Executive Summary

SSE response to SEMC Consultation Paper SEM-12-028

Treatment of Curtailment in Tie-Break situations

25th of May 2012

Introduction

SSE is pleased that the SEM Committee has chosen to revisit the issue of tie-break and curtailment, in view of the impact the final decision will have on customers and the future of the renewables industry on the island. With over 500MW of operational windfarm capacity, SSE is currently the largest operator of wind generation capacity in the SEM. With some 80% of this capacity having firm access rights and a mix of firm and non-firm projects in our development portfolio, there will be a material financial impact on our business whether the Committee's decision favours grandfathering or pro-rata curtailment.

Although the consultation sets out four options for curtailment, these are basically grandfathering (Options 1 and 3) and pro-rata (Options 2 and 4). Treatment of compensation is the principal differentiator between these options. Previous consultation and responses have considered the cost of compensation to be a significant signal for preference as to one tie-break option over another, against an alternative argument highlighting the impact of increasing renewable capacity on reducing SMP. We accept that both these positions are inadequate on their own, but do not agree that DBC is the correct measure either. As explained below, we believe the correct approach is to use the total of energy production and curtailment compensation costs, to measure the impact on consumers.

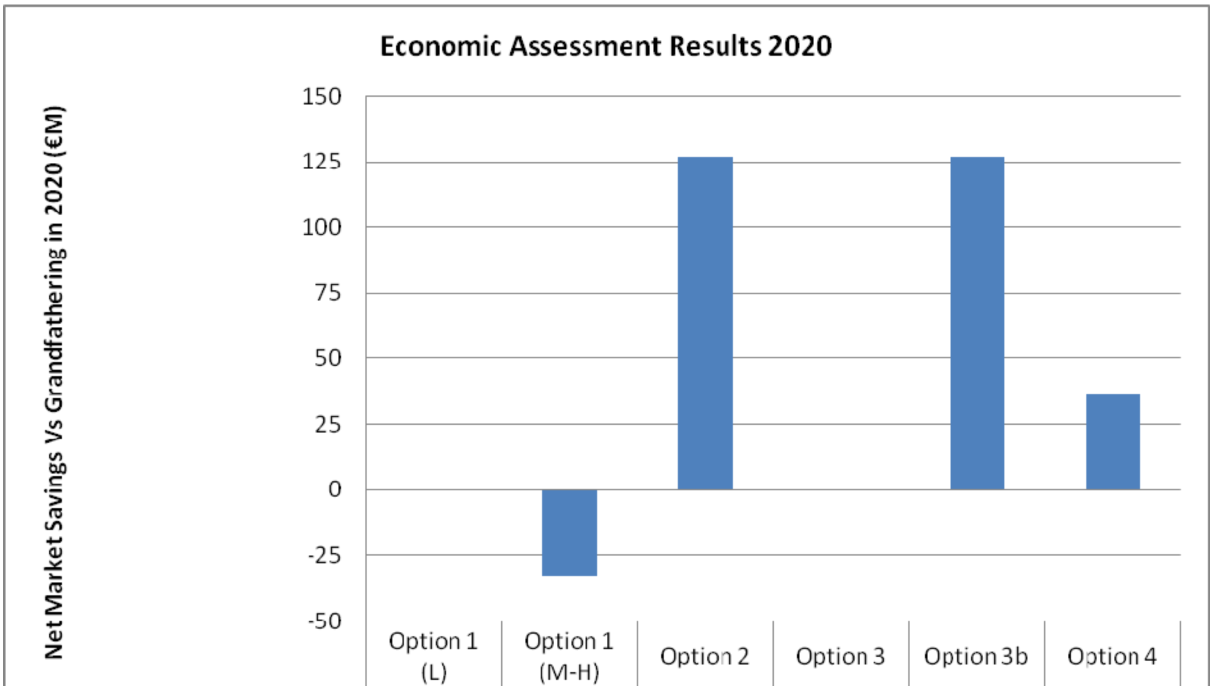
This response considers the principles that should be applied in reaching a decision on the appropriate approach to tie-break decisions. This is based on a detailed assessment of the consultation options (Appendix A), which in turn is based on detailed quantitative analysis by Irish Grid Solutions and ElectroRoute (Appendices B and C). A further option has also been developed, in conjunction with the wider wind industry, that addresses the SEMC's concerns about pure pro-rata and in our analysis, delivers value to consumers, equivalent to that of the best of the SEMC's options. While these Appendices provide detailed, quantitative analysis of the consultation options, this summary focuses on the grandfathering vs. pro-rata dichotomy.

The decision on tie-break rules should focus on incentivising delivery of the optimum capacity of renewables to achieve carbon abatement targets and to enable customers to benefit from the lowest total production cost. A decision on compensation should be about how to share value between consumers and generators in a way that maximises the overall economic value delivered by renewable investment. Compensation should certainly not be about placing an open-ended liability on consumers to pay for capacity they do not need.

Summary of findings

Results of quantitative analysis

Our analysis is based on an assessment of wind capacity build out rates, associated curtailment levels, firm access delivery for each option together with the impact on compensation costs and wind related savings as set out in Appendix A and Appendix B. It therefore takes full account of the additional costs of balancing the system as a result of high penetrations of wind.[1] As grandfathering is clearly the SEM Committee's preferred option, we have used the cost of this option as the benchmark against which the benefits of the other options have been assessed. As Figure 1 illustrates, our analysis found that both the consultation Option 2 and the alternative Option 3b (also supported by IWEA) have very similar levels of net benefit and we believe that as a result, the SEM Committee should have no hesitation in adopting pro rata curtailment as a first step.



	Option 1 (L)	Option 1 (M-H)	Option 2	Option 3	Option 3b	Option 4
Options Vs Grandfathering	0	-33	127	0	127	36

Figure 1: Summary Results of Economic Analysis. Incremental benefit of Options V's Option 1 in 2020 (Grandfathering) (Source: ElectroRoute)[2]

[1] The cost of compensation is included in the economic analysis as detailed in the SEMC consultation document.

[2] L – refers to a low risk of delay to deep reinforcements (assumed for all other options). M-H refers to a moderate to high risk of delay to deep reinforcements.

Curtailment and firmness are unrelated

Curtailment and firmness have never previously been linked by either regulators or system operators; as recently as 2010, the System Operators' "Facilitation of Renewables" studies indicated that curtailment levels of 5% could be expected at the level of connected renewables required to meet Government targets. **This is a pro-rata figure.** Firmness and the allocation of curtailment are two unrelated issues.

Firmness is about adequacy of the network to enable generation to reach the market; curtailment is about reducing generation to a level that matches system operational requirements. The RES-E Directive (Directive 2009/28/EC) obliges Member States to ensure curtailment is applied according to transparent and non-discriminatory criteria. **It is discriminatory to curtail non-firm generation that has no operational access constraint in order to save on payments to other generators, because such a decision financially favours one group of licence holders over another.** Introducing a link between the allocation of curtailment and firm access would also introduce a systematic bias that favours future, as yet unbuilt, generation with firm access, compared with currently-operating, non-firm generation.

The argument about firmness prioritising access to the market is not relevant to curtailment, because market rules on compensation relate only to technical limitations on network capacity that may not affect a non firm generator during periods of curtailment.

There is no reason for ensuring consistency of treatment for constraints and curtailment; they are distinct, and should be distinguished from one another. A clear, transparent definition which can be applied in a mechanistic manner in real-time is the key. There may be instances of over-lap, but an understood proxy definition will separate the treatment of a network issue from a system operational issue.

Will grandfathering protect existing generators?

No, grandfathering will only protect existing firm generators, by allocating the losses associated with curtailment to non firm generators.

The financial and operational impact of curtailment will be reallocated from built firm wind generation to temporary, partially firm and non firm wind farms, rather than being evenly and equitably distributed. Currently over 20% of the operational portfolio on the island is temporary, partially firm or non firm. Consequently, curtailment for these projects will be multiples of the average system curtailment level.

If grandfathering is introduced, this would represent a bonus for existing generators with firm connection access because their curtailment would be reduced as the financial and operational burden is transferred to other generators.

From 2013 onward, we have assumed that all non-controllable autonomous and variable price maker wind generation greater than 5MW, would be turned off before curtailment actions are applied to any variable price taker wind generation. This issue is important in view of the potential market changes required by European market integration and the need for a stable and enduring decision on tie-break rules.

<u>Will grandfathering deliver quality projects?</u>

No, grandfathering will deliver projects with firm access as distinct from quality projects. Firmness is only one element of a projects efficiency and viability.

Grandfathering offers a financial incentive for new, firm projects to deliver, as they will face much lower levels of curtailment than other generators, ensuring greater access to the benefits of support mechanisms based on metered output. In addition, under current compensation arrangements, they will receive market revenue for lost output.

On the basis of incentives alone, grandfathering will result in a higher proportion of connected **<u>firm</u>** access generation than would be the case under pro-rata curtailment as grandfathering will create a financial barrier to the development of non-firm projects by focusing the financial loss from curtailment onto non-firm generators. **While there may be more firm connection under grandfathering, overall there will be less wind connected.** This financial risk will be compounded as grid delivery progresses and the proportion of generators with firm access increases.

Grandfathering is therefore likely to deliver two perverse outcomes;

- If sufficient firm generation is built to meet targets, while non-firm developments fall away, the cost to consumers of curtailment will rise as the number of compensated MW increases.

- A low capacity factor project with firm access would be financially viable, whereas a higher capacity factor non-firm project would not; a poor allocation of economic resource.

Will grandfathering ensure targets are delivered?

No, grandfathering will prevent the delivery of renewable targets in Ireland and Northern Ireland.

Only firm projects will be viable under a grandfathering regime. Non-firm projects would experience curtailment levels that are multiples of the system average if built, and suffer an increasing concentration of loss as the grid is developed until they themselves become firm. Rational investors will not allocate capital to non-firm projects, and will instead wait until their firm access is delivered.

It follows that a grandfathering regime will directly link the buildout of renewables with the availability of firm access. Our all-island analysis assessed current firm access quantity dates and applied likely levels of delay dependent on the type of reinforcement required to provide firm access, with the results set out in Appendix B.

There is a high probability that there will be insufficient firm access available to deliver on 2020 renewables targets, even assuming that all projects with firm access are otherwise financially viable.

SSE believes that renewable energy targets in Ireland and Northern Ireland cannot be realised under grandfathering.

Net Market Savings/Costs

SSE would share the SEM Committee's concern that without an economic signal to the contrary, there would be an unconstrained liability placed on consumers to pay for capacity they do not need[3]. This is why we favour an approach to compensation that limits eligibility by a measure that in some way reflects consumer need.

However, SSE believes that the issue of compensation is not central to the decision on tie-break rules. Compensation is about how to share value between consumers and generators in a way that maximises the overall economic value delivered by renewable investment. Some risk mitigation must exist if developers are to provide the required level of renewables, but compensation should not place an open-ended liability on consumers. The SEM Committee paper suggests that DBC[4] are a suitable metric against which the impact on consumers can be

[3] This concern is not mitigated by grandfathering of curtailment. This option would still result in increasing compensation being paid as grid buildout increased the capacity eligible for payment.

[4] DBC refers to the sum of Constraint Payments, Uninstructed Imbalance Payments, Generator Testing Charges, Making Whole Payments and the net cost of energy imbalances.

calculated. Unquestionably, consumer impact should rank highest amongst any proposed decision making criteria, however DBC alone are not an appropriate means for judging the level of economic impact on electricity consumers. Focusing on DBC obscures the actual level of consumer benefit associated with increased levels of wind penetration.

The decision on tie-break rules should incentivise the delivery of the optimum capacity of renewables, to lower total energy costs and reduce the impact of energy price volatility[5]. Our analysis in Appendix C has focused on the balance of energy production cost and curtailment compensation cost, with a grandfathering regime as a benchmark. The inclusion of energy production costs rather than DBC allows significant savings **(each 1% increase in wind penetration reduces average energy production costs by 0.5€/MWh)** attributable to increased levels of wind generation to be netted off against potential increases in curtailment compensation costs (the average curtailment related compensation price for eligible wind generators is 46.6€/MWh), providing a more thorough conclusion on the likely level of consumer impact.

A higher buildout of price taking wind generation under a pro-rata regime offsets the higher cost of compensation, with a net market saving of €127m per annum in 2020. Grandfathering is demonstrably more expensive for the consumer and would prevent the rational allocation of economic resource. Underpinning this conclusion is the low level of installed wind, and slow build out rate that will be the inevitable result of a grandfathering regime.

Concluding remarks

A decision on the treatment of curtailment in tie-break situations must be about the sensible allocation of an economic loss. SSE believes that pro-rata treatment of curtailment better fulfils the SEM Committee decision-making criteria as defined in the consultation paper, SEM-12-028.

Pro-rata will deliver material consumer value, in that the net of energy production and curtailment compensation costs will be €127m lower in 2020 than grandfathering. The investment in generation plant that takes place will be economically rational, with no barrier to investment in, and connection of strong non-firm renewable projects. The application of a locational, network signal to a system-operation issue will simply distort the delivery of the optimum capacity of renewables required by the consumer.

Government targets of 40% of electricity consumption from renewable sources in Ireland and Northern Ireland will be met under pro-rata. Grandfathering will send a signal to every investor

[5] Our analysis does not model the economic benefit of reduced sensitivity to energy price shocks resulting from increased renewable build out, but reductions in energy price volatility should not be overlooked.

not to build projects until firmness is delivered. SSE believes that this will prevent the achievement of policy objectives in both jurisdictions, even assuming that every firm project is otherwise viable.

There must be an economic signal for generators not to build capacity that is not required by the consumer. SSE believes that some risk mitigation is required, as developers cannot effectively manage a system-operation issue. Risk mitigation must be about delivery of the renewable capacity required in Ireland and Northern Ireland, not open ended liability that obscures efficient market entry signals.

In order to deliver an economically rational buildout of renewable generation and best value for the consumer, SSE believes that pro-rata allocation of curtailment in tie-break situations should be implemented immediately.

APPENDIX A

SSE Response to SEMC Consultation Paper SEM-12-028

Treatment of Curtailment in Tie-Break situations

25th of May 2012

Table of Contents

List of Figures:

1.1 Introduction

SSE welcomes the opportunity to respond to this consultation. SSE is the largest operator and a leading developer of wind projects across the island of Ireland. The dispatch of wind generators in tie-break situations is of critical importance to our business, impacting both our existing and future plant. SSE operates over 500MW of wind farms across the island, of which 80% of the MWs are firm. Additionally, SSE is also developing significant further renewable capacity.

We believe that making the correct decision on tie-break is critical to ensuring that the very best projects are delivered and that sufficient renewable capacity is provided to optimise the sustainability of electricity production and cost to the consumer. It follows that we do not support any proposal for uncapped compensation for curtailment of renewable output for capacity in excess of customer requirements and Government policy objectives.

It is therefore essential that the solution to management of curtailment in tie break scenarios is transparent, fair and equitable; protecting existing generation while encouraging continued investment in order to deliver the required overall capacity of wind generation.

1.2 Proposed Options

The SEMC consultation paper SEM-12-028, has proposed four options to manage curtailment in tie break situations as listed below in Figure 1, which have been assessed against five specific criteria, also listed below in Figure 2. Further to the four options proposed by the SEMC, the IWEA has proposed an additional option which is an adaption of the SEMC Option 3, for ease of reference has been titled 3b and is included below. SSE supports Option 3b as proposed by IWEA.

Proposed Option References	Description
Option 1	Grandfathering based on firm access, compensation as per consultation
Option 2	Pro Rata, compensation as per consultation
Option 3	Temporary Pro Rata up to Jan.'18 or achieving Government targets, compensation as per consultation
Option 3b	Temporary Pro Rata up to Jan.'18 or achieving Government targets whichever is later, projects within this tranche receive Pro Rata for their operational life, compensation as per Option 3
Option 4	Pro Rata, compensation as per consultation

Figure 1: Proposed Options

SEMC Criteria No.	Description
Criteria 1	Impact on the consumer and Dispatch Balancing Costs
Criteria 2	Facilitation of Ireland and Northern Ireland 2020 Renewable Targets
Criteria 3	Efficiency of Entry Signal
Criteria 4	Stable Investment Environment
Criteria 5	Consistency of treatment for constraints and curtailment

Figure 2: SEMC Assessment Criteria

1.3 Criteria 5 – Consistency of treatment for constraints and curtailment

SSE agrees with the SEMC when they state:

"Curtailment is not associated with network-specific issues, in that no amount of grid roll-out will alleviate times when there is too much intermittent wind generation on the system. Therefore it is clear that constraints and curtailment are two different issues that need to be addressed by the SEMC. With constraints being a network issue, and curtailment being a market issue the TSOs should be directed to explore how to treat them separately in all instances."

Therefore, there is no reason to ensure consistency of treatment for constraints and curtailment. While we acknowledge the complexity in differentiating one from the other, it is understood that the TSOs have confirmed that they are quite willing to create a proxy definition of one and allow all else to fall into the other category. SSE appreciates that this may not be ideal in situations of over-lap and there may be arguments over category definition but are satisfied that this would be workable.

SSE would also welcome the introduction of a mechanism which would allow IPPs to distinguish between the type of a dispatch instruction being issued, a constraint or curtailment. We believe this would provide transparency as to how the system operators are applying the SEMC rules. SSE would welcome the opportunity to work with the System Operators in developing such a proxy definition of curtailment and a real-time mechanism for distinguishing the dispatch instruction.

As our position on criterion 5 remains the same regardless of option we have therefore considered only criteria 1 to 4 in our assessment of each option in the remainder of this document.

1.4 SSE Summary Position on Options

SSE has assessed each of the proposed options against the criteria 1 through 4 as outlined by the SEMC. Criteria 5 is dealt with earlier under Section 1.3 and as noted above SSE's position remains unchanged for Criteria 5 against each proposed option. Figure 3 summarises SSE's assessment of each option against the criteria for SEMC decision-making in addition to SSE's position on each option.

	Option 1	Option 2	Option 3	Option 3b	Option 4
Criteria 1	Used as Base Case for comparison	Net Market Savings of €127million p.a. in 2020 V's Grandfathering	Same Economic Impact as Grandfathering Base Case	Net Market Savings of €127million p.a. in 2020 V's Grandfathering	Net Market Savings of €36million p.a. in 2020 V's Grandfathering
Criteria 2[1]	84.4% in 2020	105.9% in 2020	84.4% in 2020	105.9% in 2020	88% in 2020
Criteria 3	Negative Signal	Positive Signal	Negative Signal	Positive Signal	Negative Signal
Criteria 4	Non firm will not build	SSE believe there will be some form of natural cap but Option does not provide formal cap	Uncertainty around status at changeover	Provides cap for generators to work towards	Negative impact on existing plant, creates barrier to build out of projects to reach targets
SSE Support	No	Yes	No	Yes	No

Figure 3: Summary Position on Options

1.5 Independent External Analysis & Assumptions

1.5.1 Irish Grid Solutions (IGS)

IGS was commissioned by SSE to conduct an analysis of the following items against Option 1 through 3, including Option 3b. ElectroRoute provided the estimated build out rate of Option 4.

- Firm Access Date Delivery, which is key to estimating build out rates for a grandfathering regime as firmness availability and wind delivery are directly linked under this regime.
- Build Out Rates, which have been assessed for each option proposed on the basis of the current portfolio and potential projects. This is the key to, not only the cost of compensation, but also the impact on energy production costs.

[1]It is assumed that the 2020 renewable target requires approximately 34% wind. Percentage shows delivery or failure of delivery against this target, assuming EirGrids renewable target numbers as per Section 1.5.3.

- Associated Curtailment Rates, which have been calculated, based on the build out rates above and the associated portfolio total and portfolio mix in terms of controllable, firm, non firm, temporary etc.

Analysis methods, assumptions and results are provided in Appendix B. The results of this analysis were then used by ElectroRoute to assess the economic impact of each option.

1.5.2 ElectroRoute

Scope

ElectroRoute[2] was commissioned by SSE to conduct an economic impact analysis of each proposed option. The metrics used to describe the results of the analysis are defined below. The assessment of each option under criteria 1 will use the cost of compensation and the energy production costs as metrics.

Analysis methods, assumptions and results are provided in Appendix C.

Basis for Market Analysis

The SEM Committee paper states that one of the principal criteria used in its decision making process will be impact on the consumer and goes on to suggest that Dispatch Balancing Costs (DBC) is a suitable metric against which the impact on consumers can be calculated. Consumer impact should indeed rank highest amongst any proposed decision making criteria, however DBC alone does not provide an appropriate means for assessing the level of economic impact on electricity consumers.

DBC refers to the sum of Constraint Payments, Uninstructed Imbalance Payments, Generator Testing Charges, Make Whole Payments and the net cost of energy imbalances[3]. Aside from the fact that some of the component elements of DBC are in no way related to the treatment of curtailment in Tie-Break situations, focusing on DBC obscures the economic benefit that increased levels of wind penetration deliver to consumers.

A more accurate gauge of the impact of different approaches to the treatment of wind curtailment can be realised by comparing the combined levels of Energy Production Costs and Curtailment Compensation Costs under each approach. The inclusion of Energy Production Costs allows significant savings attributable to increased levels of wind generation to be netted off against any potential increase in curtailment compensation costs providing a more complete metric by which to assess the level of impact on the consumer.

---

[2] ElectroRoute calculated the estimated build out rate for Option 4 based on IGS build out rate for Option 2.

[3] http://www.eirgrid.com/operations/ancillaryservicesothersystemcharges/dispatchbalancingcosts/

1.5.3 Government Targets

We understand that EirGrid has assumed the following levels of wind capacity are required to reach government targets in 2020 in their tiebreak studies and as such SSE have also based our analysis for this submission on these numbers.

- RoI = 4146MW (1603MW from Gate 3)
- NI = 1342MW

1.6 Summary of Economic Results

ElectroRoute provide the results of their analysis in terms of the cost of compensation and wind related savings, resulting in a net market cost/saving against each option in comparison to the base case of grandfathering, a summary of which is shown below in Figure 4 and 5. This shows that all options cost less than grandfathering in 2020, bar Option 3 which costs the same.

	2015			2020		
Option	**Curtailment Comp. Cost (€M)**	**Wind Related Savings (€M)**	**Net Market Savings vs. Grandfathering (€M)**	**Curtailment Comp. Cost (€M)**	**Wind Related Savings (€M)**	**Net Market Savings vs. Grandfathering (€M)**
Option 1 (L)[4]						
Option 1 (M – H)	-1	-4	**-4**	-4	-36	**-33**
Option 2	-7	49	**43**	-27	147	**127**
Option 3	-5	31	**27**	-7	0	**0**
Option 3b	-8	49	**42**	-27	147	**127**
Option 4	0	10	**11**	0	29	**36**

Figure 4: Summary Results of Economic Analysis, 2015 & 2020 (Source: ElectroRoute)

4 L refers to a low risk of delay to deep reinforcements (assumed for all other options). M-H refers to a moderate to high risk of delay to deep reinforcements.

