DS3 System Services Enduring Tariffs Consultation Curtailment & SNSP Analysis

Provided to
Element Power

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MullanGrid CONSULTING

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1. Context

- As part of EirGrid's consultation on DS3 System Services Enduring Tariffs they undertook a wind curtailment analysis in order to estimate the percentage of time when the All-Island electricity system would be operated above both 60% and 70% SNSP in 2019/20.
- Outlined as follows are EirGrid's results from this analysis:

Scenario	Curtailment	% Time above 60% SNSP	% Time above 70% SNSP
2019/20 Enhanced, Base	2.0%	15.2%	7.5%
2019/20 Enhanced, Low Wind	0.9%	7.9%	3.0%
2019/20 Enhanced, High Wind	5.8%	22.2%	14.6%
2019/20 Enhanced, High Export	2.0%	14.9%	7.5%
2019/20 Enhanced, High Import	2.0%	29.0%	12.7%
2019/20 New Providers, Base	2.0%	15.1%	7.4%
2019/20 New Providers, Low Wind	0.9%	7.8%	3.0%
2019/20 New Providers, High Wind	5.8%	22.3%	14.5%
2019/20 New Providers, High Export	2.0%	14.8%	7.4%
2019/20 New Providers, High Import	2.0%	28.7%	12.5%

Source: Figure 7 & Table 6 from EirGrid's DS3 System Services Endurring Tariffs Consultation document (4th July 2017)

- In order to assist Element Power in responding to this consultation, MullanGrid undertook a review of EirGrid's analysis, and assessed some alternative sensitivity scenarios.

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2. Review of EirGrid Base Case Analysis

- Following a review of the consultation paper coupled with some interactions with EirGrid, outlined as follows are the key input assumptions applied by EirGrid in their base case curtailment analysis:
  - 5,350MW installed wind
  - 31% capacity factor wind profile
  - SNSP Limit: 75%
  - Minimum Generation: minimum of 5nr must run high inertia conventional plants all-island are online
  - Other assumptions including demand, and other generation capacities obtained from EirGrid's All-Island Generation Capacity Statement 2017 – 2025
  - Detailed information on EirGrid's assumptions regarding interconnection was not provided in the consultation document and could not be subsequently obtained from EirGrid
- Outlined as follows are MullanGrid's observations on some of EirGrid's base case input assumptions outlined above:
  - There is the potential for up to c.300MW more installed wind in 2020 than assumed by EirGrid
  - As acknowledged by EirGrid in the consultation paper, "there could be unforeseen operational risks encountered which may force the TSOs to review the planned SNSP limit increase timeline." Another example are the current discussions on ROCOF with regards to small scale generation in Northern Ireland, which could also impact on SNSP limit increases. Any delays to the planned SNSP limit increases from the current limit of 60%, will have an impact on DS3 system services tariffs above 60% and 70% SNSP.
  - EirGrid's current System Stability rules dictate there must be at least 8nr. must run high inertia conventional plants online, consisting of 5 plants in ROI and 3 plants in NI. It is expected that when the new 400kV North-South Interconnector is in place, only 2 plants will need to be online in NI, while recent curtailment analysis by the System Operator suggests only 4 plants may be required in ROI in the future. On this basis, it's considered very optimistic that there will only be a requirement for 5nr. high inertia plants on the all-island system by 2020.
- Taking account of the observations above, coupled with the fact that EirGrid's 2020 base case curtailment estimate of 2% is less than their most recent estimate of 3% to 5%, it is considered that EirGrid's base case scenario should be viewed as a "best case" scenario, and therefore review their base case assumptions.

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3. Review of Minimum Generation Levels During Curtailment Events

Must Run Plant		MEC (MW)	Min Gen Level (MW)	Avg Generation Level During Curtailment Events (MW)		
				2016	2015	2012-14
Republic of Ireland	Dublin Bay	415	203	252	248	273
	Huntstown 2*	412	121	158	176	179
	Huntstown 1*	344	120	191	195	176
	Poolbeg A	230	120	129	236	233
	Poolbeg B	230	120	121		
	Tynagh**	384	220	224	199	198
	Moneypoint 1	285	99	105	117	125
	Moneypoint 2	285	99	119	118	126
	Moneypoint 3	285	99	121	120	120
	Aghada 1	258	112	0	0	0
	Aghada 2 (Longpoint)	431	216	225	218	216
	Tarbert 3	241	35	0	35	0
	Tarbert 4	243	35	14	0	0
	Whitegate (Glanagow)	442	180	221	187	188
	Great Island***	464	203	255	257	0
	Edenderry	118	41	74	75	74
	Lough Ree	91	71	76	79	65
	West Offaly****	137	77	96	101	83
	Sealrock 1	80	40	76	74	76
	Sealrock 2	81	40	78	75	76
Northern Ireland	Ballylumford B4	170	54	31	0	0
	Ballylumford B5	170	54	33	0	0
	Ballylumford B6	170	54	0	54	54
	Ballylumford B10	101	63	60	64	65
	Ballylumford B31	247	113	84	121	110
	Ballylumford B32	247	113	96	0	83
	Kilroot K1	238	93	105	117	122
	Kilroot K2	238	93	108	119	118
	Coolkeeragh	412	260	276	271	264

* = Min gen of Huntstown plants were previously 170MW but reduced in 2017.

