	High Gas	0	0.2	0.12	0.3	0.16	0.33	0.44	0.74	0.58	1.38
	Low Gas	0.21	0.12	0.03	0.18	0.15	0.22	0.21	0.17	0.25	0.22
	Wind	0.19	0.45	0.07	0.03	0.27	0.27	0.37	0.26	0.24	0.68
	Volatility	0.28	0.37	0.23	0.45	0.09	0.18	0.37	0.65	0.1	0.82
	Nuclear	0.18	0.38	0.06	0.15	0.15	0.28	0.19	0.3	0.54	0.81
	Alt Beta	0.09	0.08	-0.03	0.04	0.01	0.11	0.18	0.04	-0.01	0.14
On Peak LMP (£)	**Reference**	0.07	-0.03	0.38	0.26	0.34	0.44	0.23	0.27	0.25	0.24
	High Gas	0.09	0.4	0.08	-0.02	-0.01	-0.02	0.31	0.2	0.16	-0.14
	Low Gas	0.2	0.23	0.23	0.31	0.14	0.18	0.47	0.42	0.55	0.15
	Wind	0.1	0.05	0.33	0.36	0.33	0.3	0.23	0.35	0.39	0.12
	Volatility	-0.03	0.01	0.33	0.49	0.42	0.29	0.26	0.31	0.44	0.2
	Nuclear	0.07	-0.03	0.38	0.26	0.34	0.43	0.29	0.19	0.33	-0.01
	Alt Beta	-0.02	0.03	0.00	0.13	-0.01	0.07	0.12	0.07	0.00	0.03

Source: LE/Ventyx