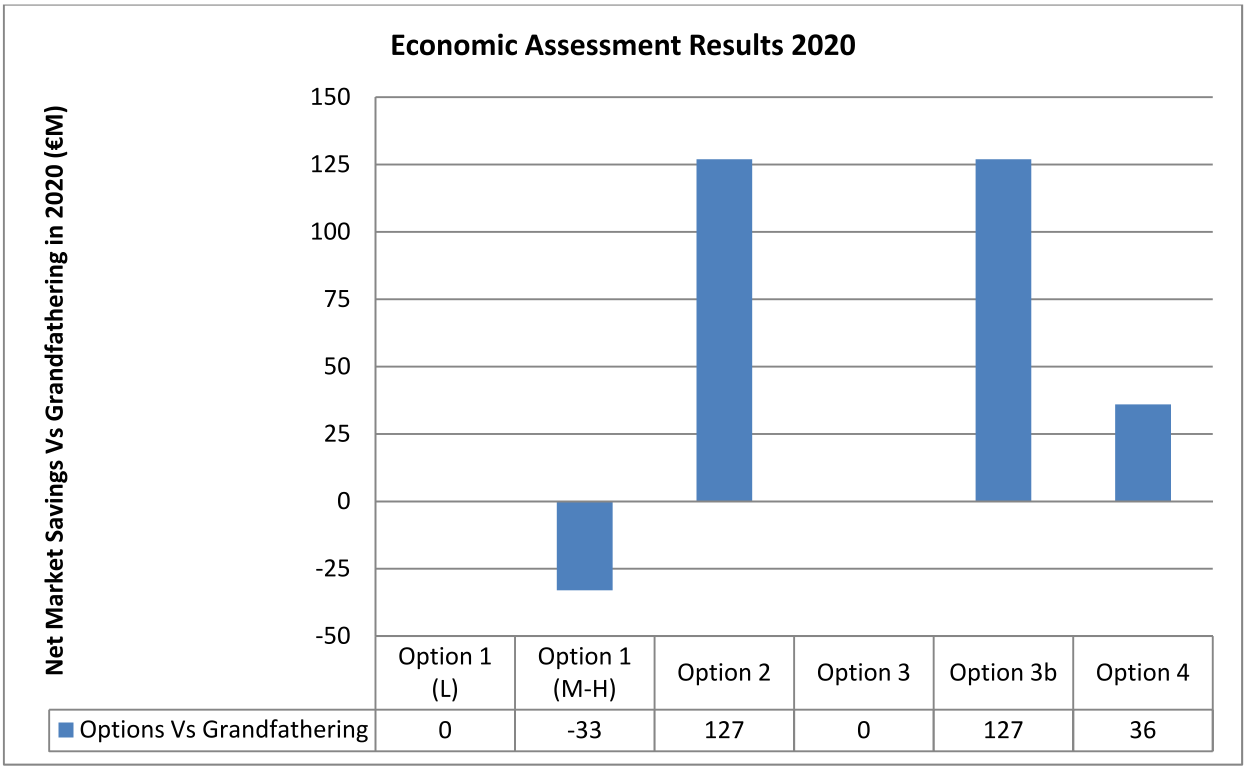


Figure 5: Summary Results of Economic Analysis. Incremental benefit of Options Vs Option 1 in 2020 (Grandfathering) (Source: ElectroRoute)

2.1 Option 1 – Grandfathering

SSE does not support this option.

SSE believes that this option will not deliver under any of the four criteria required by the SEMC. Figure 6 below sets out SSE's assessment of this option against the SEMC criteria 1 through 4.

Criteria Number	Criteria Description	SSE Assessment of Option against Criteria
Criteria 1	Impact on the consumer and Dispatch Balancing Costs	External analysis shows that pro rata will cause a net market saving in comparison to grandfathering. This is based on the net impact of energy production costs versus compensation costs for the associated build out rates in each option.
Criteria 2	Facilitation of Ireland and Northern Ireland 2020 Renewable Targets	Under a grandfathering approach RoI and NI will fail to meet renewables targets. Projects will not build under this regime until firm access is delivered due to the extreme curtailment levels they would experience as non firm generators. There will not be sufficient firm access or firm access projects to deliver on these targets.
Criteria 3	Efficiency of Entry Signal	Grandfathering sends a negative entry signal and does not promote 'the connection of economic and efficient wind projects'. Rather, it results in projects being delayed until firm access is available irrespective of the quality of the project and creates a barrier to non-firm connection.
Criteria 4	Stable Investment Environment	Grandfathering only provides a stable investment environment for existing firm generators. It significantly impacts existing non firm generators and encourages marginal projects to progress purely based on the availability of firm access.

Figure 6: SSE Assessment of Option 1 under SEMC Criteria 1 - 4

Expected Curtailment Levels Under a Grandfathering Regime

Detailed analysis carried out by Irish Grid Solutions (IGS) on our behalf as provided in Appendix B calculated likely curtailment levels for non firm projects under a grandfathering regime. Two scenarios are provided below, both assuming a low risk of delay to deep reinforcements. One scenario assumes a timely delivery of DS3 and the second with a delay to DS3. Curtailment levels for non firm generation in 2020 are in the region of 8 – 11%, multiples of the curtailment allocated to firm generation. Furthermore, these non firm generators receive no compensation. These levels will annihilate existing non firm projects and prevent future non firm projects from building.

Year	Grandfather Low[5]			Grandfather Low (Slow DS3)	
	Grandfather Build-Out (MW)	Curtailment for Non-Firm Connections	Curtailment for Firm Connections	Curtailment for Non-Firm Connections (Slow DS3)	Curtailment for Firm Connections (Slow DS3)
2012	2228	8.64%	0.89%	8.64%	0.89%
2013	2351	3.11%	0.25%	3.11%	0.25%
2014	2621	6.02%	0.49%	6.02%	0.49%
2015	2813	4.24%	0.32%	7.58%	0.70%
2016	3055	4.19%	0.37%	10.15%	1.08%
2017	3271	2.53%	0.18%	8.27%	0.85%
2018	3534	4.58%	0.47%	8.21%	0.98%
2019	3919	6.78%	0.90%	12.74%	1.82%
2020	4204	8.21%	1.27%	11.46%	1.64%

Figure 7: Estimated Curtailment Levels under Grandfathering (Source: IGS)

If we consider an ideal build out rate to meet targets but then apply grandfathering curtailment levels, the allocation of curtailment for non-firm wind is in the region of 31% to 44%. This reinforces the view that non-firm projects will not connect if curtailment is grandfathered.

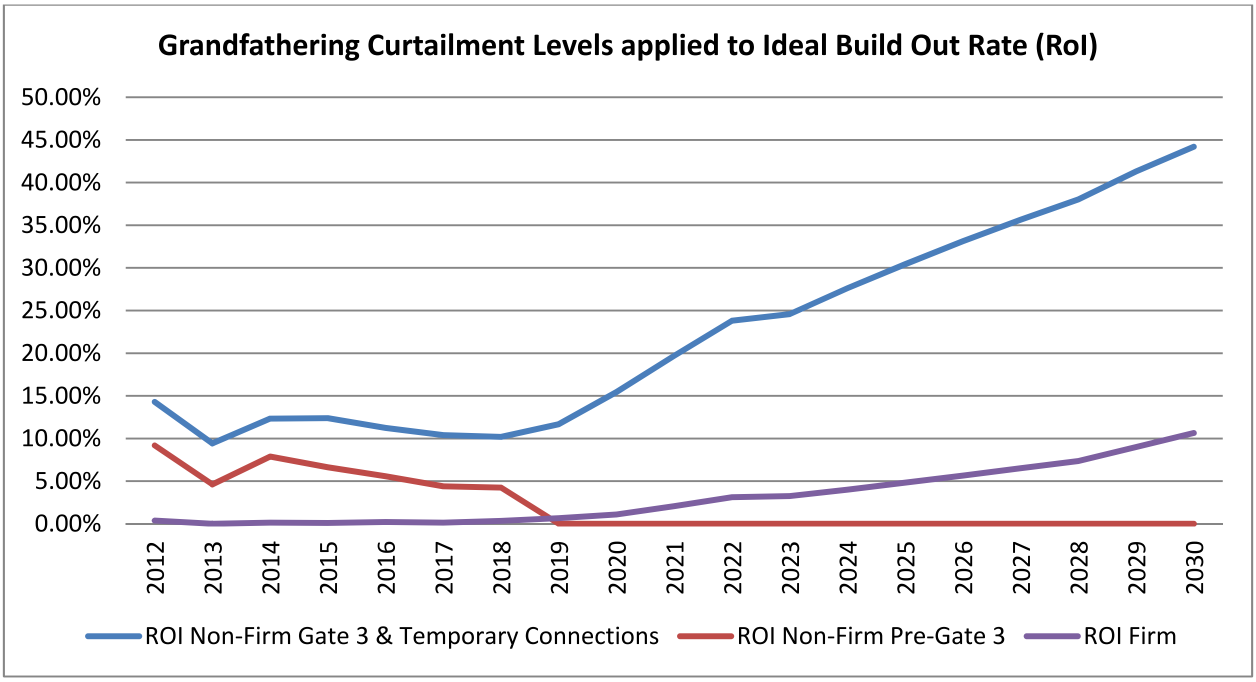


Figure 8: Grandfathering allocation of curtailment on an ideal build out rate (RoI) (Source: IGS)

5 Please see Appendix B for details on build out rates used and associated assumptions. Low refers to a low risk of delay to current FAQ dates.

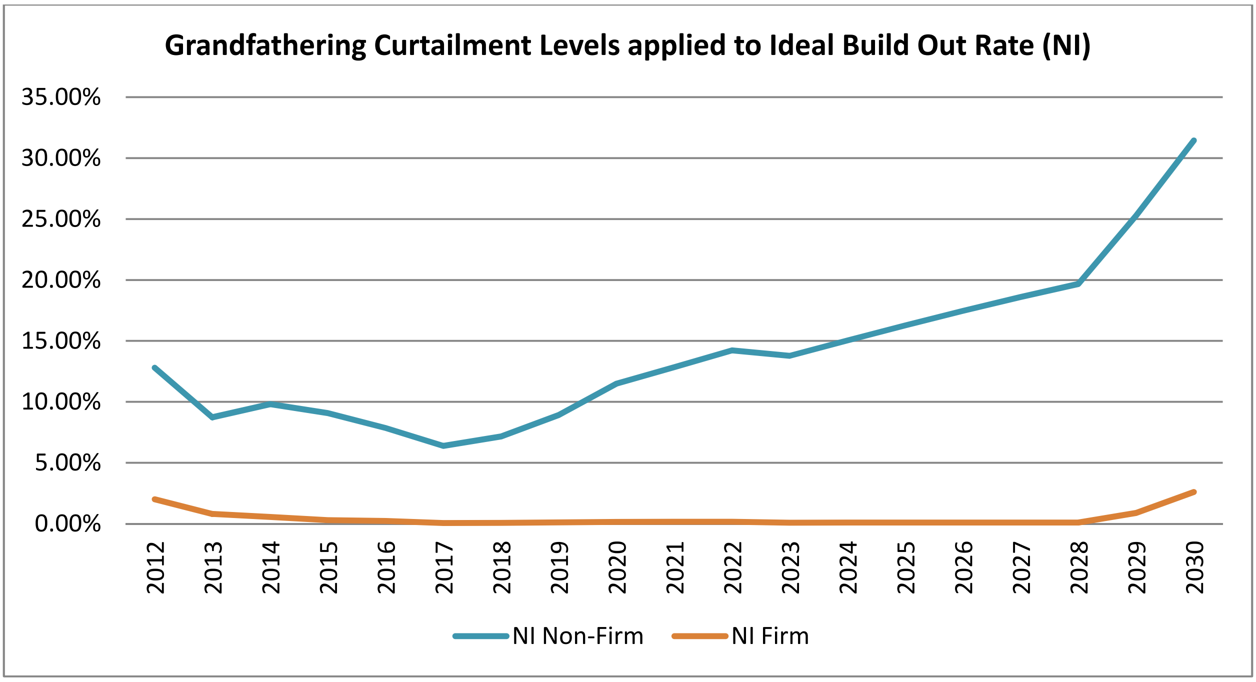


Figure 9: Grandfathering allocation of curtailment on an ideal build out rate (NI) (Source: IGS)

Firm Access Quantity (FAQ) Delivery Date Delays

Under a grandfathering regime, non-firm projects will experience extreme curtailment levels that are multiples of the average system curtailment level, with compensation only paid only up to the FAQ. SSE and the Wind Industry have stated that they will not build projects until after their firm access has been delivered under this regime. Therefore under this option build out rates will be directly linked to the availability of firm access.

Current estimated FAQ dates are unreliable and can be revised at any time until an IPP receives written confirmation of firmness. Detailed analysis carried out by Irish Grid Solutions (IGS) on SSE's behalf assessed the current FAQ dates and applied likely levels of delay dependent on the type of reinforcement required to provide firm access. The assumptions for these calculations are provided in Appendix B, the results of which are shown in Figure 10 below. It is clear that there will not be sufficient firm access to deliver on 2020 targets (levels assumed are as per Section 1.5.3.)

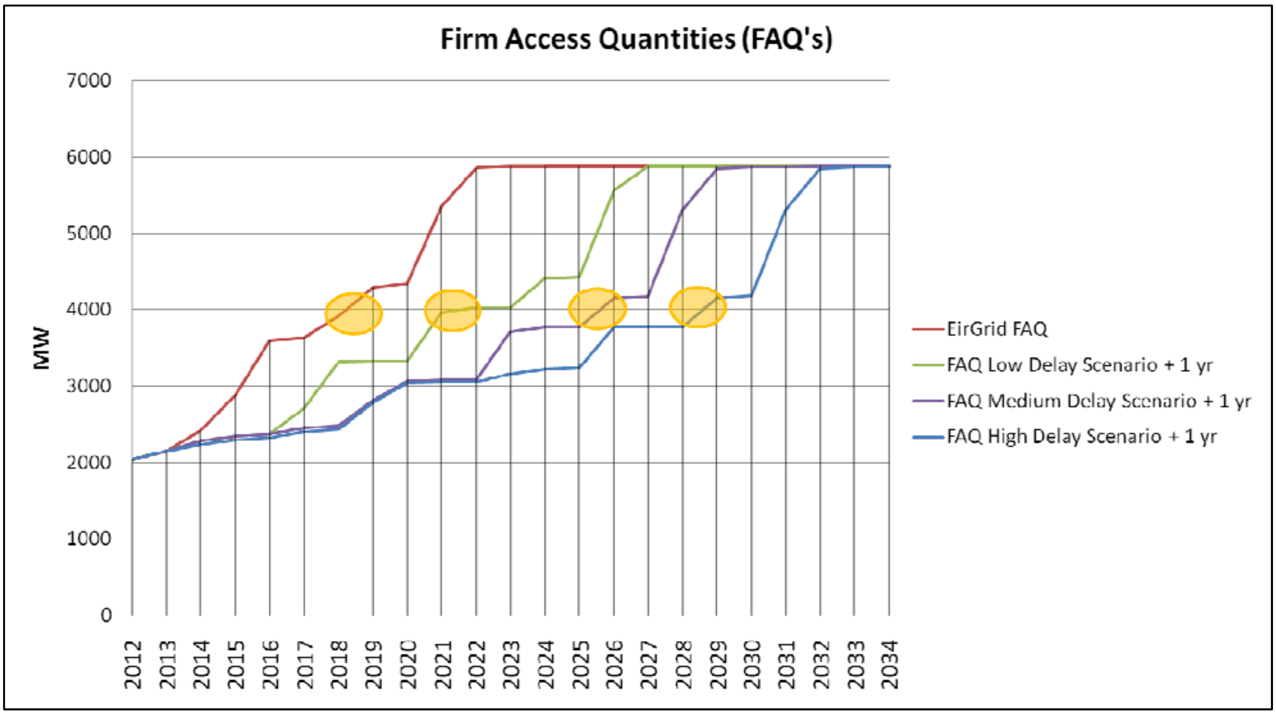


Figure 10: Firm Access Availability – Sensitivity Analysis (Source: IGS)

Delivery of Deep Reinforcements

ROI's Gate 3 firm access dates are currently being reviewed and are scheduled for issue in 2012. The dates for the majority of Gate 3 are dependent on deep reinforcements that include the North-South Interconnector and the 400kV Cork/Dublin Grid Link[6]. Both of these developments are well behind their original scheduled construction timelines and are unlikely to be completed before the end of the decade.

It is therefore reasonable to assume that, if Option 1 was implemented, any Gate 3 applications associated with these reinforcements will have their firm access pushed out beyond 2020. In NI there is no detailed grid plan post 2016 creating serious uncertainty concerning the delivery of firm MW.

The SEMC assume in footnote 11 that the required network capacity is delivered by the System Operators and Owners in order for grandfathering to ensure that sufficient firm capacity is connected by 2020. Based on evidence to date this will not be the case.

[6] SSE understands that over 70% of Gate 3 is dependent on the N-S Interconnector and over 40% is dependent on the 400kV Cork/Dublin Grid Link.

SSE Case Study

As a practical example of the potential impact of Option 1, it is SSE's intention, with its partners, to develop the 170MW Galway Wind Park via temporary and non-firm connection. If Option 1 was implemented the project would suffer significant curtailment levels as it would be one of the first to be curtailed, every time there is a curtailment event. Under this regime, the project would no longer meet our investment risk standards and would not proceed until its firm access is obtained, most likely sometime close to or after 2020. This is a fully consented project with a strong wind resource, in an area of low network constraints. It is due to enter construction in 2014; with an investment value of €304m, an annual payment of €1.2m in rates to Galway County Council and further annual payments in excess of €500,000 in community funds and landowner rents.

Figure 11: SSE Case Study

Firm MW Does not Equate to Built MW

It cannot be assumed that all firm MW are associated with viable wind farm projects. Potential build out rates cannot be based solely on the availability of firm MW. A grid connection may become firm but may at the same time be lacking associated land control, valid planning permission, sufficient wind resource or indeed sufficient financing. There is a large percentage of Gate 1, 2 and pre-gate that is firm and still not yet built. Therefore, this shortfall is likely to be even greater than a direct comparison of firm MW delivery against targets.

2.1.1 Impact on the consumer and Dispatch Balancing Costs

Option1 will produce a net market cost in comparison Option 2, 3b and 4.

Infrastructure Build Out

It will be virtually impossible for the System Operators to attain full capital approval for the development and construction plans of Grid 25 and equivalent long-term plans in NI without a strong investment signal from generators who wish to connect. These reinforcement plans are required for the facilitation and integration of renewables onto the all-island market. SSE believe that it is unlikely that the RAs will take risk on behalf of consumers, allowing the construction of potentially under-utilised assets, as wind developers either do not build or wait until the assets are fully energised. If the wind farms don't connect to the assets then TUOS bills will not be paid – this is putting a significant risk on the consumer.

Net Market Savings

SSE disagrees with the SEMC argument that "it is likely that the grandfathering of curtailment will be cheaper for the all-island customer". It is true that, under grand-fathering consumers only face risk of compensation for curtailment when firm generators are curtailed but this does not provide an accurate picture of net market savings. Based on detailed analysis carried out by ElectroRoute, contained in Appendix C, we believe that grandfathering will actually increase energy production costs in comparison to Option 2, 3b and 4 as a result of this lower build out rate. The increase in energy production costs due to the low wind build out rate outweighs any beneficial reduction in the total cost of compensation. Option 2 and Option 3b will both produce net market savings of €127m in 2020 in comparison to Option 1. Option 4 will produce net market savings of €36m in 2020 in comparison to Option 1 but will not deliver on renewable targets. ElectroRoute also carried out additional sensitivity analysis, modelling a grandfathering scenario with moderate to high delays in the delivery of firm access. This results in a net market loss of €33m in 2020 in comparison to the grandfathering base case.

The SEMC also references a desire for an "approach to curtailment which is most favourable to consumers in the long run". SSE supports this objective. This must mean choosing the option that delivers the greatest overall decrease in energy production costs. ElectroRoute's analysis shows that in the ranking of curtailment options, grand-fathering is less favourable than Options 2, 3b and 4 from the consumers' perspective.

2.1.2 Facilitation of Ireland and Northern Ireland 2020 Renewable Targets

Option 1 will not deliver on the Ireland and Northern Ireland 2020 renewable targets.

Build Out Rates

As discussed earlier, Option 1 prevents non firm projects from connecting to the system due to excessively high curtailment levels as shown above. As a result, only firm projects will be built under this regime. SSE believes that there will not be sufficient firm access available in timely manner to deliver on targets. Therefore this option results in a much lower build out rate than Option 2, 3b or 4, with only Option 2 and 3b delivering on targets.

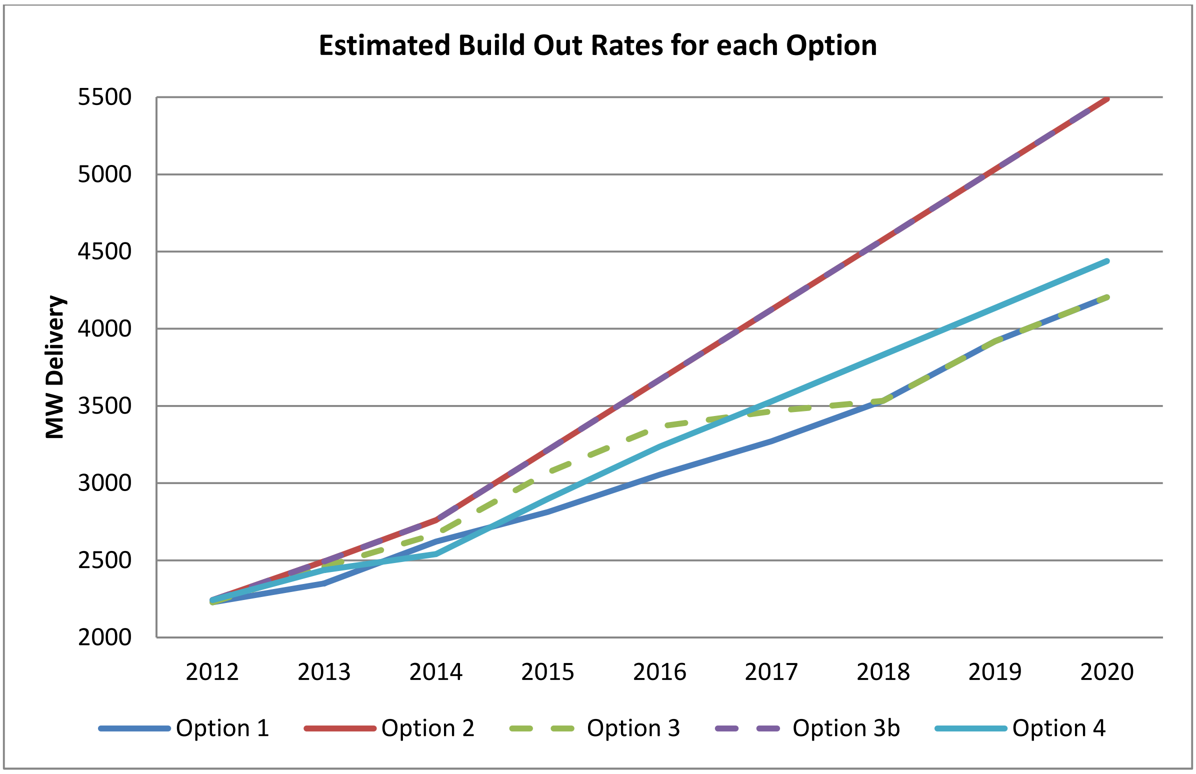


Figure 12: Estimated Build Out Rates for each Option (Source: IGS)

Impact on Operational Projects

The SEMC argues that grandfathering favours the financial viability of those projects where investments have already been made as opposed to potentially speculative projects. SSE has the largest operational wind portfolio on the island totalling over 500MW and we do not believe this is the case.

Grandfathering as the principal for curtailment will focus the impact on temporary, partially firm and non firm wind farms, rather than being evenly and equitably distributed. Currently over 20% of the operational portfolio on the island is temporary, partially firm and non firm. Consequently, curtailment for these projects will be multiples of the average system curtailment level. This will force a number of existing projects into financial default, as compensation is only received up to the firm access quantity.

SSE and many others in the industry made rational investment decisions on wind generation across the island on the basis of assumptions for expected curtailment levels that were indicated at various times by the System Operators and based on rule sets that applied at such times. Having acted as rational investors, we regard it unreasonable that some existing generators are expected to shoulder significant additional curtailment levels as a result of new rule sets which were unforeseeable at the time these investments were made.

Investor Confidence

"A grandfathering approach may enhance investor confidence in genuine viable projects". The

SEMC notes that this will, "help delivery of such renewable projects" and "by extension should contribute towards steady progress on achieving the 2020 renewable targets."