** = Min gen of Tynagh plant was previously 194MW but increased in 2017

*** = Min gen of Great Island plant was previously 232MW but reduced in 2017.

**** = Min gen of West Offaly plant was previously 48MW but increased in 2015

- Review of operation of must run plants during curtailment events indicates that some of the plants (highlighted in yellow) are consistently operating at levels well above their minimum generation levels over the past 5 years
- Total average minimum generation levels in 2016 were 1,434MW in ROI and 491MW in NI.

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4. Review of Interconnector Activity During Curtailment Events

		Q1 & Q2 2014	Q3 & Q4 2014	2014	Q1 & Q2 2015	Q3 & Q4 2015	2015	Q1 & Q2 2016	Q3 & Q4 2016	2016	Q1 2017	2014 to Q1 2017
Curtailment Events	Curtailment Events(nr.)	75	62	137	57	62	119	53	34	87	23	366
	EWIC Avg Net (MW)	262	118	190	74	-76	-1	-114	-14	-64	-209	22
	EWIC Avg Net (%)	49%	22%	36%	14%	-14%	0%	-22%	-3%	-12%	-39%	4%
	Moyle Avg Net (MW)	143	55	99	5	-96	-46	-116	-139	-127	-189	-37
	Moyle Avg Net (%)	57%	22%	40%	2%	-38%	-18%	-39%	-46%	-42%	-63%	-12%
All Periods	EWIC Absolute Avg (Day) (MW)	413	339	376	267	160	213	31	-3	14	-64	181
	EWIC Absolute Avg (Night) (MW)	103	53	78	51	-100	-24	-19	-10	-15	-118	3
	Moyle Absolute Avg (Day) (MW)	187	121	154	111	11	61	34	-56	-11	29	65
	Moyle Absolute Avg (Night) (MW)	74	25	50	-53	-132	-92	-56	-61	-59	-20	-33

Notes:

Positive figures represents imports, negative figures represent exports

- Review of interconnector activity during curtailment events over the last 3 years indicates that imports have steadily reduced over time through increased exports due to market activity and SO countertrading, with both interconnectors now operating on a net exporting basis during curtailment events.
- Summary of interconnectors over past 3 years:
  - EWIC on average importing 22MW during curtailment events which is 4% of its 530MW import capacity. During all periods EWIC on average importing 181MW per day and importing 3MW per night. However EWIC is predominantly exporting over the last 2 years.
  - Moyle on average exporting 37MW during curtailment events which is 12% of its current 300MW export capacity. During all periods Moyle on average importing 65MW per day and exporting 33MW per night. Again, Moyle is predominantly exporting over the last 2 years. Noted that export capacity of Moyle expected to reduce from 300MW to 80MW in Nov 2017 due to the connection of a number of large wind farms in Scotland.

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5. MullanGrid Replication of EirGrid Base Case Analysis

- In order to review EirGrid's base case curtailment analysis and analyse alternative sensitivity scenarios, it was necessary for MullanGrid to firstly attempt to replicate EirGrid's analysis.
- Outlined as follows were the alterations made to MullanGrid's 2020 base case curtailment model in order to replicate EirGrid's analysis:
  - Build-out of all-island wind reduced from 5,645MW to 5,350MW
  - EirGrid 31% capacity factor all-island wind profile applied
  - SNSP limit increased from 70% to 75%
  - Minimum Generation: reduction in number of must run high inertia plants from seven to five, and also assumed that all plants (including priority dispatch plants such as the peat plants) operate at their published min gen levels. As a result the total minimum generation is reduced from 1,074MW to 603MW in ROI and in the case of NI (where min gen varies depending on demand levels) it is assumed to reduce from 489/297MW to 298/186MW
  - Interconnector exports increased from 60% to 100%. Note: EirGrid's interconnector assumptions are unknown
  - Other assumptions including demand, and non-wind renewables were unchanged, and like EirGrid's analysis, is based on the All-Island Generation Capacity Statement 2017 – 2025
- Taking account of the alterations listed above, and also accounting for EirGrid's Low (24% capacity factor) and High Wind (33% capacity factor) scenarios, outlined as follows is a comparison between MullanGrid and EirGrid's results, where it is concluded there is a reasonable correlation in the results:

Scenario		Curtailment	% Time above 60% SNSP	% Time above 70% SNSP
Base Wind	EirGrid	2.0%	15.2%	7.5%
	MullanGrid	2.0%	13.9%	7.8%
Low Wind	EirGrid	0.9%	7.9%	3.0%
	MullanGrid	0.9%	6.8%	3.3%
High Wind	EirGrid	5.8%	22.2%	14.6%
	MullanGrid	5.0%	21.4%	14.3%