The reality is that adoption of grandfathering will have a materially adverse impact on **existing** investments in projects with temporary, partially firm and non firm connections. Such retrospective financial jeopardy is unrecognised by the Consultation and is damaging to investor confidence. Investors have made rational decisions based on current curtailment management arrangements and could reasonably have expected a regulatory impact assessment to recognise and address this issue. The consultation shows little evidence of understanding actual investment issues and risks delivery of a perverse economic outcome; development of poor quality projects with firm access, rather than non-firm projects that would otherwise be genuinely viable.

The concept that grandfathering will ensure renewable targets are met is truly misleading.

Based on the above discussion relating to FAQ dates and Firm MW the SEMC statement that "Grandfathering of transmission access rights on the basis of firmness **may** lead to a more reliable and efficient achievement of the Ireland and Northern Ireland 2020 renewable targets, than alternative approaches" is clearly not the case.

In conclusion, it is clear that a grandfathering approach will not allow renewable targets to be met in RoI or NI.

2.1.3 Efficiency of Entry Signal

The SEMC state that "from an economic theory perspective, grandfathering of curtailment should provide a signal to the marginal renewable plant in future years of whether it is financially viable to connect to the system". SSE disagrees with this statement. The primary signal that grandfathering will send to all projects is to delay building until firmness has been delivered. In fact, grandfathering sends a positive signal to marginal plant as their curtailment levels once firm will be less than under pro rata. Marginal and non firm are not one in the same. Firmness as stated previously is only one element of a projects viability and efficiency.

It is true that the level of renewable generation looking for connection to the system far exceeds that required to meet the 2020 renewable targets. However, there is no guarantee that the long list of grid applications equals a long list of viable or efficient projects. The RoI process to apply for grid connections did not require any confirmation of a tangible project and therefore the MW total of grid applications cannot be assumed to become built MW. To avoid a significant shortfall against renewable targets we need to remove dependency on firm access and ensure the option chosen sends a positive entry signal to viable projects.

Under grandfathering, SSE and the Industry have stated no non-firm wind will connect or even get to financial close until they have confirmation of firm access. We are going from a regime that allows non-firm connection to one which creates a barrier to non-firm connection.

2.1.4 Stable Investment Environment

SSE agrees that the financeability of SEM investments should be an important consideration. The SEMC state that “grandfathering increases certainty for generators who are closer to connection”; this is misleading statement. Grandfathering only increases certainty for generators with firm access. A grid connection may become firm but may at the same time be lacking associated land control, valid planning permission, sufficient capacity factor or indeed sufficient financing. The perceived increase in certainty for generators with firm access will not make a marginal project economically efficient, or viable.

The SEMC state that the grandfathering approach “would promote the financial viability of generators who have made investments, particularly those generators in the most efficient locations.” Please refer to Section 2.1.2, Impact on Operational Projects, where it is shown that as the largest operator on the island we do not believe this is the case. It is misleading to base any definition of the “most efficient locations” on firm access ability solely. Firm access is not the only quality that describes an 'efficient location'. Firmness doesn't take account of land control, valid planning permission, sufficient wind resource or access to finance - the other main elements that make the location for a project efficient, viable and connectable.

The SEMC suggest that grandfathering will provide predictable and stable cash-flows. Grandfathering will provide relatively predictable and stable cash-flows for built plant with firm access. However, it will allocate a significant burden on built plant with non firm, partially firm or temporary access, which currently equates to over 20% of operational wind farms across the island. It will also significantly slow down the build out of wind ensuring that, as noted in Section 2.1.2, we will not meet renewable targets. It is also important to note that a sudden change from the current regime of pro rata in favour of grandfathering will undermine the regulatory environment for investors.

Grandfathering provides generators with firm access a more stable environment by reallocating risk to generators without firm access. This favours one set of investors to the detriment of other investors which is not equitable and does not make for a stable environment. The grandfathering approach also provides a negative entry signal for all non-firm projects and will ultimately increase the cost to the consumer by encouraging marginal projects to progress. It has been shown in Section 2.1 that regardless of any perceived increase in stability for firm generators there will not be enough firm access to deliver on 2020 renewable targets, making this argument beneficial only in isolation of all other SEMC criteria requirements. In addition, this approach may add an additional value to otherwise unviable projects that happen to have firm access, delaying the clean out of grid queues.

2.2 Option 2 – Pro Rata

SSE supports this option but understands that the SEMC may have some concerns surrounding it. SSE supports the IWEA Option 3b as an alternative to Option 2, if the SEMC are not inclined towards Option 2. SSE believes Option 3b will alleviate the SEMC concerns around Option 2.

SSE believes that this option will deliver under all of the four criteria required by the SEMC. Figure 13 below outlines SSE's assessment of this option against the SEMC criteria 1 through 4.

Criteria Number	Criteria Description	SSE Assessment of Option against Criteria
Criteria 1	Impact on the consumer and Dispatch Balancing Costs	Pro rata will save the consumer significantly in comparison to the implementation of grandfathering. The increase in cost of compensation for Option2 Vs Option 1 is outweighed by the benefits of reduced energy production costs de to associated build out rates.
Criteria 2	Facilitation of Ireland and Northern Ireland 2020 Renewable Targets	Pro rata will allow the 2020 renewable targets to be achieved as delivery is not restricted to the availability of firm access and curtailment is fairly and equitably divided.
Criteria 3	Efficiency of Entry Signal	Pro rata provides a positive entry signal to viable future projects regardless of firm access.
Criteria 4	Stable Investment Environment	Pro rata provides a stable investment environment for both existing and future projects with increased certainty around curtailment and build out rates.

Figure 13: SSE Assessment of Option 2 under SEMC Criteria 1 - 4

2.2.1 Impact on the consumer and Dispatch Balancing Costs

Option2 will produce a net market savings in comparison Option 1, 3 and 4.

Build Out Rates

This option will provide far more certainty that we will meet renewable targets by 2020 when compared to a grandfathering scenario where build out rate is entirely dependent on the availability of firm access. The delinking of the application of curtailment and firmness under Option 2 will encourage viable projects to connect earlier.

Net Market Savings

As a result of independent analysis carried out by ElectroRoute, SSE believes that pro rata will save the consumer a significant amount of money in comparison to a grandfathering approach. SSE believes that the pro rata approach will lead to increased build out of wind, reducing the overall energy production costs in the SEM. While the cost of compensation in 2020 is €27m larger for Option 2 than Option 1, the increased build out rate results in wind related savings of €147m in 2020 for Option 2 in comparison to Option 1.

Therefore Option 2 will have a net market saving of €127m in 2020 alone, in comparison to Option 1 as shown in Figure 4 and 5.

The SEMC note that this "extra wind" provided by the pro rata option will further dampen the SMP. SSE believes there will be a dampening of SMP in the short-term but will probably not be borne out in the long-term under the current design for deriving SMP due to its dependency on 'number of starts', that will eventually work against this dampening. We believe it is more accurate to measure impact on overall energy production costs in the market which we have shown to be significantly reduced under pro-rata regimes versus grandfathering.

Natural Caps

Pro rata provides some natural protection against overbuild versus targets. In ROI, REFIT will not be released in quantities much in excess of national targets[7], creating a de facto cap. In NI there will be a de facto cap on capacity in NI due to wider Electricity Market Reform policy changes (post-2017)[8]. Investment in projects will become less viable as more wind is added to the system and overall curtailment levels increase; this will significantly slow down the rate of connection beyond that required on the system and is dependent on future targets and implementation of mitigation measures.

Increased Curtailment from Increased Wind

SSE accepts that with more wind on the system there may be higher levels of curtailment; however increased levels of wind penetration are required in order to efficiently meet renewable targets. Therefore curtailment can and should be mitigated by delivery of DS3, greater interconnection and the reduction of minimum generation levels for conventional plant.

Grid Roll-Out

Pro-rata supports building of non-firm projects in advance of their firm connection date; this will facilitate the roll-out of Grid development projects both North and South. Projects will connect and

[7] The REFIT 2 support scheme has a quantitative limit of 4000MW in total between onshore wind, hydro and biomass landfill gas. The earlier REFIT 1 support scheme applied for 400MW of biomass, hydro or wind capacity, with a reserve list to allocate additional support that might become available.

[8] In the Draft Energy Bill, the UK Government, informed by evidence from National Grid and SONI will have control of auction volumes for the low carbon generation support mechanism, Contracts for Difference.

will not only pay their shallow connection costs but will also contribute to the TUOS fund, which in turn will finance Grid development projects. This will remove unnecessary risk from the consumer; once a site is energised the revenue stream that will flow to the TUOS fund has a high degree of certainty for the lifetime of the project.

2.2.2 Facilitation of Ireland and Northern Ireland 2020 Renewable Targets

A pro rata approach will support the delivery of the Government 2020 renewable targets. Please refer to Figure 12 for estimated build out rates for all proposed options.

As noted by the SEMC, curtailment is a system-operation issue and therefore highly dependent on how the system is operated in real time, hence firm access and the conditions resulting in curtailment are unrelated. Pro rata provides a more equitable option than grandfathering, in that curtailment and firm access are delinked in terms of dispatch.

Therefore, under pro rata, the delivery of the 2020 renewable targets is not dependent on the availability of firm access which is not within the generators control. Under the pro rata approach the delta experienced by all generators is much less than the significant delta that would be experienced by a large group of existing and potential generators under grandfathering. It is clear that pro rata is the most equitable option of equal burden sharing, improving the overall financial viability of future generation and protecting all existing generation. A pro rata approach will provide a positive entry signal and stable investment environment and as a result will ensure delivery of wind achieves 2020 renewable targets.

Grandfathering will make many non-firm investments unviable until firmness is obtained, however this can be due to the new curtailment regime alone and not necessarily linked to a high constraint area. Please refer to Section 2.1 which details the SSE Case study of Galway West, 170MW, which would be not built as planned under grandfathering regardless of the fact that it is an unconstrained area.

It is agreed that allocating curtailment for all wind generation in an equal fashion is a more equitable solution.

2.2.3 Efficiency of Entry Signal

A pro rata approach will send a positive entry signal to the market up to a point.

Under this option the application of curtailment and firmness will be delinked, removing the restriction on non firm generators to build. Curtailment will be evenly spread, encouraging viable wind to connect but creating certainty in the likely levels of curtailment associated with 2020 renewable target build out rates. The entry signal will incentivise viable projects to connect to the system.

Pro rata will provide some natural protection against overbuild versus targets as detailed in Section

2.2.1. However, SSE understands that this may not provide sufficient comfort to the SEMC. As a result SSE supports the IWEA proposal, Option 3b which manages these concerns.

2.2.4 Stable Investment Environment

SSE believes that a pro rata approach to curtailment will provide a stable investment environment up to a point.

SSE agrees with the SEMC that as all wind farms, both firm and non-firm are effectively “contributing” to the problem of curtailment, that attributing this problem across wind farm generators in an equal fashion, will provide greater certainty for all projects (connecting or expected to connect) and not just a particular subset of wind farms (i.e. firm). As all wind farms are contributing to the issue it is equitable that all wind farms see an impact.

SSE supports the SEMC proposal “that as pro-rata equitably manages curtailment by turning down all generation equally to meet system stability limits, this establishes a reasonable principal by which risk can be assessed by potential investors.” Furthermore, if projections are inaccurate and curtailment levels turn out to be marginally higher than expected the delta impact on wind farms, once curtailment is evenly divided, is much smaller and an easier risk to manage.

While there is uncertainty on curtailment levels post 2020 this remains the case for all methods of allocation of curtailment. At present the focus must be on delivering the 2020 targets in an efficient manner and minimum impact on the consumer, with a view to implementing a management system that enables the continued delivery of wind beyond this point if required.

2.3 Option 3 – Temporary Pro-Rata

SSE does not support this option.

SSE does not support this option, particularly as non firm operational projects are grandfathered from the cut off point and as result will experience excessive curtailment levels that will make them unviable. Therefore, this option differs only slightly from Option 1 as it is essentially grandfathering with a few years delay, either to January 2018 or until Government targets have been met. SSE does not believe that the renewable targets will be met by January 2018, particularly if there is a link between allocation of curtailment and firmness, and as such this option has two potentially very different changeover dates.

The achievement of firm access is beyond the control of the generator and there is still no reliability in the firm access dates which are provided; generators cannot be certain of their status when the changeover occurs. While this may provide certainty in the short term it does nothing for the long-term certainty of these projects, will delay future build out, put the efficient achievement of Government targets at serious risk and only improves the bankability of some projects.

SSE believes that this option will not deliver on any of the four criteria required by the SEMC. Figure 14 below outlines the SSE assessment of this option against the SEMC required criteria 1 through 4.

Criteria Number	Criteria Description	SSE Assessment of Option against Criteria
Criteria 1	Impact on the consumer and Dispatch Balancing Costs	This option produces a similar economic impact as grandfathering, which is the worst of all options proposed.
Criteria 2	Facilitation of Ireland and Northern Ireland 2020 Renewable Targets	This approach will not deliver on the 2020 renewable targets as it creates huge uncertainty at the changeover point. In addition the build out rate is dependent on firm access availability for which there is insufficient to meet renewable targets.
Criteria 3	Efficiency of Entry Signal	This approach has a similar impact on the entry signal as straight grandfathering – only firm projects should build. Firm MW ≠ Operational MW.
Criteria 4	Stable Investment Environment	Generators cannot be certain of their status when the changeover occurs and therefore the only stability this approach brings is certainty not to build until firmness is delivered.

Figure 14: SSE Assessment of Option 3 under SEMC Criteria 1 - 4

2.3.1 Impact on the consumer and Dispatch Balancing Costs

This option produces the same economic impact as the base case of grandfathering, which is the worst of all options assessed.

SSE believes all of the arguments outlined in Option 1 will also apply to this option, the only difference being that some of the existing non-firm sites should be firm by 2018 and therefore protected from grandfathering. At the same time, non-firm sites, and certainly sites which are reliant on high risk grid reinforcements will not build until firm. This is clearly shown in Figure 12, where the estimated build out rates for all options are provided, showing Option 3 and Option 1 having the lowest build out rate.

The SEMC note that "the point raised in Option 2 concerning the impact on DBC being somewhat off-set or balanced by a possible slight decrease in the level of SMP applies here also" and that "this option would facilitate early connection of wind which should dampen SMP." This option cannot be compared to Option 2 as the build out rates will clearly not be the same. It cannot be assumed that non-firm generators will build to avail of a few years of pro rata when they will be grandfathered at the changeover point and get hit with excessive curtailment rates. This option is firmness dependent, projects will still only build when firmness has been delivered or is definite in the short term. Given the likely delays in the delivery of firmness, build out rates will be slower than under a pro rata option and will deliver fewer MW by 2020. This option cannot facilitate the early connection of wind, particularly when compared to a pro rata option.

The SEMC continue by stating that "post achievement of the renewable targets (or post a certain date), DBC would be lowered as non-firm generation are not entitled to constraint compensation and these generators would be turned down first". Firstly, this option will not support the delivery of the 2020 renewable targets. Secondly, the ElectroRoute analysis shows that while this option will have a lower compensation cost than Option 2 or 3b due to its lower build out rate, it will result in higher energy production costs. This option will have a similar economic impact to that of Option 1, grandfathering.

2.3.2 Facilitation of Ireland and Northern Ireland 2020 Renewable Targets

This approach will not support the delivery of the Government's 2020 renewable targets in Ireland and Northern Ireland.

The achievement of firm access is beyond the control of the generator and FAQ dates are unreliable and subject to change up until written confirmation is received of firm access level. Generators cannot be certain of their status when the changeover occurs. While this may provide certainty in the short term it does nothing for the long-term certainty of these projects. This option will delay future build out and put the achievement of Government targets at serious risk without significantly improving the bankability of most projects.

While we agree with the SEMCs comment that "as noted in Option 2 it has been argued to the SEMC that placing curtailment on all wind generation in an equal fashion is a fairer solution, considering it is not a network-specific issue" this option only does so for a period of time with many potential generators having no certainty over their status when the changeover occurs. Therefore, Option 3 as suggested is more comparable to Option 1 than Option 2. It is accepted that Option 3 is likely to deliver the same amount of wind as Option 1 which is less than Options 2, 3b and 4 as shown in Figure 12.

This temporary pro rata option makes long term projects only marginally more financially viable than grandfathering, but as the approach is still firmness dependent it will not ensure 2020 targets are achieved.

A date for the implementation of grandfathering, will only encourage firm or soon to be firm projects to be incentivised to accept their offers and start building their plant. As there is likely to only be a small amount of non firm on the system at the changeover point this non firm will take all of the hit of curtailment, annihilating the viability of non firm projects; generators will not take this risk.

2.3.3 Efficiency of Entry Signal

This approach only provides a positive entry signal for firm generators and as such will fail to meet 2020 targets.

SSE supports the onus put on the SEMC to have regard to the need, where appropriate, to promote the use of energy from renewable energy sources. This option promotes firm projects as opposed to strong, viable projects.

It is agreed that increasing levels of wind generation connecting to the system will increase curtailment levels. However, this can be mitigated by delivery of DS3, greater interconnection and reductions in minimum generation levels for conventional plant. In addition, increasing levels of curtailment will more significantly affect connected parties ability to finance their activities if they are non-firm and therefore without compensation. If they are firm, the delta they experience is marginal in comparison to that of a group of non firm generators who transfer from pro rata to grandfathering based on firmness. Therefore, everyone feels a small impact as opposed to one group feeling a detrimental impact.

SSE does not agree that this option “treats curtailment in a manner which allows generation irrespective of firmness to connect and contribute to the achievement of the targets, yet limits the exposure of customers post achievement of the targets is an appropriate way.” Generators will not connect until they are firm unless they are certain of their status at the changeover point, preventing targets from being achieved. Protection is required for generators that are contributing to the renewable targets and should experience pro rata for their operational life, please refer to the IWEA Option 3b.

Grandfathering that is based on firm access could annihilate an otherwise strong yet non firm project; the level of curtailment allocated to the project would make it unviable. The assumption that non firm projects are not otherwise viable is incorrect, unless the definition of viable is reduced to that of firmness, SSE believes that viability should reflect the economic efficiency of investments, as well as factors like land control, wind resource and planning permission. SSE agrees that over-incentivisation of connection beyond the 40% renewables target will not necessarily be efficient and have a direct impact on consumers in terms of grid roll-out and the Public Service Obligation levy. SSE believes that Option 3b can better manage potential over-incentivisation, with an approach that properly manages the delivery of the required wind needed to make the system sustainable without significant impacts on existing generation or consumers.

SSE prefers an approach that focuses on delivering the current renewables targets, but also creates a system that will enable the wind industry to continue beyond this point in a sustainable manner as required.

2.3.4 Stable Investment Environment

Given that FAQ dates are unreliable and likely to be significantly delayed; this option will only somewhat alleviate the concern that moving immediately to grandfathering will make non-firm investment in the medium term unbankable, particularly if the January 2018 date is being used as the changeover point as opposed to the achievement of renewable targets. This adds further uncertainty to the investment environment.

The SEMC states that “like Option 2 this option establishes a reasonable principal by which risk can be assessed by potential investors with the knowledge that the treatment of curtailment will change as of say 1 January 2018. Within the interim period, curtailment is shared across all wind generation, irrespective of allocated FAQ, in an equal fashion, until the 40% renewables target has been met on the island.” This statement assumes that the renewable targets will be achieved by January 2018. SSE does not believe that this will be the case, particularly if achievement depends on availability of firm access. This option adds certainty for some firm or soon to be firm projects, but investors may not have certainty or visibility of their status before the relevant changeover point. If there is any uncertainty regarding firmness projects will not build until firmness has been delivered.

The SEMC note that “generators who are still non-firm by the time the 40% targets are nonetheless in a better position than under option 1, as they will have seen lower levels of curtailment in the year preceding achievement of the targets, plus they will be closer to their firm date.” However, if a generator is non-firm at this point it will suffer so much curtailment that it will not be viable, rational investors will not take significant risks for the benefit of a few years pro rata curtailment.

2.3b Option 3b – IWEA Proposal – Pro Rata to Government Targets

SSE supports this option which is an amended version of the SEMC proposal Option 3; as it provides additional comfort to the SEMC with regard to overbuild while protecting projects that contribute to the 2020 renewable targets. This option provides a positive entry signal to ensure delivery of 2020 targets by providing certainty surrounding the investment environment. The high level principles for Option 3b are as follows:-

A. There should be a tranche of projects required to deliver the MW required to meet the 2020 targets in each jurisdiction independently, which would be curtailed for the operational lifetime of the project on a pro-rata basis. These projects would be protected from higher curtailment as a result of further connections.

B. Any projects connected and exporting power by a cut off date (no earlier than 1 January 2018 or at a later date if targets are unlikely to have been met by this time), will be in this first tranche.

C. This tranche could in principle grow in size, but in a controlled fashion as curtailment mitigation measures arrive such that it doesn't apply higher curtailment than would otherwise have been expected.

D. The treatment of new projects post the achievement of the 2020 targets will need to be defined at a later date.

E. Projects being developed explicitly for export should not add to the curtailment of projects that contribute to 2020 targets.

SSE believes that this option will deliver under all of the four criteria required by the SEMC. Figure 15 below outlines the satisfaction or failure, as appropriate, of this option against the SEMC required criteria 1 through 4.

Criteria Number	Criteria Description	SSE Assessment of Option against Criteria
Criteria 1	Impact on the consumer and Dispatch Balancing Costs	This option will save the consumer money in terms of a significant reduction in energy production costs which far outweigh the costs of compensation in this option. Therefore has a positive impact in comparison to grandfathering.
Criteria 2	Facilitation of Ireland and Northern Ireland 2020 Renewable Targets	This option clearly focuses on delivering the 2020 renewable targets.
Criteria 3	Efficiency of Entry Signal	This option provides an efficient signal to those projects that will contribute to the 2020 targets and a reasonable signal to projects beyond this date to be cognisant of the market and target scenario at the time. It will also ensure earlier delivery of wind projects.
Criteria 4	Stable Investment Environment	This option provides certainty around a clear stable investment environment as projects can be clearly classed as contributing to the 2020 renewable targets or not.

Figure 15: SSE Assessment of Option 3b under SEMC Criteria 1 - 4

2.3b.1 Impact on the consumer and Dispatch Balancing Costs

Option 3b will reduce energy production costs and provide a net market saving in comparison to grandfathering.

Option 3b is an amended version of pro-rata curtailment. It is assumed that compensation will continue to be paid in the current manner (i.e. compensation for curtailment up to FAQ) and ElectroRoute's economic analysis is based on this assumption.

This option recognises that the application of curtailment and firm access are unrelated and it shares the burden of curtailment equitably between generators. As a result, it will incentivise delivery of efficient wind projects and not provide a perverse incentive to build more capacity than consumers require. Our quantitative analysis also shows that this option will deliver material financial savings to consumers.

Option 3b will encourage wind to build out to achieve the 2020 renewable targets, whereas as previously noted grandfathering will fall significantly short of these targets. When comparing this option to grandfathering it is true that there is an increase in compensation costs of approximately €27m in 2020.

<u>However, due to the increased build out rate under Option 3b, there is a reduction in energy production costs of €147m in 2020, providing net market savings of €127m in 2020 under Option 3b in comparison to Option 1.</u>

SSE believes that Option 2 will reach some form of natural cap for various reasons, as stated under Section 2.2.1; however it appreciates that the SEMC may not be fully comfortable with this option. SSE believes that Option 3b will provide the comfort required in focusing on the delivery of the current 2020 targets.

2.3b.2 Facilitation of Ireland and Northern Ireland 2020 Renewable Targets

Option 3b will deliver the 2020 renewable targets. Please refer to Figure 12 for estimated build out rates for all proposed options.

Option 3b focuses on the delivery of the 2020 renewable targets while creating a method for management of continued development as required beyond this point. Generators have an explicit MW target at which to aim and as a result they accelerate their projects to participate in the capacity as required by Government policy. The cut off point allows for review within a secure policy framework and therefore provides a decision point for developers that believe they can provide the final MW to reach the overall capacity target.

Furthermore, this option will incentivise projects with all the elements required for viability rather than incentivising projects solely on the basis of their firmness. Therefore projects can build when they are ready, not restricted to unreliable firm access dates, hence more likely to build earlier, contributing to the 2020 renewable targets in a more timely manner. As noted above, this option improves on Option 2 by providing comfort around uncapped curtailment but encourages build out to achieve the 2020 renewable targets.

2.3b.3 Efficiency of Entry Signal

Option 3b provides an efficient entry signal.

Option 3b provides a positive entry signal for strong projects, regardless of their firm access, to ensure Government targets will be achieved. Furthermore, Option 3b provides a signal beyond the renewable targets to connect at a level that is aligned to further mitigation measures or extended renewable targets.

SSE supports the suggestion that the use of December 2018 is a more appropriate proxy for when the government target will be met rather than January 2018. However, this date is clearly linked to the achievement of Government targets and the cut off will fall on whichever point is the later. This date can be extended as can the MW but not brought forward or reduced. This date and the linked achievement of targets will obviously need to be reviewed on a regular basis, sufficiently in advance of the date to ensure a clear signal issues if further build is required to meet renewable targets.

2.3b.4 Stable Investment Environment

Option 3b provides a stable investment environment for those projects required to achieve the 2020 targets while allowing for further development as required.

As all projects are curtailed on the same basis to a cut off point, developers can form their own views as to the likely impact of curtailment for their projects and will seek to deploy their strongest projects. This framework offers a lower-risk environment that provides a robust basis for economic assessment of projects.

2.3b.5 Compensation

It is essential to ensure sufficient wind capacity is in place to meet Government policy requirements. While different compensation regimes carry different costs, energy production costs in aggregate are reduced as the capacity of wind connected increases. Only pro-rata curtailment delivers a risk environment in which the best projects can be delivered; grandfathering creates such a level of risk that targets will be significantly undershot.

The precise compensation framework is only important in determining the share of benefit between developers and consumers, but we believe that an important principle in deciding such a framework must be that consumers do not face an open-ended bill for compensating generation capacity in excess of the level required to meet demand. A cap to compensation will ensure that there is an economic incentive to limit wind development to an economically-useful level.

Option 3b is recommended assuming that the compensation regime remains as is, i.e. compensation up to FAQ. When comparing this option to grandfathering it is true that there is an increase in compensation costs, approximately €27m in 2020. However, due to the increased build out rate under Option 3b, there is a reduction in energy production costs of €147m in 2020, providing net market savings of €127m in 2020 under Option 3b in comparison to Option 1.

2.4 Option 4 – Pro-rata with generators taking the risk

SSE does not support this option.

SSE believes that this option will only deliver on one of the four criteria required by the SEMC. Figure 16 below outlines the SSE assessment of this option against the SEMC required criteria 1 through 4.

Criteria Number	Criterion Description	SSE Assessment on Deliverability of Option 4
Criteria 1	Impact on the consumer and Dispatch Balancing Costs	Option 4 will have no cost of compensation, however due to the lower build out rate under this option it will not benefit from the energy production cost savings of Options 2 and 3b. Therefore the net market savings of this option is much less than that of Option 2 and 3b.
Criteria 2	Facilitation of Ireland and Northern Ireland 2020 Renewable Targets	This option will not deliver on 2020 targets as some projects will be made unviable with the removal of compensation.
Criteria 3	Efficiency of Entry Signal	This option will not provide an efficient entry signal to viable generation due to uncertainty over curtailment levels combined with the lack of compensation. As a result it will fail to meet the Governments 2020 targets.
Criteria 4	Stable Investment Environment	This option will not provide a stable investment environment to sufficient viable generation, due to uncertainty over curtailment levels combined with the lack of compensation, to meet the Governments 2020 targets. As curtailment is a risk that cannot be managed by the generator, SSE believes that compensation is appropriate.

Figure 16: SSE Assessment of Option 4 under SEMC Criteria 1 – 4

2.4.1 Impact on the consumer and Dispatch Balancing Costs

SSE believes that much less wind generation will connect in this option due to the uncertainty over curtailment levels combined with the lack of compensation. This, which would be seen as a retrospective change will certainly impact on the business case of many wind projects.

Option 4 will have no cost of compensation, however due to the lower build out rate under this option it will not benefit from the energy production cost savings of Options 2 and 3b. Therefore the net market savings of this option is much less than under Option 2 and 3b.

As curtailment is a risk that cannot be managed by the generator, SSE believes that it is inappropriate to place further risk on the developer and therefore compensation is appropriate. This option will require a fundamental change to how the market is settled. Introducing this regime will have a significant negative impact on existing plant that has been developed on the basis of the current compensation rules, causing financial difficulty for existing investments.

Compensation is a separate issue, about which there are many options, this should be subject to further consultation. The exact treatment of compensation should reflect European law and is a topic for later consultation. This aspect of the structure of the market schedule was discussed in detail in the "Wind in the SEM consultation" where as recently as August 2011 the SEM Committee decided not to change. Further to this lost revenue due to curtailment was not taken into account in the calculation of REFIT or ROC price levels, i.e. compensation for curtailment was assumed to exist. While SSE supports pro rata the form in which is takes is essential to ensure the build out of wind to reach targets. While Option 4 will have no compensation cost, Option 2 and 3b will provide a higher build out rate and therefore have a higher reduction in energy production costs, offsetting any cost of compensation under these options.

2.4.2 Facilitation of Ireland and Northern Ireland 2020 Renewable Targets

This option will not deliver the Governments 2020 renewable targets. Please refer to Figure 12 for estimated build out rates for all proposed options.

SSE believes that this approach will make many wind projects financially unviable and as a result there will be a lower build out rate. The SEMC suggests that wind generation willing to connect on a non firm basis under Options 2 and 3 have already taken account of an acceptable level of curtailment and are less linked to the availability of market compensation. However, business cases such as these have taken account of non compensated non firm access for a period of time as opposed to the operational life time of the project which provides very different results in terms of financial viability.

2.4.3 Efficiency of Entry Signal

This option will not provide an efficient entry signal to viable generation due to uncertainty over curtailment levels. As a result it will fail to meet the Governments 2020 targets.

This approach will encourage in the first instance high capacity factor projects to connect, however it is SSE's belief that availability of these projects will be sufficient to deliver on the 2020 renewable targets. In addition to this, strong projects may not be in a good location in terms of network, i.e. considerable distance from network and may cause the delivery of a different network than under options 1 - 3.

2.4.4 Stable Investment Environment

This option will not provide a stable investment environment for sufficient renewable generation required to meet the Governments 2020 targets due to uncertainty over likely curtailment levels

There is currently over 2000MW of operational wind generation on the island that has been receiving compensation up to FAQ. The retrospective implementation of this option will have a significant negative impact on the current operational portfolio. This will impact the financial stability of these existing projects where investments have already been made and send a negative signal for future investment.

The SEMC has responsibility for ensuring that efficient generators are in a position to finance their activities. Option 4 would represent a fundamental change to the SEM principles and does not ensure that all efficient generators are in a position to finance their activities due to:-

- Retrospective impact on existing generators
- Uncertainty surrounding build out rates
- Uncertainty surrounding curtailment

3. Conclusion

It has been clearly shown that **<u>only</u>** Option 2 and Option 3b will deliver on all of the SEMC assessment criteria.

	Option 1	**Option 2**	**Option 3**	**Option 3b**	**Option 4**
Criteria 1	Used as Base case for comparison	Net Market Savings of €127million p.a. in 2020 V's Grandfathering	Same Economic Impact as Grandfathering Base Case	Net Market Savings of €127million p.a. in 2020 V's Grandfathering	Net Market Savings of €36million p.a. in 2020 V's Grandfathering
Criteria 2	84.4% in 2020	105.9% in 2020	84.4% in 2020	105.9% in 2020	88% in 2020
Criteria 3	Negative Signal	Positive Signal	Negative Signal	Positive Signal	Negative Signal
Criteria 4	Non firm will not build	SSE believe there will be some form of natural cap but Option does not provide formal cap	Uncertainty around status at changeover	Provides cap for generators to work towards	Negative impact on existing plant, creates barrier to build out of projects to reach targets
SSE Support	No	Yes	No	Yes	No

Figure 17: Summary Position on Options

3.1 Impact on the consumer and Dispatch Balancing Costs

Option 2 and Option 3b will create a net market saving in comparison to grandfathering considering that the wind related savings outweigh the cost of compensation.

3.2 Facilitation of Ireland and Northern Ireland 2020 Renewable Targets

Option 2 and Option 3b will deliver on the 2020 renewable targets in Ireland and Northern Ireland.

Option 1, 3 and 4 will fail to deliver on the 2020 renewable targets in Ireland and Northern Ireland.

3.3 Efficiency of Entry Signal

Option 2 and Option 3b will provide a positive entry signal to strong viable projects.

Option 1 and 3 provide a negative entry signal and will prevent viable non-firm projects from connecting.

Option 4 provides an inefficient entry signal to all viable generation due to uncertainty over curtailment levels.

3.4 Stable Investment Environment

Option 2 and 3b will create a stable investment environment for both existing and future projects.

Option 1, 3 and 4 create unstable investment environments for both existing and future projects. They create extensive uncertainty surrounding future curtailment levels.

APPENDIX B

Firm Access Quantity Analysis Report

Unit 4
Village Court
Lucan
Co. Dublin
Tel: +353 1 621 9069
Email: info@gridsolutions.ie

Title:		Firm Access Quantity Analysis Report			
Prepared for:		SSE Renewables			
Issue No	Revision Comment	Issue Date	Author	Reviewer	Approver
1	Original	23/5/12			
Document Reference: 248-102 Firm Access Quantity Analysis Report v1.docx					

No representation or warranty, express or implied is made by Irish Grid Solutions as to the accuracy or completeness of any information contained in this report, and Irish Grid Solutions, accepts no responsibility in relation to such information whether fact, opinion, expectation or otherwise, or for any opinion or conclusion which the addressee may draw from this report.

The contents of this report are for confidential use of only those parties to whom it is addressed, and may not be reproduced or circulated in whole or in part.

1 Introduction

The Single Electricity Market Committee (SEMC) published a consultation paper in April 2012 entitled "Treatment of Curtailment in Tie-Break situations" (SEM-12-028). The consultation relates to how curtailment will be allocated, with a number of options being considered including pro-rata and grandfathering. The grandfathering proposal is based on the principle of non-firm generators being curtailed before generators with firm access. If the regulators decide to adopt this grandfathering approach, analysis by industry has concluded that it will only be viable for windfarms with firm access to connect. Hence the Firm Access Quantities (FAQ) of wind farm projects could become one of the critical factors in deciding when windfarms connect.

Irish Grid Solutions (IGS) has been commissioned by SSE Renewables to undertake a high level review of FAQs for windfarm projects in Ireland and Northern Ireland. This analysis will help to establish if it is likely that the 2020 renewable targets of 40% can be achieved in Ireland and Northern Ireland if grandfathering based on firmness is adopted for the allocation of curtailment.

2 Scheduled Firm Access Quantities

2.1 Ireland

EirGrid published scheduled FAQs for Gate 1, 2 and 3 generators in 2010 and 2011, with the total FAQs relating to wind farms presented in **Figure 2.1** below. The scheduled dates include some optimistic assumptions on the completion of deep reinforcement projects. As there is currently no renewable support scheme available for offshore wind generation in Ireland all east-coast Gate 3 offshore projects were removed from the analysis.

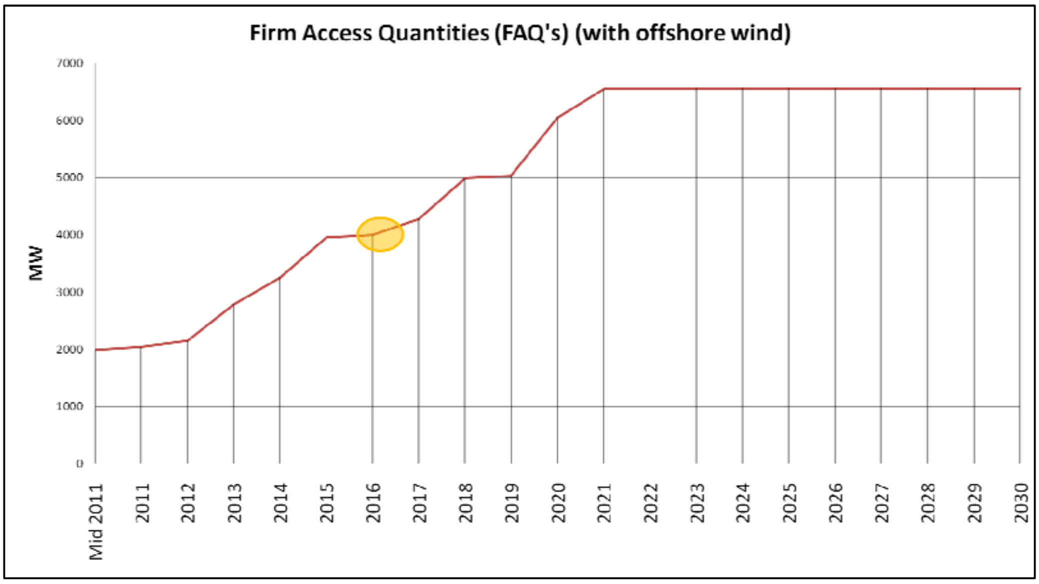


Figure 2.1: Ireland FAQs (published by EirGrid in 2010 and 2011)

Based on current and predicted demand levels it is estimated that approximately 4,000MW of wind generation will be required to meet the government's 40% renewable targets in 2020. Current scheduled FAQs presented in **Figure 2.1** indicate that 4,000MW of firm access would be available during 2016.

2.2 Northern Ireland

SONI published indicative FAQ information as part of the Connection Process Consultation in October 2011. The analysis assumed that the 400MW of wind generation already connected will have firm access. The analysis reviewed the FAQ for the 907MW of wind generation that had received planning at the time of publishing the consultation. SONI analysis found that approx 730MW of the 907MW would receive firm access when NIE's medium 110kV works are complete. Although there is available firm access in the eastern half of Northern Ireland the windfarm projects in the west of Northern Ireland would require new 275kV works (Renewable Integration Development Works - RIDP) before they would receive firm access.

Approximately 1300 MW of wind generation is required to meet the government's renewable target in Northern Ireland. Considering the likely timeline to complete the RIDP works there does not appear to be sufficient scheduled firm access for onshore wind generation in Northern Ireland to meet the 2020 renewable target.

3 Firm Access Quantity Analysis

As outlined in Section 2, FAQs are related to the scheduled completion dates of deep reinforcement projects associated with each wind farm. Furthermore the FAQs currently published are based on optimistic deep reinforcement completion dates. For example, in the initial Gate 3 FAQ analysis it was assumed that the North-South Interconnector would be complete in 2012/13. The earliest date for this circuit to be complete is now 2017. This new scheduled date is based on no further delays during the planning, wayleaving or construction process. Considering the scale, complexity and public opposition it is IGS' opinion that it will realistically be 2020-2025 at the earliest before this circuit is complete.

Based on IGS' database of connection offers, together with the assumptions outlined below, IGS have reviewed the deep reinforcements associated with each wind farm project. The deep reinforcements for each project were categorised being low, moderate or high risk in accordance with the following assumptions:

- Low Risk: Circuit upgrades or new infrastructure in construction, for example upgrading the Cahir-Tipperary 110kV line: potential delays assumed = 1-3 years;
- Medium Risk: New infrastructure, for example new 110kV lines or 220/400kV substations, for example the new 400kV substation at Portlaoise: potential delays assumed = 2-4 years; and
- High Risk: New 220-400kV circuits, for example the new N-S 400kV interconnector or Cork-Dublin 400kV circuit: potential delays assumed N-S interconnector 2020-2023, other 275/400kV circuits = 5-10 years.

Low, moderate and high delay scenarios were then associated with the deep reinforcement categories as presented in **Table 1** below.

It should be noted that windfarms will have multiple deep reinforcements. Therefore there is a cumulative risk to delay to the FAQ. For example, if a windfarm had associated deep reinforcements of only one 110kV upgrade it would be reasonable to assume that in terms of the low delay scenario it should be considered that the upgrade is complete on schedule. However in reality projects will have multiple 110kV upgrades associated so it is reasonable to assume that at least one of the upgrades will be delayed by one year for the low delay scenario.

Deep Reinforcements	Delay Scenarios (years)		
	Low	Medium	High
Low Risk	1	2	2
Medium Risk	2	3	4
High Risk	5	7	10
N-S Interconnector	2020	2023	2025

Table 1: Firm Access Quantity Analysis Assumptions

As previously outlined, it will be unviable for wind farm projects to connect until they have firm access under a grandfathering scenario. Analysis has shown that even for relatively low levels of average curtailment (2%), under grandfathering non-firm generators would experience curtailment levels over 10%. Hence a further key assumption for this analysis is that wind farms will not connect until they have firm access.

It should be noted that FAQ and curtailment levels are only one of many critical factors that have to be in place before a project can commence construction. To clearly illustrate this point there are pre-gate windfarms that have had grid connection offers and firm access since pre-2005 but are only connecting in 2011 and 2012. However to ensure the analysis is conservative it has been assumed that it will take only one year for a project to connect after it has obtained firm access.

4 Firm Access Quantity Analysis Results

Taking into consideration current FAQs presented in Section 2, coupled with IGS' FAQ analysis outlined in Section 3, set out below are the results of the FAQ analysis for Ireland and Northern Ireland, together with All-Island FAQ results.

4.1 Republic of Ireland

Figure 4.1 below present EirGrid's scheduled FAQ levels, together with the FAQs for IGS' low, medium and high delay scenarios.

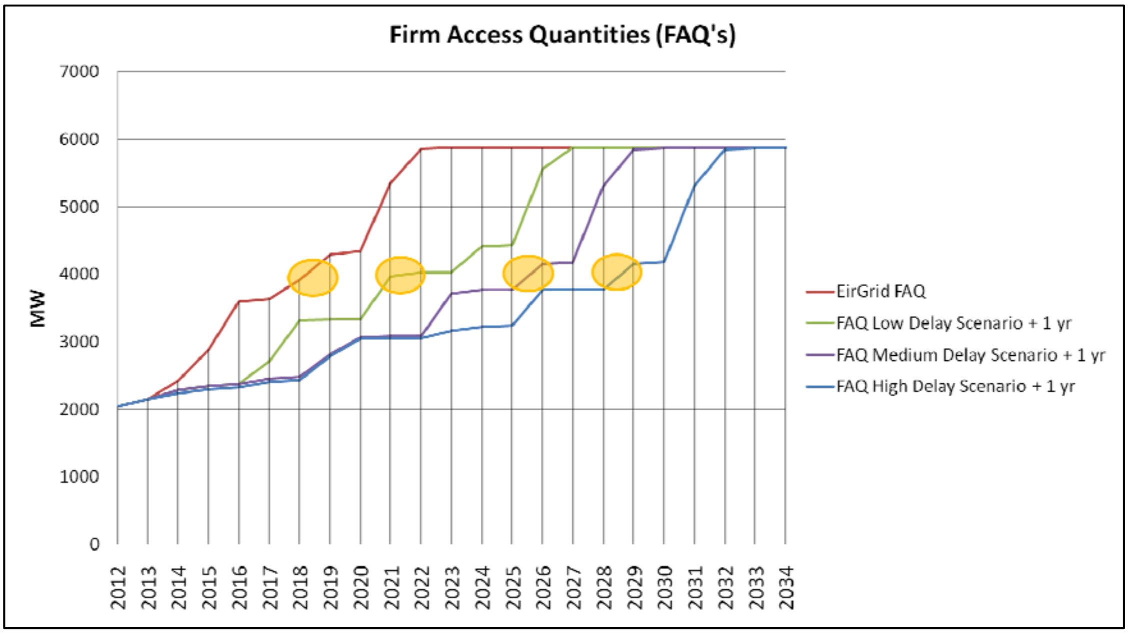


Figure 4.1: Ireland FAQs

As outlined in Section 2, based on current and predicted demand levels it is estimated that approximately 4,000MW of wind generation will be required to meet the government's 40% renewable targets in 2020. However in the event that there are delays in delivering deep reinforcement projects, firm access may not be available until 2021 (low delay scenario), 2025 (medium delay scenario), or 2028 (high delay scenario) as shown in **Figure 4.1.** It can be clearly seen that the government's 40% renewable target would not be realised by 2020 under the grandfathering option.

4.2 Northern Ireland

Figure 4.2 below presents the FAQs for IGS' low, medium and high delay scenarios for Northern Ireland. The NIE 110kV medium term works are assumed to be complete in 2017 (low delay), 2018 (medium delay) 2019 (high delay). The RIDP 275 kV works are assumed to be complete in 2024 (low delay), 2026 (medium delay) 2029 (high delay). It is assumed that the majority of new onshore windfarms will have the RIDP works associated as a deep reinforcement. However an additional 15MW of firm access was added annually to allow for windfarms connecting outside of the area requiring the RIDP works.

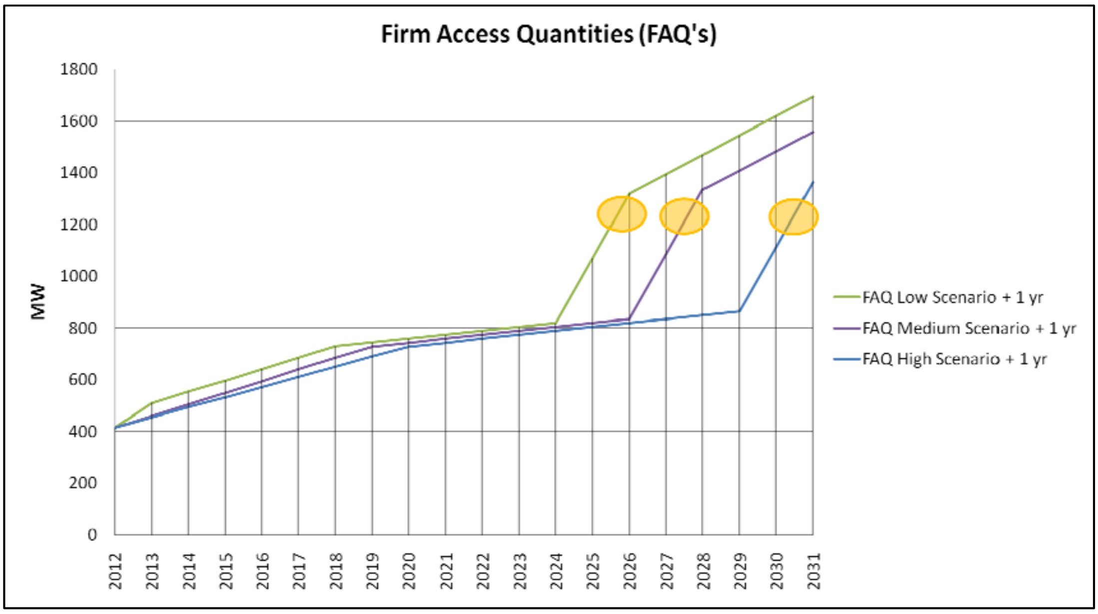


Figure 4.2: Northern Ireland FAQs

Assuming 1250MW of wind generation is required to meet the 2020 renewable target in Northern Ireland the IGS analysis suggests that it will be 2025 (low delay scenario), 2027 (medium delay scenario), or 2030 (high delay scenario) before there will be sufficient wind generation connected to meet the renewable target. It is clear that the government's 40% renewable target would not be realised by 2020 under the grandfathering option.

4.3 All-Island

Taking into consideration the FAQ results for Ireland and Northern Ireland outlined in Sections 4.1 and 4.2, **Figure 4.3** below presents All-Island FAQs for IGS' low, medium and high delay scenarios.