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6. Alternative Sensitivity Scenario Analysis

- Outlined as follows are the alternative sensitivity scenarios modelled by MullanGrid:
  1. 5nr. must run high inertia plants exporting current generation levels (instead of their published min gen levels) during curtailment events. Compared to the base case, this results in total minimum generation increasing from 603MW to 819MW in ROI and in the case of NI, increasing from 298/186MW to 326/213MW. This scenario reflects how the must run plants currently operate, where the majority do not turn down fully to their min gen level.
  2. 6nr. must run high inertia plants exporting current generation levels (instead of their published min gen levels) during curtailment events. Compared to the base case, this results in total minimum generation increasing from 603MW to 1,074MW in ROI and in the case of NI, increasing from 298/186MW to 326/213MW. This reflects a scenario where it is determined that the system cannot remain stable with only 5nr. must run plants.
  3. 8nr. must run high inertia plants exporting current generation levels (instead of their published min gen levels) during curtailment events. Compared to the base case, this results in total minimum generation increasing from 603MW to 1,366MW in ROI and in the case of NI, increasing from 298/186MW to 489MW. This reflects a scenario where current min gen levels do not reduce by 2020.
  4. Interconnector exports reduced from 100% to 60%.
  5. Interconnector exports reduced from 100% to 30%.
  6. 4 month winter outage of EWIC interconnector.
  7. Increased demand from data centres but levels of installed renewables remaining the same. Information for this scenario was obtained from EirGrid's high demand scenario in the All-Island Generation Capacity Statement 2017-2025
  8. Lower level of installed renewables, where it is assumed there will be 400MW less installed wind all-island compared to EirGrid's assumption of 5,350MW.

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6. Alternative Sensitivity Scenario Analysis (cont'd)

Scenario		EirGrid's Base Case 31% Capacity Factor Wind Profile			EirGrid's Low Wind 24% Capacity Factor Wind Profile			EirGrid's High Wind 33% Capacity Factor Wind Profile		
		Curtailment	% Time above 60% SNSP	% Time above 70% SNSP	Curtailment	% Time above 60% SNSP	% Time above 70% SNSP	Curtailment	% Time above 60% SNSP	% Time above 70% SNSP
Base Case (MullanGrid Replication of EirGrid analysis)		2.0%	13.9%	7.8%	0.9%	6.8%	3.3%	5.0%	21.4%	14.3%
Sensitivity Scenarios	**1**: 5nr. must run plants exporting current min gen levels	2.1%	13.9%	7.8%	1.0%	6.8%	3.3%	5.2%	21.4%	14.1%
	2: 6nr. must run plants exporting current min gen levels	3.1%	13.9%	4.2%	1.7%	6.8%	1.4%	6.8%	21.4%	8.5%
	3: 8nr. must run plants exporting current min gen levels	6.9%	7.4%	0.0%	4.0%	3.2%	0.0%	12.3%	11.7%	0.1%
	4: Interconnector exports reduced from 100% to 60% of capacity	2.8%	16.0%	9.5%	1.4%	8.3%	4.1%	6.36%	23.5%	16.5%
	5: Interconnector exports reduced from 100% to 30% of capacity	3.5%	17.8%	11.2%	1.8%	9.4%	5.0%	7.6%	25.3%	18.2%
	6: 4 Month Winter Outage of EWIC	2.7%	15.8%	9.2%	1.3%	8.3%	4.2%	5.8%	23.6%	16.1%
	7: Increased demand from data centres but levels of installed renewables remaining the same	1.5%	12.6%	6.6%	0.7%	5.9%	2.8%	4.0%	20.0%	12.7%
	8: Lower level of installed renewables (400MW less installed wind all-island)	1.1%	10.7%	5.2%	0.5%	4.7%	2.2%	3.1%	18.0%	10.9%

- One key conclusion from the sensitivity analysis is that variations in minimum generation levels, has a material impact on the percentage of time when the system operates above 60% and 70% SNSP i.e. if minimum generation levels increase (as per scenarios 2 and 3), the percentage of time above 60% and 70% significantly reduces, whereas, if minimum generation levels remain low (as per scenarios 4 to 8) then the percentage of time increases depending on other factors such as interconnection, demand and levels of installed renewables.
- A poor wind year, which is obviously outside everyone's control, could also have a material impact on the percentage of time above 60% and 70% SNSP.
- Separate to this analysis, MullanGrid's 2020 base case curtailment scenario estimates 3% curtailment, with the system estimated to operate above 60% SNSP 13.4% of the time and only 0.6% of the time above 70% SNSP. The main reasons why the time durations (particularly above 70% SNSP) is so low are as follows:
  - Approx. 300MW more wind assumed
  - Approx. 600MW more minimum generation as it is assumed there will be 7nr must run plants online instead of 5 as assumed by EirGrid
  - Less interconnector exports assumed, where MullanGrid's base case assumes 60% exports.

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