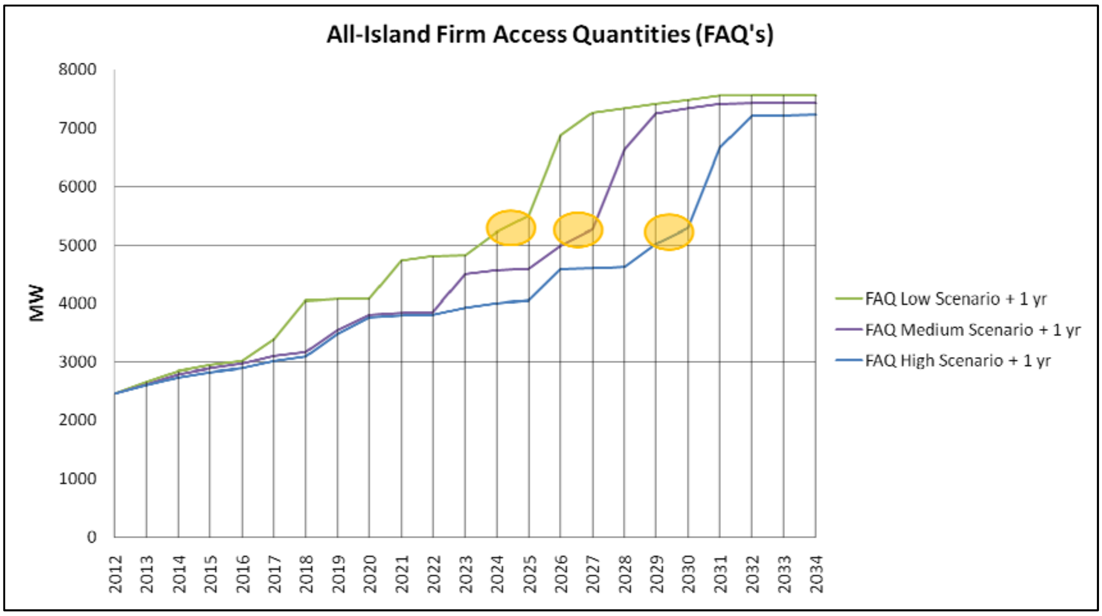


Figure 4.3: All-Island FAQs

Based on current and predicted demand levels it is estimated that approximately 5,250MW (ROI: 4,000MW & NI: 1,250MW) of wind generation will be required to meet the 40% renewable targets in 2020 in both jurisdictions. However in the event that there are delays in delivering deep reinforcement projects, firm access may not be available until 2024 (low delay scenario), 2026 (medium delay scenario), or 2029 (high delay scenario) as shown in **Figure 4.3.** It is clear that the 40% renewable target would not be realised by 2020 under the grandfathering option in either Ireland or Northern Ireland.

5 Summary and Conclusion

Irish Grid Solutions (IGS) has been commissioned by SSE Renewables to undertake a high level review of FAQs in Ireland and Northern Ireland. IGS has reviewed the scheduled firm access quantities of all renewable projects in Ireland and Northern Ireland. Based on the level of risk associated with the associated deep reinforcements for each project a low, medium and high delayed FAQ was calculated for each project. A conservative assumption was made that all windfarms connect the year after they receive firm access. This reflects the impact of the grandfathering decision on non-firm generators. However it should be noted that there are many factors required to be in place before a windfarm can proceed to construction, with firm access being only one of these factors.

It is concluded from the FAQ analysis that neither Ireland or Northern Ireland's 40% renewable target will not be realised by 2020 under the grandfathering option.

Curtailment Analysis Study for the Tie-Break Consultation

May 2012

Unit 4
Village Court
Lucan
Co. Dublin
Tel: +353 1 621 9069
Email: info@gridsolutions.ie

Title:		Curtailment Analysis Study for the Tie-Break Consultation			
Prepared for:		SSE Renewables			
Issue No	Revision Comment	Issue Date	Author	Reviewer	Approver
2	Revised Option 3 Build-Out	29/05/12			
1	Includes SSE Comments	28/05/12			
Document Reference: 248-102 Curtailment Analysis Study v2.docx					

1 Introduction

Irish Grid Solutions (IGS) has been commissioned by SSE Renewables (hereafter referred to as the Developer) to undertake an analysis of the curtailment levels likely to be experienced by their portfolio of existing and future wind farm projects in Ireland and Northern Ireland, based on scenarios and input assumptions agreed with the Developer. The study period for the analysis is 2012-2030.

2 Background

Curtailment occurs when renewable generation is constrained down to maintain system-wide security. Curtailment is likely to occur at times of high wind generation relative to demand levels, such as the summer nighttime, or to maintain sufficient inertia on the system from conventional synchronous generation. It should be noted that curtailment is generally a system wide rather than a local issue. Please note that this report does not consider local network constraint issues.

The Single Electricity Market Committee (SEMC) published its decision paper on “Treatment of Price Taking Generation in Tie Breaks in Dispatch in the Single Electricity Market and Associated Issues” in December 2011 (SEM-11-025). This decision document outlines how constraint and curtailment will be allocated between windfarms. In this decision the SEMC proposed that curtailment will be grandfathered in all areas based on the level of firm access associated with the project. For example, a Gate 3 non-firm wind farm will be curtailed off before a gate 3 wind farm with firm access. However on the 29th of March 2012 the SEMC decided to withdraw its decision to grandfather curtailment based on firm access. The SEMC determined that further consultation was necessary to provide an additional opportunity for industry to comment on the merits of the options for the allocation of curtailment. The SEMC subsequently published a consultation paper in April 2012 entitled “Treatment of Curtailment in Tie-Break situations” (SEM-12-028). The consultation relates to how curtailment will be allocated, with a number of options being considered including pro-rata and grandfathering.

3 Methodology

The flow diagram shown in **Figure 1** provides a simple high-level overview of the methodology employed by IGS for the curtailment analysis.

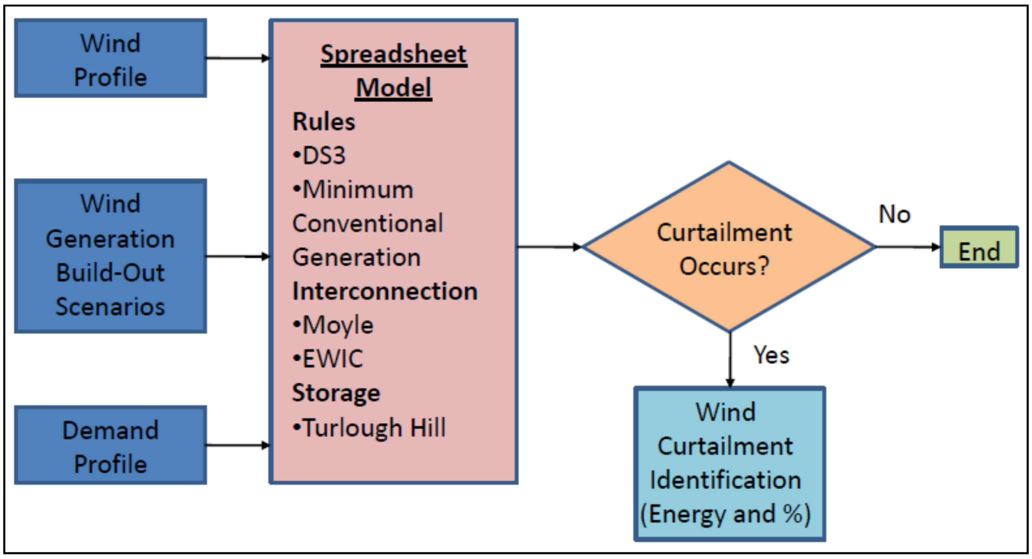


Figure 1: Flow Diagram Overview of Methodology

3.1 Estimation of Curtailment

The curtailment model considers all-island demand, imports, and exports, together with both controllable and uncontrollable wind generation levels. The wind generation levels for each hour period are determined by an unconstrained wind profile provided by EirGrid. The 'perfect foresight' nature of the wind profile assumed could lead to reduced curtailment levels in comparison to what might be experienced in real-time operation.

Curtailment is estimated based on the following binding criteria:

- EirGrid's limits on the Instantaneous Wind Penetration: DS3 50-75% wind penetration thresholds; and
- Minimum Conventional Generation requirements

3.1.1 Limits on the Instantaneous Wind Penetration (DS3)

In order to ensure that the 2020 renewable targets are achievable EirGrid and SONI have to manage the integration of very high levels of instantaneous renewable penetration on the island. The main operational areas that need to be addressed are the management of the system frequency, balancing the system in real time, managing system voltage and ensuring the compliance of plant with the Grid Code requirements. To achieve these objectives, EirGrid and SONI have established a programme of work entitled "Delivering a Secure Sustainable Electricity System (DS3)". This work programme includes enhancing the portfolio performance, developing new operational policies and system tools to efficiently use the plant portfolio to the best of its capabilities, and regularly reviewing the needs of the system as the portfolio capability evolves.

To ensure adequate frequency performance and dynamic stability, the sum of the All-Island instantaneous wind generation (plus interconnector imports) is limited to a percentage of the total All-Island demand (plus interconnector exports). The limit is currently 50%, with EirGrid planning to increase it to 75% before 2020. The levels of curtailment experienced by wind generation in each hourly period due to the DS3 limit is estimated based on the following calculation:

$$\boldsymbol{Demand\ served\ by\ Controllable\ Wind\ Generation} = \{\boldsymbol{DS3}\% \times (\boldsymbol{D} + \boldsymbol{E})\} - \boldsymbol{I} - \boldsymbol{U}$$

where D = Demand
E = Exports
I = Imports
U = Uncontrollable Wind Generation

Curtailment due to limits on the instantaneous wind penetration occurs during periods when:

$$\boldsymbol{Demand\ served\ by\ Controllable\ Wind} < Available\ Controllable\ Wind$$

3.1.2 Minimum Conventional Generation

There is a requirement to have a minimum number of conventional generators synchronized at all times to provide inertia to the power system, ensure voltage stability and to ensure that network limitations are respected. The levels of curtailment experienced by wind generation in each hourly period due to the minimum conventional generational level is estimated based on the following calculation:

$$\boldsymbol{Demand\ served\ by\ Controllable\ Wind\ Generation} = \boldsymbol{D} + \boldsymbol{E} - \boldsymbol{M} - \boldsymbol{I} - \boldsymbol{U}$$

where D = Demand
E = Exports
M = Minimum Conventional Generation
I = Imports
U = Uncontrollable Wind Generation

Curtailment due to minimum conventional generation again occurs during periods when:

$$\boldsymbol{Demand\ served\ by\ Controllable\ Wind} < Available\ Controllable\ Wind$$

The curtailment applicable for each time period is the greater of the curtailment due to:

- Limits on the Instantaneous Wind Penetration: DS3 50-75% wind penetration thresholds;

  OR

- Minimum Conventional Generation requirement

Finally the average annual curtailment is calculated as follows:

$$\boldsymbol{Annual\ Average\ Curtailment}\ (\%) = \frac{\sum \boldsymbol{Curtailed\ Controllable\ Wind\ Generation}}{\sum \boldsymbol{Available\ Controllable\ Wind\ Generation}}$$

3.2 Allocation of Curtailment

As previously outlined, curtailment is a system wide issue. In recent SEMC documents and from discussions with senior management in EirGrid and SONI, it has been confirmed that it is likely that in operations the curtailment levels required will be calculated on an all-island basis and then reallocated to ROI and NI generators based on the ratio of controllable windfarms.

Taking into consideration the SEMC's consultation paper (SEM-12-028), and IWEA's response to the consultation dated 24th May 2012, the following five curtailment allocations options have been considered:

1. Grandfather: based on level of firm access, eg a gate 3 non-firm wind farm will be curtailed off before a gate 3 wind farm with firm access;
2. Pro-Rata: curtailment shared equally across all generators - compensation to FAQ;

3[1] Temporary Pro-Rata up to start of 2018 and grandfathering based on firmness thereafter;

3b. Pro-Rata for projects connected by the end of 2020, and some form of grandfathering for projects connected post 2020. The form of grandfathering is unknown at this point.

4. Pro-Rata: curtailment shared equally across all generators - no compensation;

4 Input Assumptions

This section provides an overview of the input assumptions employed in the development of the model for the study years of 2012 – 2030. The assumptions were discussed and agreed with the Developer.

4.1 Base Case Assumptions

4.1.1 Wind Profile

As outlined in Section 3, the wind generation levels for each hour period are determined by an unconstrained wind profile provided by EirGrid. As part of the Gate 3 process EirGrid developed regional wind profiles with hourly values. Area B wind profile with a capacity factor of 30.02% was used in this analysis. As noted in Section 3, the 'perfect foresight' nature of the wind profile assumed could lead to reduced curtailment levels in comparison to what might be observed in real-time operation.

4.1.2 Build-Out of Wind Generation

The analysis was completed based on the following seven build-out scenarios, which are presented graphically in **Figure 2**, and detailed further in **Appendix A**:

---

[1] **As per footnote no. 14 in SEM-12-028, Option 3 could be designed in a number of ways e.g. grandfathering could be applied once the 40% targets have been achieved, or alternatively it could be applied from a certain date (e.g. 1 January 2018). Furthermore grandfathering could then apply with reference to firmness or connection date.**

4.1.2.1 Option 1: Grandfathering (low)

This build-out rate took cognisance of EirGrid's most recent firm access quantities, and assumes that a total of approximately 4,200MW of all-island wind generation will be connected by 2020. This build out rate recognises that windfarms would not connect until they received firm access, while it is also assumed that there is a low risk that associated deep reinforcement projects would be delayed. Further information regarding matters relating to firm access is outlined in IGS' Firm Access Quantity Analysis Report, issued 23/5/12.

4.1.2.2 Option 1: Grandfathering (moderate – high)

This option again takes cognisance of EirGrid's firm access quantities, and assumes that a total of approximately 3,900MW of all-island wind generation will be connected by 2020. This build out rate again recognises that most windfarms would not connect until they received firm access. Furthermore it is a slower build-out rate compared to Option 1 low case due to the fact that it is assumed that there is a moderate risk that associated deep reinforcement projects would be delayed.

4.1.2.3 Option 2: Pro-Rata

This build-out rate assumes that the government renewable targets of 40% are reached in 2020 with a total of approximately 5,488MW of wind generation assumed to be connected on an all-island basis. Post 2020 it is assumed that 250MW in RoI and an average of approx 80MW in NI are connected per year. The build-out trend is generally a straightline commencing at current connected levels, and increasing linearly up to and beyond the government target in 2020. This option assumes the highest build-out given that factors such as firmness and compensation would not impact on the build-out of wind farms.

4.1.2.4 Option 3: Temporary Pro-Rata up to start of 2018

Given that curtailment would be allocated based on firmness from 2018 onwards, the key assumption is that it will only be viable for generators who are certain to be firm from 2018 onwards to connect. It is assumed that approximately 3,465MW will be connected by the start of 2018, with the build-out rate assumed to follow similar trends to Option 1 low case from 2018 onwards.

4.1.2.5 Option 3b: Pro-Rata up to end of 2020

This option assumes the same build-out rate as Option 2 up to 2020. Given that the form of grandfathering post 2020 is unknown at this point, the post 2020 build-out cannot be determined.

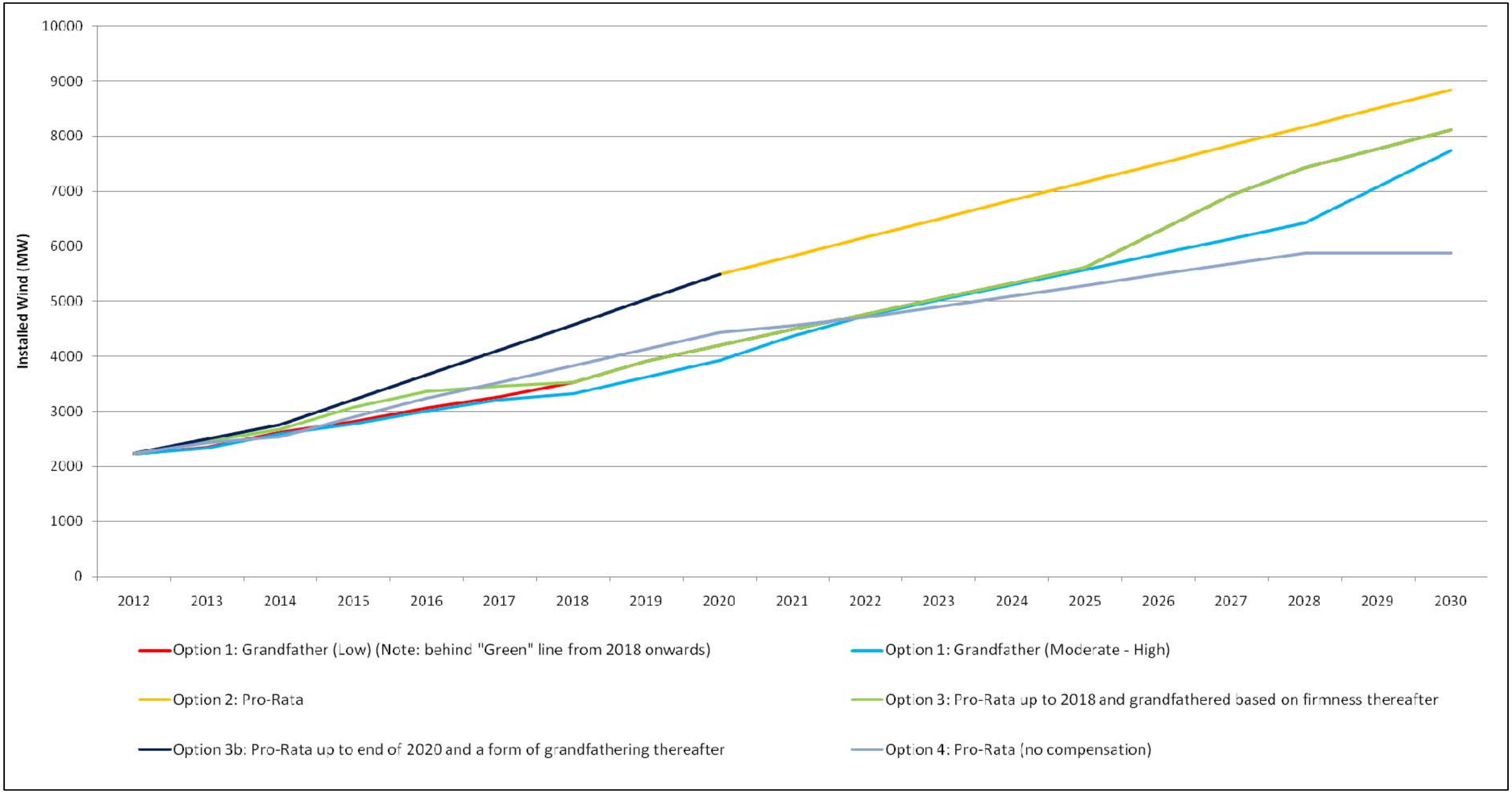


Figure 2: Build-Out of Wind Generation

4.1.2.6 Option 4: Pro-Rata (no compensation)

This build-out was developed by Electroroute, and is based on Option 2. Electroroute estimate that half of Option 2's new firm generators would connect due to the fact that there would be no compensation for any generators. On this basis it is assumed that approximately 4,440MW is connected by 2020.

The wind generation build-out rates also include for uncontrollable wind generation. Based on IGS' database of the current and future level of wind generation build-out it is assumed that there will be approximately 500MW of uncontrollable wind generation (all-island) connected in 2013, increasing to a total of approximately 635MW by 2020.

4.1.3 Demand

The hourly demand profile employed is the SEM's 2012 demand forecast which was downloaded from the regulator's All-Island Project website (www.allislandproject.org). Demand growth rates for the study period 2012 to 2030 were applied to the demand profile based on the projected demand growth rates in the EirGrid / SONI's All-Island Generation Capacity Statement 2012-2021.

4.1.4 Storage

In order to ensure a conservative estimate of curtailment, the Turlough Hill pumped storage unit was excluded from the base case analysis. Furthermore two Gate 3 pumped storage units (Knocknagreenan 70MW & Coomacheo 35MW) have also been excluded from the analysis as it is IGS' understanding that these projects are only in the early stages of development.

4.1.5 Interconnection

4.1.5.1 Imports

Northern Ireland and Scotland's electricity grids are currently connected via the Moyle Interconnector. This interconnector has generally been importing energy from Scotland. The historical import profile applied, which was obtained from www.mutual-energy.com, has a maximum import of 427MW and a 68% import capacity factor. It is assumed that with improved fluidity in the market, SONI trading with the British system operator and through trading exchanges that this level of import during periods of high wind generation will reduce to zero by 2019. In order to ensure a conservative model, the base case analysis assumes that Moyle does not export at any stage.

4.1.5.2 Exports

EirGrid are currently developing the East-West Interconnector (EWIC) to Great Britain. It is scheduled to be complete by the end of 2012. It is assumed that EWIC will be operational by 2013 and will operate at 80% of its export capacity of 500MW during periods of high wind.

4.1.6 Limits on the Instantaneous Wind Penetration (DS3)

As outlined in Section 3, instantaneous wind penetration plus imports is currently limited to 50% of demand plus exports. EirGrid plan to increase the DS3 limit to 75% through various network technology improvements by 2019, as outlined in EirGrid's Constraints Modelling Presentation in the Gate 3 Liaison Group Meeting No. 29 on 7/2/12 (www.cer.ie/en/electricity-transmission-network-overview.aspx?article=154f174b-86de-4d3b-b1aa-e120518307c1). **Appendix C** outlines the DS3 limits applied in the model throughout the study period.

4.1.7 Minimum Conventional Generation

As outlined in Section 3, there is a requirement to have a minimum number of conventional generators synchronized to the system at all times to provide inertia to the power system, ensure voltage stability and to ensure that network limitations are respected.

In Ireland there is no published minimum generation information. In a presentation by Marie Hayden at an EirGrid workshop on 7th July 2011 it was stated for a sample summer night valley there would be a minimum conventional generation of 1230MW for system constraints reasons and a further 170MW of must run CHP and peat power stations. (www.eirgrid.com/media/Power System Seminar 4.pdf)

A review of periods of curtailment for 2011 indicated that conventional generation levels range from 1100MW to 1400MW. EirGrid have stated in the interim Gate 3 constraint & curtailment reports that the level of minimum conventional generation required will reduce in approximately 2016 due to system upgrades that remove voltage stability issues.

Following discussions with EirGrid it is assumed that there is 1300MW of must-run conventional generation in RoI for the period 2012-2016 and 1000 MW from 2017 onwards.

In Northern Ireland there is 420MW of conventional must run conventional generation. This is confirmed in the Oct 2011 SONI Generator Connection Process Consultation Paper. This will reduce to approx 300MW when the new N-S interconnector is constructed (assumed 2020+). However given that the study period is 2013 to 2030, must run conventional generation was assumed to be fixed at 420MW.

4.2 Alternative Scenario Assumptions

4.2.1 Limits on the Instantaneous Wind Penetration (DS3)

As outlined in Section 3, instantaneous wind penetration plus imports is currently limited to 50% of demand plus exports. EirGrid plan to increase the DS3 limit to 75% through various network technology improvements by 2019. However for the purposes of a more conservative assessment, it is assumed in an alternative scenario that the DS3 programme experiences delays with the DS3 limit reaching 75% three years later in 2022. **Appendix C** outlines the alternative DS3 limits applied for this scenario.

4.2.2 Post 2020 Mitigation Measures

It is unknown what measures will be in place post 2020 to mitigate against curtailment. The base case scenario assumes that there are no mitigation measures in place post 2020. However an alternative scenario assumes that the following post 2020 mitigation measures will be in place:

- Increased demand of 100MW per year from 2021 onwards due to Demand Side Management and the increase use of electric transport and heating;
- 3rd Interconnector exporting 500MW from 2023 onwards; and
- 500MW of storage from 2025 onwards

5 Results

Based on the input assumptions (Section 4) being applied to the modelling methodology (Section 3) average all-island curtailment levels were estimated and are presented in **Figures 3** to **8,** and listed in **Appendix D**.

5.1 Option 1: Grandfathering (low)

Figure 3 presents the estimated curtailment levels for Option 1: Grandfathering (low). Curtailment for firm generators is estimated to reach 1.3% and 9.8% in 2020 and 2030 respectively. Non-firm generator curtailment is estimated to reach 8.2% and 39.7% in 2020 and 2030 respectively. In the event that the DS3 programme is delayed curtailment could increase to 1.8% and 12.7% for firm and non-firm generators respectively during the period up to the end of 2021. Furthermore if mitigation measures are adopted post 2020 curtailment could drop to 1.1% and 9.7% for firm and non-firm generators respectively in 2030.

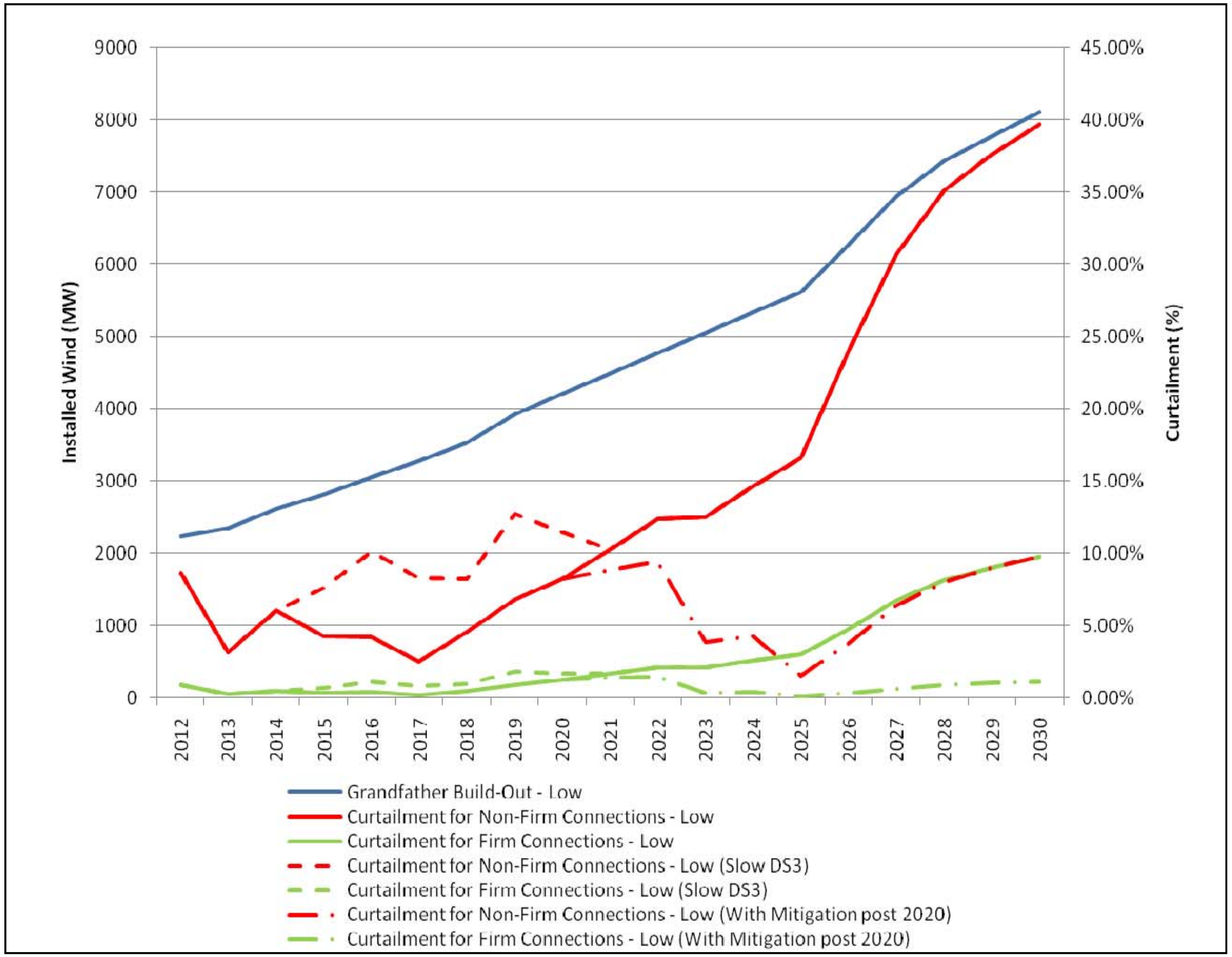


Figure 3: Option 1 Grandfather (low) Curtailment Estimates

5.2 Option 1: Grandfathering (moderate - high)

Figure 4 presents the estimated curtailment levels for Option 1: Grandfathering (moderate - high). Curtailment is estimated to be less than the low grandfathering option due to the fact that a lower build-out rate is estimated as a result of the assumed increased likelihood of deep reinforcement delivery delays. Curtailment for firm generators is estimated to reach 0.8% and 8.3% in 2020 and 2030 respectively. Non-firm generator curtailment is estimated to reach 6.1% and 35.7% in 2020 and 2030 respectively. In the event that the DS3 programme is delayed curtailment could increase to 0.9% and 9.4% for firm and non-firm generators respectively during the period up to the end of 2021. Furthermore if mitigation measures are adopted post 2020 curtailment could drop to 0.7% and 7.3% for firm and non-firm generators respectively in 2030.

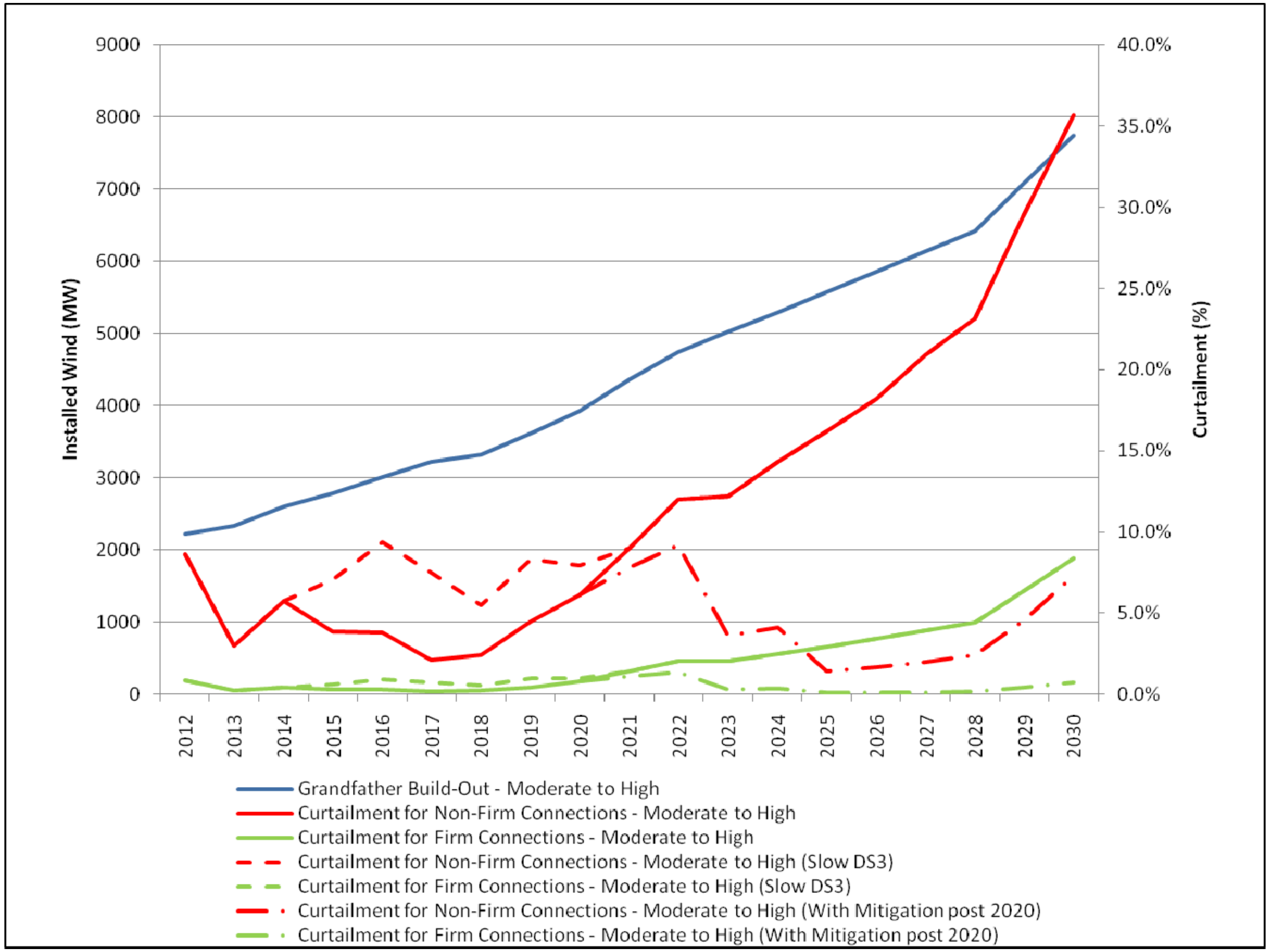


Figure 4: Option 1 Grandfather (moderate-high) Curtailment Estimates

5.3 Option 2: Pro-Rata

Figure 5 presents the estimated curtailment levels for Option 2: Pro-Rata. As outlined in Section 4.1.2.3 this option assumes the highest build-out given that factors such as firmness and compensation would not impact on the build-out of wind farms. However, regardless of the high build-out rate, average curtailment levels are generally lower than Options 1 and 3 due to the fact that curtailment is shared equally by all generators. Compared to Options 1 and 3, non-firm curtailment significantly reduces by approximately 70%, while curtailment for firm generators would increase by approximately 15%. Pro-Rata curtailment is estimated to reach 5.4% and 12.9% in 2020 and 2030 respectively. In the event that the DS3 programme is delayed curtailment could increase to 7.8% during the period up to the end of 2021. Furthermore if mitigation measures are adopted post 2020 curtailment could drop to 2.2% in 2030.

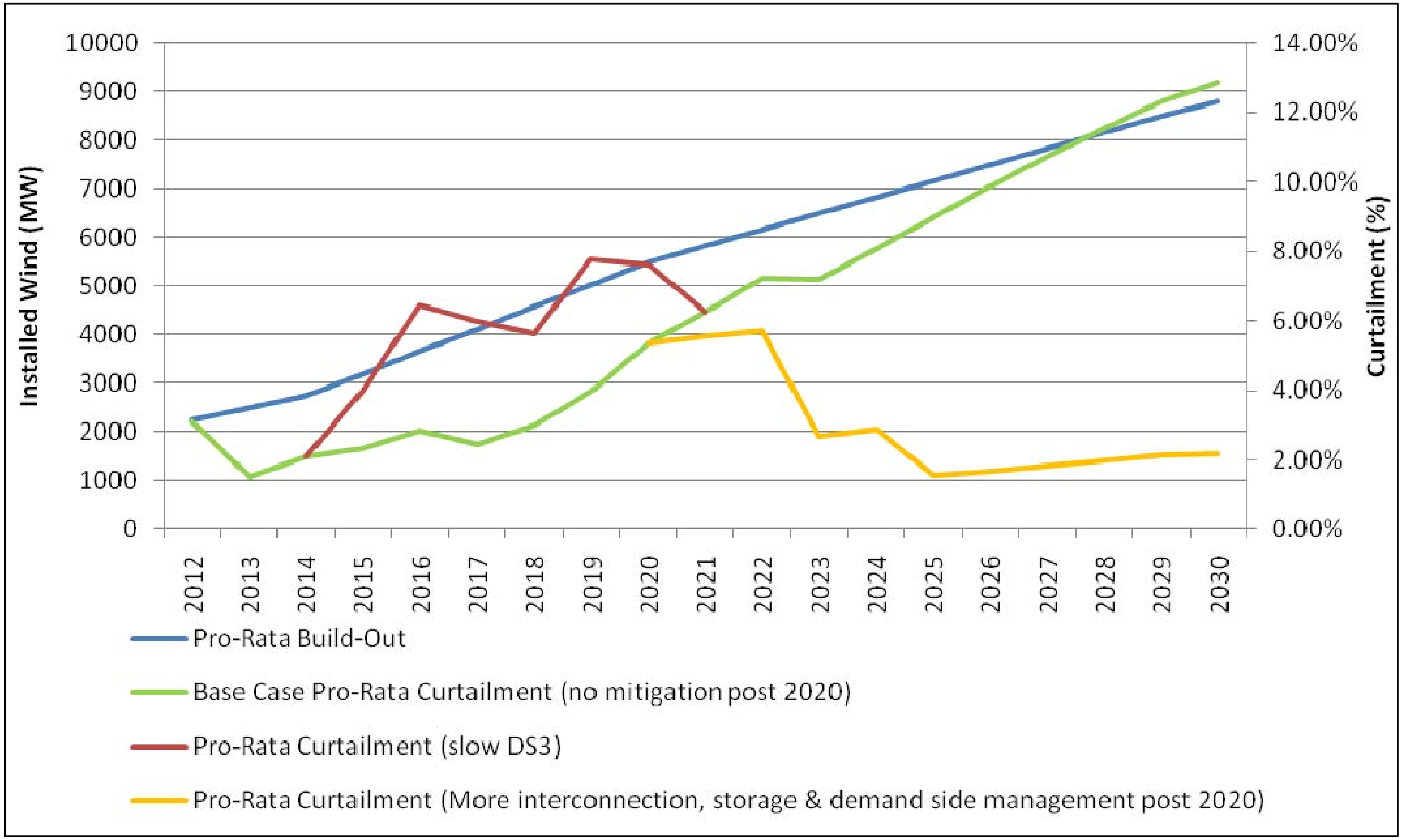


Figure 5: Option 2 Pro-Rata Curtailment Estimates

5.4 Option 3: Temporary Pro-Rata up to start of 2018

Figure 6 presents the estimated curtailment levels for Option 3: Temporary Pro-Rata up to the start of 2018. As outlined in Section 4.1.2.4, given that curtailment would be allocated based on firmness from 2018 onwards, the key assumption is that it will only be viable for generators who are certain to be firm by end of 2017 to connect. During the period up to end of 2017, pro-rata curtailment is estimated to reduce each year down to 0.7% by the end of 2017. In the event that the DS3 programme is delayed, pro-rata curtailment could peak at 4.3% in 2016. From the start of 2018 onwards, curtailment is allocated based on firmness. As a result, non-firm curtailment significantly increases each year and reaches 8.2% and 39.7% in 2020 and 2030 respectively. Curtailment for firm generators increases at a slower rate and reaches 1.3% and 9.8% in 2020 and 2030 respectively. In the event that mitigation measures are adopted post 2020 curtailment could drop to 1.1% and 9.7% for firm and non-firm generators respectively in 2030.

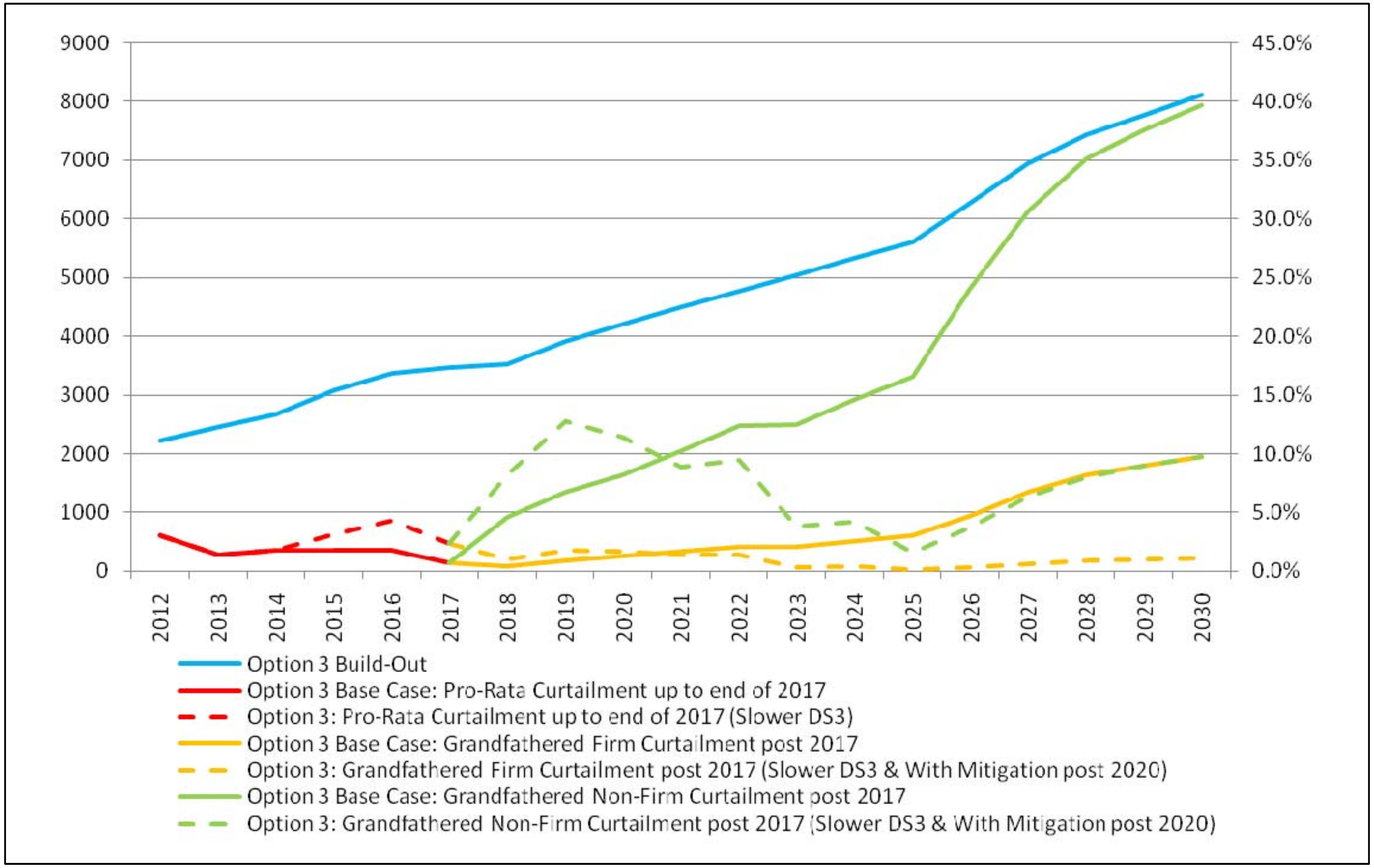


Figure 6: Option 3 Temporary Pro-Rata Curtailment Estimates

5.5 Option 3b: Pro-Rata up to end of 2020

Figure 7 presents the estimated curtailment levels for Option 3b: Pro-Rata up to end of 2020. As outlined in Section 4.1.2.5, this option assumes the same build-out rate as Option 2 up to 2020. Hence pro-rata curtailment for generation connected up to the end of 2020 is again estimated to reach 5.36% in 2020. In the event that the DS3 programme is delayed curtailment could increase to 6.6% for during the period up to the end of 2021. Given that the form of grandfathering post 2020 is unknown at this point, curtailment for generation connected up to end of 2020 is assumed to be capped at 5.36%, while curtailment for generation connected post 2020 cannot be determined at this stage.

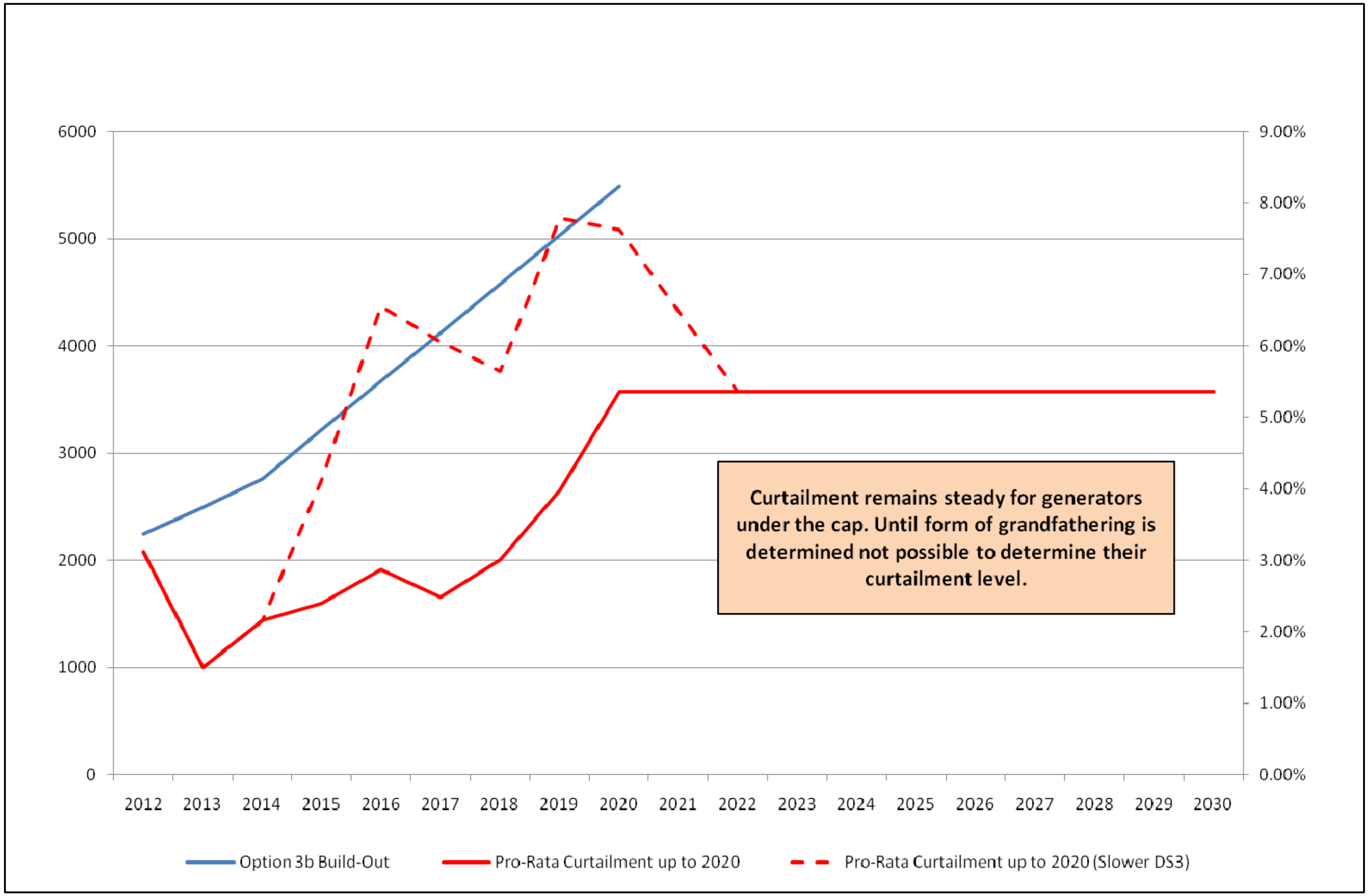


Figure 7: Option 3b Pro-Rata (up to end of 2020) Curtailment Estimates

5.6 Option 4: Pro-Rata (no compensation)

Figure 8 presents the estimated curtailment levels for Option 4. As outlined in Section 4.1.2.6, this build-out was developed by Electroroute, and is based on Option 2, where half of Option 2's new firm generators would connect due to the fact that there would be no compensation for any generators. As a result curtailment levels are lower than Option 2, where it is estimated to reach 1.9% and 2.5% in 2020 and 2030 respectively. In the event that the DS3 programme is delayed curtailment could increase to 3.5% for during the period up to the end of 2021. Furthermore if mitigation measures are adopted post 2020 curtailment could drop to zero in 2030.

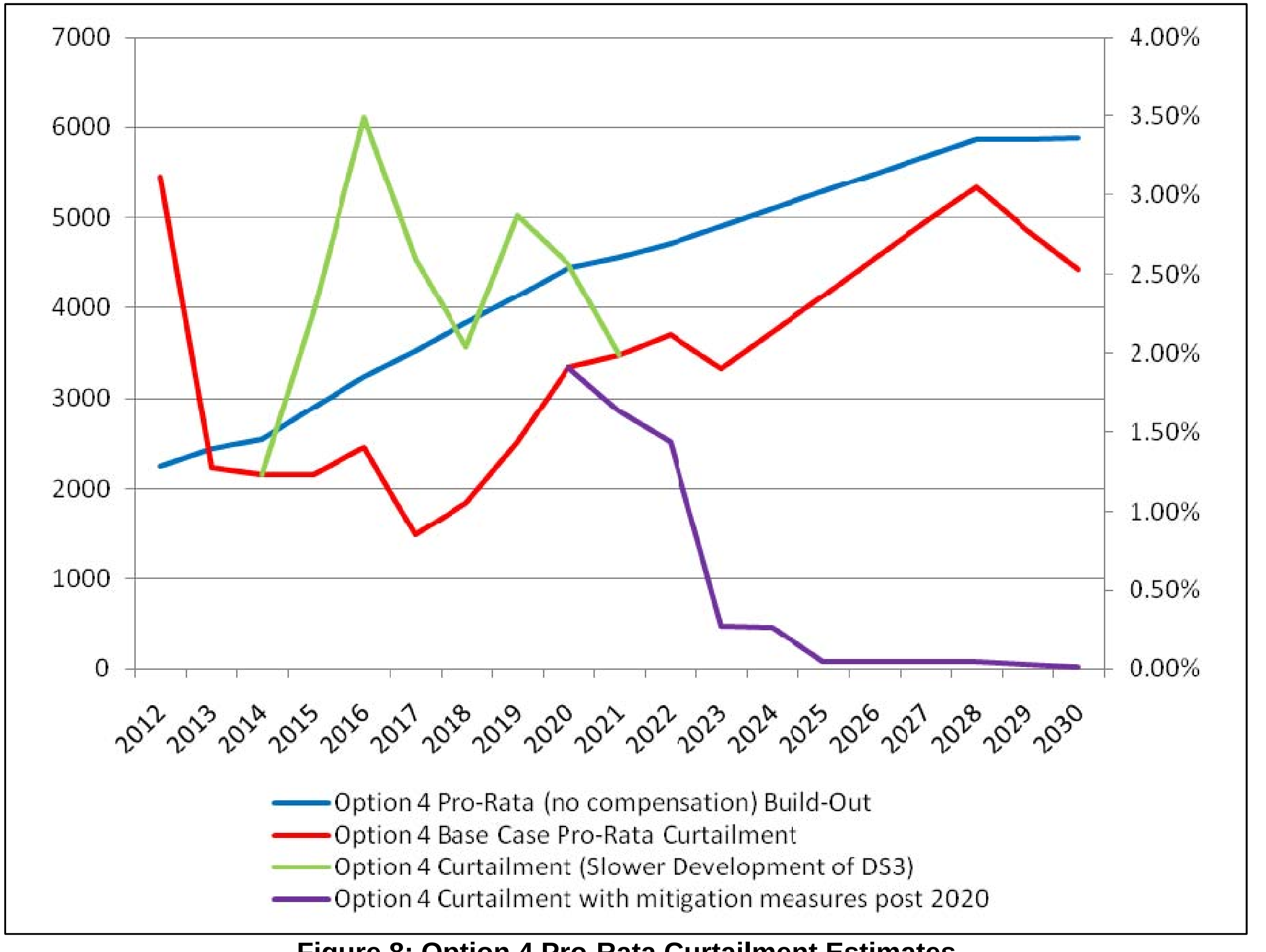


Figure 8: Option 4 Pro-Rata Curtailment Estimates

Appendix A – Wind Generation Build-Outs

Year	ROI: Option 1: Grandfathering (Low)								
	Uncontrollable	Non-firm Gate 3	Temporary Connections	Non-firm Pre-Gate 3	Partial-firm Gate 3	Partial-firm Pre-Gate 3	Firm	Total Controllable	Total Wind Generation
2012	375	0	95	248	0	201	844	1388	1763
2013	385	50	95	192	0	228	867	1431	1816
2014	395	50	95	124	0	228	1141	1638	2033
2015	405	50	95	110	0	228	1283	1766	2171
2016	415	50	95	124	0	143	1532	1944	2359
2017	425	50	77	49	0	116	1804	2096	2521
2018	435	50	0	0	0	0	2245	2295	2730
2019	445	50	0	0	0	0	2595	2645	3090
2020	455	50	0	0	0	0	2845	2895	3350
2021	465	50	0	0	0	0	3095	3145	3610
2022	475	50	0	0	0	0	3345	3395	3870
2023	485	50	0	0	0	0	3595	3645	4130
2024	495	50	0	0	0	0	3845	3895	4390
2025	505	50	0	0	0	0	4095	4145	4650
2026	515	50	0	0	0	0	4495	4545	5060
2027	525	50	0	0	0	0	4895	4945	5470
2028	535	50	0	0	0	0	5295	5345	5880
2029	545	50	0	0	0	0	5545	5595	6140
2030	555	50	0	0	0	0	5795	5845	6400

Year	NI: Option 1: Grandfathering (Low)					
	Uncontrollable	Non-Firm	Partial-Firm	Firm	Total Controllable Wind	Total Wind Generation
2012	102	51	0	313	363	465
2013	112	15	0	407	422	534
2014	122	15	0	451	466	588
2015	132	15	0	495	510	642
2016	142	15	0	539	554	696
2017	152	15	0	583	598	750
2018	162	15	0	627	642	804
2019	172	15	0	642	657	829
2020	182	15	0	657	672	854
2021	192	15	0	672	687	879
2022	197	15	0	687	702	899
2023	202	15	0	702	717	919
2024	207	15	0	717	732	939
2025	212	15	0	732	747	959
2026	217	15	0	982	997	1214
2027	222	15	0	1232	1247	1469
2028	227	15	0	1307	1322	1549
2029	232	15	0	1382	1397	1629
2030	237	15	0	1457	1472	1709

Year	ROI: Option 1: Grandfathering (Moderate - High)								
	Uncontrollable	Non-firm Gate 3	Temporary Connections	Non-firm Pre-Gate 3	Partial-firm Gate 3	Partial-firm Pre-Gate 3	Firm	Total Controllable	Total Wind Generation
2012	375	0	95	248	0	201	812	1356	1731
2013	385	50	95	191.5	0	227.7	867	1431.2	1816.2
2014	395	50	95	124.1	0	227.7	1141	1637.8	2032.8
2015	405	50	95	110.1	0	227.7	1283	1765.8	2170.8
2016	415	50	95	124.1	0	142.7	1532	1943.8	2358.8
2017	425	50	77	48.6	0	116	1804	2095.6	2520.6
2018	435	50	0	0	0	0	2095	2145	2580
2019	445	50	0	0	0	0	2345	2395	2840
2020	455	50	0	0	0	0	2595	2645	3100
2021	465	50	0	0	0	0	2995	3045	3510
2022	475	50	0	0	0	0	3345	3395	3870
2023	485	50	0	0	0	0	3595	3645	4130
2024	495	50	0	0	0	0	3845	3895	4390
2025	505	50	0	0	0	0	4095	4145	4650
2026	515	50	0	0	0	0	4345	4395	4910
2027	525	50	0	0	0	0	4595	4645	5170
2028	535	50	0	0	0	0	4845	4895	5430
2029	545	50	0	0	0	0	5245	5295	5840
2030	555	50	0	0	0	0	5645	5695	6250

Year	NI: Option 1: Grandfathering (Moderate - High)					
	Uncontrollable	Non-Firm	Partial-Firm	Firm	Total Controllable Wind	Total Wind Generation
2012	102	51	0	313	363	465
2013	112	15	0	396	411	523
2014	122	15	0	429	444	566
2015	132	15	0	462	477	609
2016	142	15	0	495	510	652
2017	152	15	0	528	543	695
2018	162	15	0	561	576	738
2019	172	15	0	594	609	781
2020	182	15	0	627	642	824
2021	192	15	0	642	657	849
2022	197	15	0	657	672	869
2023	202	15	0	672	687	889
2024	207	15	0	687	702	909
2025	212	15	0	702	717	929
2026	217	15	0	717	732	949
2027	222	15	0	732	747	969
2028	227	15	0	747	762	989
2029	232	15	0	997	1012	1244
2030	237	15	0	1247	1262	1499

Year	ROI: Option 2: Pro-Rata								
	Uncontrollable	Non-firm Gate 3	Temporary Connections	Non-firm Pre-Gate 3	Partial-firm Gate 3	Partial-firm Pre-Gate 3	Firm	Total Controllable	Total Wind Generation
2012	375	0	95	248	0	201	844	1388	1763
2013	385	50	95	298.5	0	227.7	867	1538	1923
2014	395	100	95	124.1	0	227.7	1141	1688	2083
2015	405	200	95	216.1	0	227.7	1283	2022	2427
2016	415	300	95	286.1	0	142.7	1532	2356	2771
2017	425	400	77	292.6	0	116	1804	2690	3115
2018	435	750	0	178	0	0	2095	3023	3458
2019	445	1012	0	0	0	0	2345	3357	3802
2020	455	1096	0	0	0	0	2595	3691	4146
2021	465	936	0	0	0	0	2995	3931	4396
2022	475	826	0	0	0	0	3345	4171	4646
2023	485	816	0	0	0	0	3595	4411	4896
2024	495	806	0	0	0	0	3845	4651	5146
2025	505	796	0	0	0	0	4095	4891	5396
2026	515	786	0	0	0	0	4345	5131	5646
2027	525	776	0	0	0	0	4595	5371	5896
2028	535	766	0	0	0	0	4845	5611	6146
2029	545	606	0	0	0	0	5245	5851	6396
2030	555	446	0	0	0	0	5645	6091	6646

Year	NI: Option 2: Pro-Rata					
	Uncontrollable	Non-Firm	Partial-Firm	Firm	Total Controllable Wind	Total Wind Generation
2012	102	51	0	327	378	480
2013	112	62	0	396	458	570
2014	122	126	0	429	556	678
2015	132	194	0	462	656	788
2016	142	262	0	495	757	899
2017	152	329	0	528	858	1010
2018	162	397	0	561	959	1121
2019	172	465	0	594	1059	1231
2020	182	533	0	627	1160	1342
2021	192	598	0	642	1240	1432
2022	197	663	0	657	1320	1517
2023	202	728	0	672	1400	1602
2024	207	793	0	687	1480	1687
2025	212	858	0	702	1560	1772
2026	217	923	0	717	1640	1857
2027	222	988	0	732	1720	1942
2028	227	1053	0	747	1800	2027
2029	232	883	0	997	1880	2112
2030	237	713	0	1247	1960	2197

Year	ROI: Option 3: Pro-Rata up to start of 2018 and grandfathered thereafter based on firmness								
	Uncontrollable	Non-firm Gate 3	Temporary Connections	Non-firm Pre-Gate 3	Partial-firm Gate 3	Partial-firm Pre-Gate 3	Firm	Total Controllable	Total Wind Generation
2012	375	0	95	248	0	201	844	1388	1763
2013	385	50	95	299	0	228	867	1538	1923
2014	395	100	95	124	0	228	1141	1688	2083
2015	405	200	95	216	0	228	1283	2022	2427
2016	415	200	95	286	0	143	1532	2256	2671
2017	425	100	77	193	0	116	1804	2290	2715
2018	435	50	0	0	0	0	2245	2295	2730
2019	445	50	0	0	0	0	2595	2645	3090
2020	455	50	0	0	0	0	2845	2895	3350
2021	465	50	0	0	0	0	3095	3145	3610
2022	475	50	0	0	0	0	3345	3395	3870
2023	485	50	0	0	0	0	3595	3645	4130
2024	495	50	0	0	0	0	3845	3895	4390
2025	505	50	0	0	0	0	4095	4145	4650
2026	515	50	0	0	0	0	4495	4545	5060
2027	525	50	0	0	0	0	4895	4945	5470
2028	535	50	0	0	0	0	5295	5345	5880
2029	545	50	0	0	0	0	5545	5595	6140
2030	555	50	0	0	0	0	5795	5845	6400

Year	NI: Option 3: Pro-Rata up to start of 2018 and grandfather thereafter based on firmness					
	Uncontrollable	Non-Firm	Partial-Firm	Firm	Total Controllable Wind	Total Wind Generation
2012	102	51	0	313	363	465
2013	112	75	0	347	422	534
2014	122	100	0	366	466	588
2015	132	100	0	410	510	642
2016	142	100	0	454	554	696
2017	152	50	0	548	598	750
2018	162	15	0	627	642	804
2019	172	15	0	642	657	829
2020	182	15	0	657	672	854
2021	192	15	0	672	687	879
2022	197	15	0	687	702	899
2023	202	15	0	702	717	919
2024	207	15	0	717	732	939
2025	212	15	0	732	747	959
2026	217	15	0	982	997	1214
2027	222	15	0	1232	1247	1469
2028	227	15	0	1307	1322	1549
2029	232	15	0	1382	1397	1629
2030	237	15	0	1457	1472	1709

Year	ROI: Option 3b: Pro-Rata up to end of 2020 and some form of grandfathering thereafter								
	Uncontrollable	Non-firm Gate 3	Temporary Connections	Non-firm Pre-Gate 3	Partial-firm Gate 3	Partial-firm Pre-Gate 3	Firm	Total Controllable	Total Wind Generation
2012	375	0	95	248	0	201	844	1388	1763
2013	385	50	95	298.5	0	227.7	867	1538	1923
2014	395	100	95	124.1	0	227.7	1141	1688	2083
2015	405	200	95	216.1	0	227.7	1283	2022	2427
2016	415	300	95	286.1	0	142.7	1532	2356	2771
2017	425	400	77	292.6	0	116	1804	2690	3115
2018	435	750	0	178	0	0	2095	3023	3458
2019	445	1012	0	0	0	0	2345	3357	3802
2020	455	1096	0	0	0	0	2595	3691	4146
2021	Curtailment remains steady for generators under the cap. Until form of grandfathering is determined not possible to determine their curtailment level.								
2022									
2023									
2024									
2025									
2026									
2027									
2028									
2029									
2030									

Year	NI: Option 3b: Pro-Rata up to end of 2020 and some form of grandfathering thereafter					
	Uncontrollable	Non-Firm	Partial-Firm	Firm	Total Controllable Wind	Total Wind Generation
2012	102	51	0	327	378	480
2013	112	62	0	396	458	570
2014	122	126	0	429	556	678
2015	132	194	0	462	656	788
2016	142	262	0	495	757	899
2017	152	329	0	528	858	1010
2018	162	397	0	561	959	1121
2019	172	465	0	594	1059	1231
2020	182	533	0	627	1160	1342
2021	Curtailment remains steady for generators under the cap. Until form of grandfathering is determined not possible to determine their curtailment level.					
2022						
2023						
2024						
2025						
2026						
2027						
2028						
2029						
2030						

Year	ROI: Option 4: Pro-Rata (No Compensation)								
	Uncontrollable	Non-firm Gate 3	Temporary Connections	Non-firm Pre-Gate 3	Partial-firm Gate 3	Partial-firm Pre-Gate 3	Firm	Total Controllable	Total Wind Generation
2012	375	0	95	248	0	201	844	1388	1763
2013	385	50	95	299	0	228	824	1495	1880
2014	395	100	95	124	0	228	988	1534	1929
2015	405	200	95	216	0	228	1054	1793	2198
2016	415	300	95	286	0	143	1213	2037	2452
2017	425	400	77	293	0	116	1360	2246	2671
2018	435	750	0	178	0	0	1535	2463	2898
2019	445	1012	0	0	0	0	1668	2680	3125
2020	455	1096	0	0	0	0	1802	2898	3353
2021	465	936	0	0	0	0	2039	2975	3440
2022	475	826	0	0	0	0	2246	3072	3547
2023	485	816	0	0	0	0	2392	3208	3693
2024	495	806	0	0	0	0	2537	3343	3838
2025	505	796	0	0	0	0	2682	3478	3983
2026	515	786	0	0	0	0	2827	3613	4128
2027	525	776	0	0	0	0	2972	3748	4273
2028	535	766	0	0	0	0	3118	3884	4419
2029	545	606	0	0	0	0	3268	3874	4419
2030	555	446	0	0	0	0	3444	3890	4445

Year	NI: Option 4: Pro-Rata (No Compensation)					
	Uncontrollable	Non-Firm	Partial-Firm	Firm	Total Controllable Wind	Total Wind Generation
2012	102	51	0	327	378	480
2013	112	62	0	384	445	557
2014	122	126	0	363	489	611
2015	132	194	0	374	569	701
2016	142	262	0	382	643	785
2017	152	329	0	377	706	858
2018	162	397	0	375	772	934
2019	172	465	0	373	838	1010
2020	182	533	0	371	903	1085
2021	192	598	0	331	929	1121
2022	197	663	0	299	961	1158
2023	202	728	0	279	1006	1208
2024	207	793	0	259	1051	1258
2025	212	858	0	238	1096	1308
2026	217	923	0	218	1141	1358
2027	222	988	0	198	1186	1408
2028	227	1053	0	178	1230	1457
2029	232	883	0	345	1227	1459
2030	237	713	0	486	1199	1436

Appendix B – Demand Growth Rates

	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
NI	1.2%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
ROI	1.9%	1.8%	1.6%	1.4%	1.1%	1.1%	1.1%	1.6%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%

Source: EirGrid / SONI's All-Island Generation Capacity Statement 2012-2021

Appendix C – DS3 Limits

Year	Base-case DS3 %	Alternative DS3 %
2012	50%	50%
2013	50%	50%
2014	50%	50%
2015	55%	50%
2016	60%	50%
2017	65%	55%
2018	70%	60%
2019	75%	60%
2020	75%	65%
2021	75%	70%
2022	75%	75%
2023	75%	75%
2024	75%	75%
2025	75%	75%
2026	75%	75%
2027	75%	75%
2028	75%	75%
2029	75%	75%
2030	75%	75%

Appendix D – Results

Year	Option 1: Grandfather Low Base Case			Option 1: Grandfather Low (Slow DS3)		Option 1: Grandfather Low (With Mitigation post 2020)	
	Grandfather Build-Out - Low	Curtailment for Non-Firm Connections - Low	Curtailment for Firm Connections - Low	Curtailment for Non-Firm Connections - Low (Slow DS3)	Curtailment for Firm Connections - Low (Slow DS3)	Curtailment for Non-Firm Connections - Low (With Mitigation post 2020)	Curtailment for Firm Connections - Low (With Mitigation post 2020)
2012	2228	8.6%	0.9%	8.6%	0.9%		
2013	2351	3.1%	0.2%	3.1%	0.2%		
2014	2621	6.0%	0.5%	6.0%	0.5%		
2015	2813	4.2%	0.3%	7.6%	0.7%		
2016	3055	4.2%	0.4%	10.2%	1.1%		
2017	3271	2.5%	0.2%	8.3%	0.8%		
2018	3534	4.6%	0.5%	8.2%	1.0%		
2019	3919	6.8%	0.9%	12.7%	1.8%		
2020	4204	8.2%	1.3%	11.5%	1.6%	8.2%	1.3%
2021	4489	10.2%	1.7%	10.2%	1.7%	8.9%	1.4%
2022	4769	12.4%	2.1%	12.4%	2.1%	9.4%	1.4%
2023	5049	12.5%	2.1%	12.5%	2.1%	3.8%	0.3%
2024	5329	14.6%	2.5%	14.6%	2.5%	4.2%	0.4%
2025	5609	16.6%	3.0%	16.6%	3.0%	1.6%	0.1%
2026	6274	24.1%	4.7%	24.1%	4.7%	3.8%	0.3%
2027	6939	30.7%	6.7%	30.7%	6.7%	6.4%	0.6%
2028	7429	35.1%	8.2%	35.1%	8.2%	8.0%	0.9%
2029	7769	37.6%	9.0%	37.6%	9.0%	9.0%	1.0%
2030	8109	39.7%	9.8%	39.7%	9.8%	9.7%	1.1%

Year	Option 1: Grandfather Moderate to High (Base Case)			Option 1: Grandfather Moderate to High (Slow DS3)		Option 1: Grandfather Moderate to High (With Mitigation post 2020)	
	Grandfather Build-Out - Moderate to High	Curtailment for Non-Firm Connections - Moderate to High	Curtailment for Firm Connections - Moderate to High	Curtailment for Non-Firm Connections - Moderate to High (Slow DS3)	Curtailment for Firm Connections - Moderate to High (Slow DS3)	Curtailment for Non-Firm Connections - Moderate to High (With Mitigation post 2020)	Curtailment for Firm Connections - Moderate to High (With Mitigation post 2020)
2012	2228	8.6%	0.9%	8.6%	0.9%		
2013	2340	3.0%	0.2%	3.0%	0.2%		
2014	2599	5.7%	0.4%	5.7%	0.4%		
2015	2780	3.9%	0.3%	7.1%	0.6%		
2016	3011	3.8%	0.3%	9.4%	0.9%		
2017	3216	2.1%	0.1%	7.5%	0.7%		
2018	3318	2.4%	0.2%	5.5%	0.5%		
2019	3621	4.5%	0.5%	8.3%	1.0%		
2020	3924	6.1%	0.8%	8.0%	1.0%	6.1%	0.8%
2021	4359	9.0%	1.4%	9.0%	1.4%	7.8%	1.1%
2022	4739	12.0%	2.0%	12.0%	2.0%	9.2%	1.4%
2023	5019	12.2%	2.0%	12.2%	2.0%	3.6%	0.3%
2024	5299	14.3%	2.5%	14.3%	2.5%	4.1%	0.4%
2025	5579	16.2%	2.9%	16.2%	2.9%	1.4%	0.1%
2026	5859	18.2%	3.4%	18.2%	3.4%	1.7%	0.1%
2027	6139	20.9%	3.9%	20.9%	3.9%	2.0%	0.1%
2028	6419	23.1%	4.5%	23.1%	4.5%	2.4%	0.2%
2029	7084	29.5%	6.3%	29.5%	6.3%	4.6%	0.4%
2030	7749	35.7%	8.3%	35.7%	8.3%	7.3%	0.7%

Year	Option 2 Pro-Rata Build-Out	Option 2 Base Case Pro-Rata Curtailment	Option 2 Pro-Rata Curtailment (Slower DS3)	Option 2 Pro-Rata Curtailment (with mitigation measures post 2020)
2012	2243	3.1%	3.1%	3.1%
2013	2493	1.5%	1.5%	1.5%
2014	2743	2.1%	2.1%	2.1%
2015	3201	2.3%	4.0%	2.3%
2016	3658	2.8%	6.5%	2.8%
2017	4116	2.5%	6.0%	2.5%
2018	4573	3.0%	5.6%	3.0%
2019	5031	4.0%	7.8%	4.0%
2020	5488	5.4%	7.6%	5.4%
2021	5828	6.3%	6.3%	5.5%
2022	6163	7.2%	7.2%	5.7%
2023	6498	7.2%	7.2%	2.7%
2024	6833	8.1%	8.1%	2.9%
2025	7168	9.0%	9.0%	1.5%
2026	7503	9.9%	9.9%	1.7%
2027	7838	10.7%	10.7%	1.8%
2028	8173	11.5%	11.5%	2.0%
2029	8508	12.3%	12.3%	2.1%
2030	8793	12.9%	12.9%	2.2%

Year	Option 3 Build-Out	Option 3 Base Case: Pro-Rata Curtailment up to end of 2017	Option 3 Base Case: Grandfathered Non-Firm Curtailment post 2017	Option 3 Base Case: Grandfathered Firm Curtailment post 2017	Option 3: Pro-Rata Curtailment up to end of 2017 (Slower DS3)	Option 3: Grandfathered Non-Firm Curtailment post 2017 (Slower DS3 & With Mitigation post 2020)	Option 3: Grandfathered Firm Curtailment post 2017 (Slower DS3 & With Mitigation post 2020)
2012	2228	3.0%			3.0%		
2013	2458	1.4%			1.4%		
2014	2671	1.7%			1.7%		
2015	3069	1.8%			3.2%		
2016	3367	1.8%			4.3%		
2017	3465	0.7%	0.7%	0.7%	2.3%	2.3%	2.3%
2018	3534		4.6%	0.5%		8.2%	1.0%
2019	3919		6.8%	0.9%		12.7%	1.8%
2020	4204		8.2%	1.3%		11.5%	1.6%
2021	4489		10.2%	1.7%		8.9%	1.4%
2022	4769		12.4%	2.1%		9.4%	1.4%
2023	5049		12.5%	2.1%		3.8%	0.3%
2024	5329		14.6%	2.5%		4.2%	0.4%
2025	5609		16.6%	3.0%		1.5%	0.1%
2026	6274		24.1%	4.7%		3.8%	0.3%
2027	6939		30.7%	6.7%		6.4%	0.6%
2028	7429		35.1%	8.1%		8.0%	0.9%
2029	7769		37.6%	9.0%		9.0%	1.0%
2030	8109		39.7%	9.8%		9.7%	1.1%

Year	Option 3b Build-Out	Option 3b Base Case: Pro-Rata Curtailment up to 2020	Option 3b: Pro-Rata Curtailment up to 2020 (Slower DS3)
2012	2243	3.1%	3.1%
2013	2493	1.5%	1.5%
2014	2761	2.2%	2.2%
2015	3215	2.4%	4.1%
2016	3670	2.9%	6.6%
2017	4124	2.5%	6.1%
2018	4579	3.0%	5.7%
2019	5033	4.0%	7.8%
2020	5488	5.4%	7.6%
2021	5488	5.4%	6.5%
2022	5488	5.4%	5.4%
2023	5488	5.4%	5.4%
2024	5488	5.4%	5.4%
2025	5488	5.4%	5.4%
2026	5488	5.4%	5.4%
2027	5488	5.4%	5.4%
2028	5488	5.4%	5.4%
2029	5488	5.4%	5.4%
2030	5488	5.4%	5.4%

APPENDIX C

Economic modelling of wind in the SEM

Dr. A.Mullane, E.O'Donoghue and Dr. R.Doherty

Abstract- This document describes an economic modelling exercise that was carried out by ElectroRoute Market Access Limited ("ElectroRoute") to provide supporting information of relevance to the SEM Committee paper entitled "Treatment of Curtailment in Tie-Break Situations" (Reference: SEM-12-028). Previously conducted studies in the area of focus were reviewed and an independent SEM modelling exercise was carried out to determine a reliable relationship between wind penetration and the cost of energy in the SEM.

A review of previous studies which reported on the relationship between the total wind share of load on the all-island system and the cost of generation was completed. The results of this review are shown Table 1 below.

Study	**IWEA**[1]			**SEM**[2]			**EirGrid**[3]		**AIGS**[4]			**Pyory**[5]	
Wind share	0%	25%	45%	9%	19%	28%	36%	47%	11%	21%	32%	45%	68%
Year	2020	2020	2020	2020	2020	2020	2025	2025	2020	2020	2020	2035	2035
Cost (€/MWh)	60.78	43.41	30.67	82.4	72.01	59.5	58.5	53.5	59	56	51	87	72
Price (€/MWh)	81.32	78.28	72.05	135	124	115							

Table 1: Results of Review of Related Modelling Studies

Although these studies were carried out for a variety of purposes the clear and intuitive trend of increasing wind generation causing reduced energy production costs was consistent throughout. Where reported, SEM price reductions vs. cost reductions were less pronounced as more frequent unit starts increase uplift payments which dampen the benefit of shadow price reductions.

In addition to this review ElectroRoute conducted an independent study comprising half hourly 2020 modelling runs at differing wind levels using a dedicated half hourly Mixed Integer SEM model. The dataset used in the model was the Regulatory Authorities published 2011 validated data parameters[6], input commodity costs were sourced from commodity exchanges[7] and other public domain sources[8]. The results of the model runs are summarised in Table 2 on the following page.

---

1 The impact of wind on pricing within the Single Electricity Market - IWEA 2011
2 Impact of High Levels of Wind Penetration in 2020 on the Single Electricity Market (SEM) A Modelling Study by the Regulatory Authorities January 2009 (SEM-09-002)
3 EirGrid, Interconnector Economic Feasibility Report, EirGrid 2009
4 All Island Grid Study, 2008.
5 Low Carbon Generation Options for the All-Island Market. Pyory 2010
6 http://www.allislandproject.org/en/market_modelling_group.aspx
7 http://www.nasdaqomxcommodities.com/trading/marketprices/= Gas at £65p per Therm
8 http://www.commodity3.com/physical/energycoal/energy-steam-coal = Coal at 109USD/mT, Distillate at 954 USD/mT, Carbon at €15/mT

	Low	Central	High
2020 Installed Wind MW	3,300	4,400	5,500
Demand GWh/yr	40,996.4	40,996.4	40,996.4
Average Shadow Price €/MWh	38.9	37.8	36.8
Average SMP €/MWh	56.6	57.5	59.1
Average SMP when curtailed to 75% level	40.0	46.6	53.8
Fuel + Carbon Cost M€/yr	2,017.6	1,844.2	1,599.2
Start Cost M€/yr	20.9	23.5	23.8
Total Production Cost M€/yr	2,038.5	1,867.7	1,623.0
Average Production cost €/MWh	49.7	45.6	39.9

Table 2: Results of ElectroRoute 2020 Modelling Study

The results collated from previously published modelling exercises, together with results determined by ElectroRoute's independent study, are presented in the following chart.

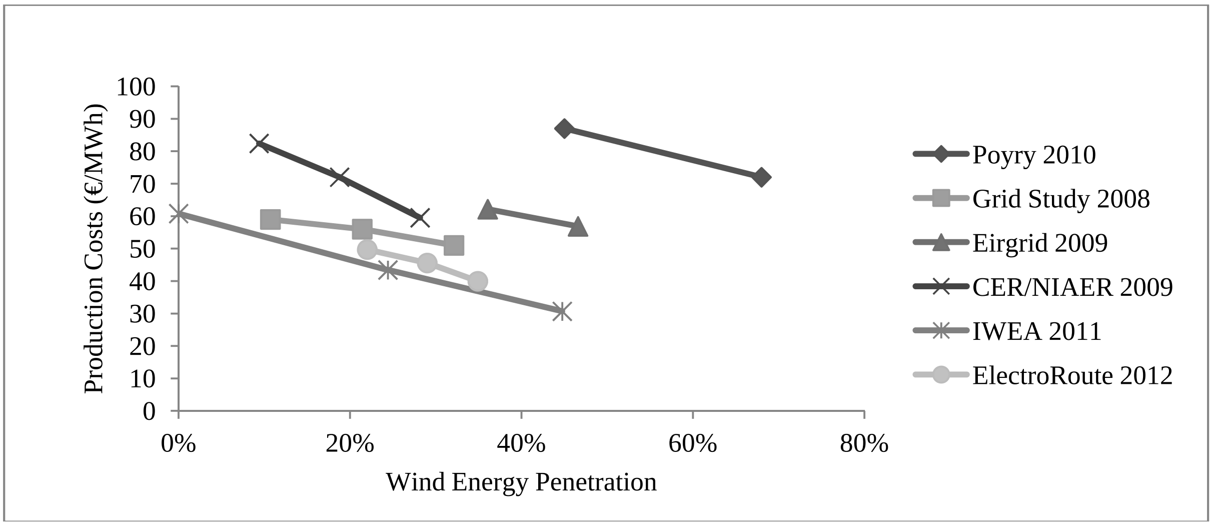


Figure 1: Relationship between Wind Penetration and SEM Production Costs

The trend whereby increasing levels of wind penetration drives reductions in energy production costs is clearly evident within the presented results. ElectroRoute collated the outputs of various studies described in the above diagram and derived the conservative relationship that a 1% increase in wind energy penetration causes the energy production costs of the 2020 system to reduce by 0.5€/MWh.

ElectroRoute noted a slight increase in average SMP with increasing wind penetrations. This was found to be due to the increased frequency of unit starts in the higher wind runs which causes SEM uplift to increase. This phenomena is solely an artefact of the SEM uplift design which did not pass on the clear wind related production cost savings to the market at large.

The SEM modelling study carried out by ElectroRoute also facilitated the determination of a wind compensation price. As can be seen in Table 1, in the results for the central wind case the average curtailment compensation price to be paid to eligible wind generators under a 75% Instantaneous Wind Penetration Cap scenario is 46.6 €/MWh.

The following economic factors derived from the modelling may be used when calculating economic factors related to wind in the 2020 power system.

- **Each 1% increase in wind penetration reduces average energy production costs by 0.5€/MWh**.
- **The average curtailment related compensation price for eligible wind generators is 46.6 €/MWh.**

Date: *25/05/2012*	*25/05/2012*
Author: *Electro-Route*	*ElectroRoute*
Version: *2.4*	*2.4*
Economic Argument	Ths sheet takes output from IGS analysis in terms of build-out rates and curtailment levels and applies ElectroRoute market modelling in order to determine the impact on Cost of Energy Production and Cost of Compensation- the analysis is conducted for years 2012-2030
2015 & 2020 Summary	This sheet presents a summary of the nett impacts of the various options for the years 2015 and 2020

Economic Argument

	Capacity Factor	0.32																		
	Market price reduction in €/MWh per % increase in re penetration	0.5																		
	Curtailment compensation price	46.60																		
	Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
	All-Island Load (GWh)	36,500	37,000	37,500	38,000	38,500	39,000	39,500	40,000	40,500	41,000	41,500	42,000	42,500	43,000	43,500	44,000	44,500	45,000	45,500
Option 1 (Low)	Total Firm	1,746	1,883	2,221	2,427	2,669	3,005	3,469	3,854	4,139	4,424	4,704	4,984	5,264	5,544	6,209	6,874	7,364	7,704	8,044
	Total Non Firm	483	467	400	386	386	266	65	65	65	65	65	65	65	65	65	65	65	65	65
	Total Wind Installed	2,228	2,351	2,621	2,813	3,055	3,271	3,534	3,919	4,204	4,489	4,769	5,049	5,329	5,609	6,274	6,939	7,429	7,769	8,109
	Curtailment for Non-Firm Connections - Low	8.6%	3.1%	6.0%	4.2%	4.2%	2.5%	4.6%	6.8%	8.2%	10.2%	12.4%	12.5%	14.6%	16.6%	24.1%	30.7%	35.1%	37.6%	39.7%
	Curtailment for Firm Connections - Low	0.9%	0.2%	0.5%	0.3%	0.4%	0.2%	0.5%	0.9%	1.3%	1.7%	2.1%	2.1%	2.5%	3.0%	4.7%	6.7%	8.2%	9.0%	9.8%
	Energy Lost to curtailment (MWh) -Low	160,308	53,692	97,738	67,535	72,900	33,707	53,740	109,704	162,245	226,891	301,247	315,571	402,347	499,196	868,950	1,355,429	1,746,734	2,006,654	2,278,629
	% of yearly demand lost to curtailment	0.4%	0.1%	0.3%	0.2%	0.2%	0.1%	0.1%	0.3%	0.4%	0.6%	0.7%	0.8%	0.9%	1.2%	2.0%	3.1%	3.9%	4.5%	5.0%
	RE Target	16.7%	17.7%	19.3%	20.6%	22.1%	23.4%	24.9%	27.2%	28.7%	30.1%	31.5%	32.9%	34.2%	35.4%	38.4%	41.1%	42.9%	43.9%	45.0%
	Curtailment Compensation Cost M€				1	1	1	2	5	7										
	Wind related market savings relative to grandfathered 1a1 Low M€				n/a	n/a	n/a	n/a	n/a	n/a										
	Net wind related market savings relative to grandfathered 1a1 Low	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	0	0	0	0	0	0	0	0	0	0
Option (Moderate - High)	Total Firm	1,746	1,872	2,199	2,394	2,625	2,950	3,253	3,556	3,859	4,294	4,674	4,954	5,234	5,514	5,794	6,074	6,354	7,019	7,684
	Total Non Firm	483	467	400	386	386	266	65	65	65	65	65	65	65	65	65	65	65	65	65
	Total Wind	2,228	2,340	2,599	2,780	3,011	3,216	3,318	3,621	3,924	4,359	4,739	5,019	5,299	5,579	5,859	6,139	6,419	7,084	7,749
	Curtailment for Non-Firm Connections - Moderate to High	8.6%	3.0%	5.7%	3.9%	3.8%	2.1%	2.4%	4.5%	6.1%	9.0%	12.0%	12.2%	14.3%	16.2%	18.2%	20.9%	23.1%	29.5%	35.7%
	Curtailment for Firm Connections - Moderate to High	0.9%	0.2%	0.4%	0.3%	0.3%	0.1%	0.2%	0.5%	0.8%	1.4%	2.0%	2.0%	2.5%	2.9%	3.4%	3.9%	4.5%	6.3%	8.3%
	Energy Lost to curtailment (MWh) -Moderate to High	160,308	51,349	90,951	60,431	64,236	27,371	26,909	53,289	94,732	185,604	289,332	303,555	388,414	483,457	588,732	705,689	834,846	1,301,071	1,862,002
	% of yearly demand lost to curtailment	0.4%	0.1%	0.2%	0.2%	0.2%	0.1%	0.1%	0.1%	0.2%	0.5%	0.7%	0.7%	0.9%	1.1%	1.4%	1.6%	1.9%	2.9%	4.1%
	RE Target	16.7%	17.6%	19.2%	20.4%	21.8%	23.0%	23.5%	25.2%	26.9%	29.4%	31.3%	32.8%	34.0%	35.2%	36.4%	37.5%	38.6%	41.2%	43.7%
	Curtailment Compensation Cost M€				1	1	1	1	2	4										
	Wind related market savings relative to grandfathered 1a1 Low M€				-4	-6	-7	-29	-39	-36										
	Net wind related market savings relative to grandfathered 1a1 Low	0	0	0	-4	-6	-7	-28	-37	-33	0	0	0	0	0	0	0	0	0	0

	Capacity Factor	0.32																		
	Market price reduction in €/MWh per % increase in re penetration	0.5																		
	Curtailment compensation price	46.60																		
	Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
	All-Island Load (GWh)	36,500	37,000	37,500	38,000	38,500	39,000	39,500	40,000	40,500	41,000	41,500	42,000	42,500	43,000	43,500	44,000	44,500	45,000	45,500
Option 2	Total Firm	1,760	1,872	2,199	2,394	2,625	2,950	3,253	3,556	3,859	4,294	4,674	4,954	5,234	5,514	5,794	6,074	6,354	7,019	7,684
	Total Non Firm	483	621	561	821	1,045	1,174	1,325	1,477	1,629	1,534	1,489	1,544	1,599	1,654	1,709	1,764	1,819	1,489	1,159
	Total Wind	2,243	2,493	2,761	3,215	3,670	4,124	4,579	5,033	5,488	5,828	6,163	6,498	6,833	7,168	7,503	7,838	8,173	8,508	8,843
	Curtailment for Non-Firm Connections - Base Case	3.1%	1.5%	2.1%	2.3%	2.8%	2.5%	3.0%	4.0%	5.4%	6.3%	7.2%	7.2%	8.1%	9.0%	9.9%	10.7%	11.5%	12.3%	12.9%
	Curtailment for Firm Connections- Base Case	3.1%	1.5%	2.1%	2.3%	2.8%	2.5%	3.0%	4.0%	5.4%	6.3%	7.2%	7.2%	8.1%	9.0%	9.9%	10.7%	11.5%	12.3%	12.9%
	Energy Lost to curtailment (MWh)- Base Case	195,818	104,466	160,658	210,705	289,772	283,685	383,738	559,585	824,040	1,024,941	1,247,461	1,311,740	1,550,532	1,805,893	2,075,703	2,355,444	2,644,616	2,941,713	3,194,176
	% of yearly demand lost to curtailment	0.5%	0.3%	0.4%	0.6%	0.8%	0.7%	1.0%	1.4%	2.0%	2.5%	3.0%	3.1%	3.6%	4.2%	4.8%	5.4%	5.9%	6.5%	7.0%
	RE Target	16.7%	18.6%	20.2%	23.2%	26.0%	28.9%	31.5%	33.9%	36.0%	37.3%	38.6%	40.2%	41.4%	42.5%	43.6%	44.6%	45.5%	46.5%	47.5%
	Curtailment Compensation Cost M€				7	10	9	13	18	27										
	Wind related market savings relative to grandfathered 1a1 Low M€				49	75	107	130	134	147										
	Net wind related market savings relative to grandfathered 1a1 Low	0	0	0	43	67	98	119	120	127	0	0	0	0	0	0	0	0	0	0

Capacity Factor	0.32
Market price reduction in €/MWh per % increase in re penetration	0.5
Curtailment compensation price	46.60

	Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
	All-Island Load (GWh)	36,500	37,000	37,500	38,000	38,500	39,000	39,500	40,000	40,500	41,000	41,500	42,000	42,500	43,000	43,500	44,000	44,500	45,000	45,500
Option 3	Total Firm	1,634	1,711	2,024	2,230	2,543	2,929	3,469	3,854	4,139	4,424	4,704	4,984	5,264	5,544	6,209	6,874	7,364	7,704	8,044
	Total Non Firm	595	746	647	839	824	536	65	65	65	65	65	65	65	65	65	65	65	65	65
	Total Wind	2,228	2,458	2,671	3,069	3,367	3,465	3,534	3,919	4,204	4,489	4,769	5,049	5,329	5,609	6,274	6,939	7,429	7,769	8,109
	Curtailment for Non-Firm Connections - (Base Case)	3.0%	1.4%	1.7%	1.8%	1.8%	0.7%	4.6%	6.8%	8.2%	10.2%	12.4%	12.5%	14.6%	16.6%	24.1%	30.7%	35.1%	37.6%	39.7%
	Curtailment for Firm Connections - Low (Base Case)	3.0%	1.4%	1.7%	1.8%	1.8%	0.7%	0.5%	0.9%	1.3%	1.7%	2.1%	2.1%	2.5%	3.0%	4.7%	6.7%	8.1%	9.0%	9.8%
	Energy Lost to curtailment (MWh) -Low (Base Case)	188,891	93,100	130,727	155,400	167,628	70,372	53,678	109,612	162,136	226,756	301,086	315,408	402,159	498,984	868,646	1,355,049	1,746,302	2,006,193	2,278,144
	% of yearly demand lost to curtailment	0.5%	0.3%	0.3%	0.4%	0.4%	0.2%	0.1%	0.3%	0.4%	0.6%	0.7%	0.8%	0.9%	1.2%	2.0%	3.1%	3.9%	4.5%	5.0%
	RE Target	16.6%	18.4%	19.6%	22.2%	24.1%	24.7%	24.9%	27.2%	28.7%	30.1%	31.5%	32.9%	34.2%	35.4%	38.4%	41.1%	42.9%	43.9%	45.0%
	Curtailment Compensation Cost M€				5	6	3	2	5	7										
	Wind related market savings relative to grandfathered 1a1 Low M€				31	39	25	0	0	0										
	Net wind related market savings relative to grandfathered 1a1 Low	0	0	0	27	34	23	0	0	0	0	0	0	0	0	0	0	0	0	0
Option 3b	Total Firm	1,760	1,872	2,199	2,394	2,625	2,950	3,253	3,556	3,859										
	Total Non Firm	483	621	561	821	1,045	1,174	1,325	1,477	1,629										
	Total Wind	2,243	2,493	2,761	3,215	3,670	4,124	4,579	5,033	5,488										
	Curtailment for Non-Firm Connections - (Base Case)	3.1%	1.5%	2.2%	2.4%	2.9%	2.5%	3.0%	4.0%	5.4%										
	Curtailment for Firm Connections - Low (Base Case)	3.1%	1.5%	2.2%	2.4%	2.9%	2.5%	3.0%	4.0%	5.4%										
	Energy Lost to curtailment (MWh) -Low (Base Case)	195,818	104,524	167,240	216,515	294,853	287,420	386,200	560,990	824,040										
	% of yearly demand lost to curtailment	0.5%	0.3%	0.4%	0.6%	0.8%	0.7%	1.0%	1.4%	2.0%										
	RE Target	16.7%	18.6%	20.2%	23.1%	26.0%	28.9%	31.5%	33.9%	36.0%										
	Curtailment Compensation Cost M€				8	10	10	13	18	27										
	Wind related market savings relative to grandfathered 1a1 Low M€				49	75	107	130	134	147										
	Net wind related market savings relative to grandfathered 1a1 Low	0	0	0	42	67	98	119	120	127										

Capacity Factor	0.32
Market price reduction in €/MWh per % increase in re penetration	0.5
Curtailment compensation price	46.60

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
All-Island Load (GWh)	36,500	37,000	37,500	38,000	38,500	39,000	39,500	40,000	40,500	41,000	41,500	42,000	42,500	43,000	43,500	44,000	44,500	45,000	45,500

Option 4

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total Firm (IGS Option 2)	1,760	1,872	2,199	2,394	2,625	2,950	3,253	3,556	3,859	4,294	4,674	4,954	5,234	5,514	5,794	6,074	6,354	7,019	7,684
New Firm Build per year (IGS Option 2)		112	327	195	231	325	303	303	303	435	380	280	280	280	280	280	280	665	665
New Firm Build reduced by 50% due to no compensation, non firm unchanged as it is already uncompensated		56	164	98	116	163	152	152	152	218	190	140	140	140	140	140	140	333	333
Total Firm (Option 4)	1,760	1,816	1,980	2,077	2,193	2,355	2,507	2,658	2,810	3,027	3,217	3,357	3,497	3,637	3,777	3,917	4,057	4,390	4,722
Total Non Firm (IGS Option 2)	483	621	561	821	1,045	1,174	1,325	1,477	1,629	1,534	1,489	1,544	1,599	1,654	1,709	1,764	1,819	1,489	1,159
Total Wind	2,243	2,437	2,541	2,898	3,237	3,529	3,832	4,135	4,438	4,561	4,706	4,901	5,096	5,291	5,486	5,681	5,876	5,878	5,881
Curtailment for Non-Firm Connections - Base Case	3.1%	1.3%	1.2%	1.2%	1.4%	0.8%	1.1%	1.4%	1.9%	2.0%	2.1%	1.9%	2.1%	2.4%	2.6%	2.8%	3.1%	2.8%	2.5%
Curtailment for Firm Connections - Base Case	3.1%	1.3%	1.2%	1.2%	1.4%	0.8%	1.1%	1.4%	1.9%	2.0%	2.1%	1.9%	2.1%	2.4%	2.6%	2.8%	3.1%	2.8%	2.5%
Energy Lost to curtailment (MWh) -Low	195,818	86,910	87,543	99,881	127,304	84,030	113,432	166,239	237,845	254,445	279,214	261,608	304,617	350,438	399,095	449,771	502,474	458,368	416,783
% of yearly demand lost to curtailment	0.5%	0.2%	0.2%	0.3%	0.3%	0.2%	0.3%	0.4%	0.6%	0.6%	0.7%	0.6%	0.7%	0.8%	0.9%	1.0%	1.1%	1.0%	0.9%
RE Target	16.7%	18.2%	18.8%	21.1%	23.2%	25.2%	26.9%	28.6%	30.1%	30.6%	31.1%	32.1%	32.9%	33.7%	34.4%	35.2%	35.9%	35.6%	35.3%
Curtailment Compensation Cost M€				0	0	0	0	0	0										
Wind related market savings relative to grandfathered 1a1 Low M€				10	23	34	39	27	29										
Net wind related market savings relative to grandfathered 1a1 Low	0	0	0	11	24	34	41	32	36	0	0	0	0	0	0	0	0	0	0

2015 & 2020 Summary

	2015			2020		
	Curtailment Comp. Cost (€M)	Wind Related Savings (€M)	Net Market Savings (€M)	Curtailment Comp. Cost (€M)	Wind Related Savings (€M)	Net Market Savings (€M)
Option 1 (Low)						
Option 1 (Moderate - High)	1	-4	-4	4	-36	-33
Option 2	7	49	43	27	147	127
Option 3	5	31	27	7	-0	-0
Option 3b	8	49	42	27	147	127
Option 4	0	10	11	0	29	36