Single Electricity Market Committee

Preliminary Analysis of the Treatment of Different Technology Types under the Capacity Payment Mechanism

Information Note

AIP-SEM-08-177

17th December 2008

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1. Executive Summary

On 11th February 2008, the Single Electricity Market Committee (SEM Committee) published a discussion paper regarding the treatment of wind generation (SEM/008/02) in the Single Electricity Market (SEM). One area identified within that paper was the treatment of wind generation under the Capacity Payment Mechanism (CPM). The treatment of wind generation under the CPM was also flagged for analysis during the early stage of the design of the SEM (AIP/SEM/53/05).

Several responses were received in relation to the wind discussion paper.[1] A high level response paper has been published detailing the next steps to review the issues raised in the wind discussion paper (SEM/08/127). This information note represents the next step in the work being carried out by the Regulatory Authorities in relation to the CPM in that context.-

This note sets out the results of initial analysis carried out in relation to the remuneration of wind and other technologies under the CPM for the first eight months of the SEM. The analysis compares the value of a generator technology's capacity contribution to security of supply ("Study-Calculated Capacity Credit") to the CPM valuations of that same generation technology ("CPM-Inferred Capacity Credit"). Study-Calculated Capacity Credits only exist for wind generation at this time and therefore are only presented for that technology type.

The analysis reveals that, subject to certain caveats, the CPM is overvaluing wind generation by approximately 44% in comparison to its Study-Calculated Capacity Credit. The wind CPM-Inferred Capacity Credit is calculated at 0.34 (as a decimal percentage of installed megawatts) in comparison to the wind Study-Calculated Capacity Credit of 0.23.

The remuneration of other generation types under the CPM, for which no Study-Calculated Capacity Credits are available, is also examined and the results are set out in Section 6 of this note.

The impact of the overpayment to wind generation on other forms of generation is analysed, and is considered to be quite small on average for the duration in question, given the relatively small payments to wind in comparison to the total capacity pot. Based on the analysis to date, Demand Side Units, Energy Limited Hydro generation and Pumped Storage generation, and not conventional thermal generation, appear to be underpaid the most arising from the overpayment to wind. Whilst the analysis to date indicates that this is not currently having a material impact on other generation types being rewarded by the CPM, with increasing wind penetration the level of underpayment to others will become more pronounced. The overpayment to wind generation is demonstrated to occur because of the consulted on design of the CPM which contains stable forecasts of capacity value (the fixed and variable streams of the CPM) and monthly settlement. The lower-risk revenue under the CPM for all generators, i.e. the fact that generators are not punitively penalised if on maintenance or unavailable during the peak requirements for generator availability, means that wind generators will fare better under the CPM than the wind Study-Calculated Capacity Credit suggests. The contribution of a generator's availability to

[1] Published response are available on the All island Project website:| http://www.allislandproject.org/en/generation.aspx?article=5bb9b3bb-d35f-43aa-ad50-d2f0d18cc436

security of supply as determined through the calculation of a Study-Calculated Capacity Credit does not contain such revenue-stabilising features.

The Regulatory Authorities note, however, that an overpayment of approximately 44% is significant and must be addressed to ensure that all generators are rewarded under the CPM in accordance with the objectives of that mechanism. The Regulatory Authorities note that, under the CPM, all generators should be rewarded in a manner that is reflective of their contribution to security of supply.

The Regulatory Authorities acknowledge that it is necessary to carry out further analysis in relation to this matter prior to proceeding to address this issue. This includes determination of actual capacity credits for all generation, including Demand Side Units, for the first twelve months of the SEM and completion of analysis regarding remuneration under the CPM for that period. The next steps in this regard are set out in Section 8 of this information note.

2. Introduction

2.1 Background

On 11th February 2008, the SEM Committee published a discussion paper regarding the treatment of wind generation (SEM/008/02) in the Single Electricity Market (SEM), in the context of non-diverse intermittent generation in general.[2] The wind discussion paper was issued to promote discussion in relation to certain key issues that may potentially arise due to increasing levels of wind generation on the island of Ireland and the possible solutions to those issues. The wind discussion paper was published post publication of the All Island Grid Study and against the backdrop of the launch of the EU Climate Change Package that set out proposals regarding binding renewable targets for Member States for 2020.[3]

The wind discussion paper set out certain key matters that the SEM Committee considered necessary to address in the context of increasing wind in the areas of System Operator dispatch and market pricing, including the remuneration of wind generation under the capacity payment mechanism (the CPM).

The wind discussion paper stated that the consultation process would be guided by governing legislation in relation to renewables and wider legislative requirements in relation to the SEM. In this context, any changes to existing rules and procedures arising out of the consultation process will be proportionate and limited to those which are necessary and appropriate. Furthermore, it was acknowledged that other bodies of work are progressing in parallel and certain matters raised in the discussion paper are being dealt with in those work streams, notably, the ancillary services work stream.

During the development of the SEM, a Regulatory Authority (RA) decision paper (AIP/SEM/07/13) stated a need for a review of the remuneration of wind generation under the CPM. This statement resulted from views expressed by participants that the chosen approach may serve to over-value the contribution of wind. This potential over remuneration of wind generation is related to the publication of forward-looking studies of the contribution of wind generation per installed megawatt of capacity to generation adequacy. This contribution is called the "Study-Calculated Capacity Credit" in this paper. The wind discussion paper sought comments on the valuation of wind generation by the CPM. Specifically, the following two questions were posed in relation to the CPM:

1. Does the CPM accurately reflect the value of wind capacity and will it continue to do so as wind penetration increases?
2. How could the CPM be best revised so as to accurately value wind capacity going forward?

The comments received in response to the above questions are set out in Appendix A, and are responded to in detail there. These CPM comments have been distilled from the complete responses which are published on the All Island Project (AIP)

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[2] http://www.allislandproject.org/GetAttachment.aspx?id=054790c0-107d-413c-beb7-3c1d7c887c76

[3] http://ec.europa.eu/energy/climate_actions/index_en.htm
http://www.dcmnr.gov.ie/Energy/North-South+Co-operation+in+the+Energy+Sector/All+Island+Grid+Study.htm

website.[4] Several general responses regarding the unduly wind-specific focus of the wind discussion paper were received. These comments are responded to in the paper responding to comments received on the wind discussion paper[5]. Nevertheless, in line with the concerns raised in those responses, this paper analyses the remuneration of all SEM generation technologies, and not just wind generation. It is noted, however, that Study-Calculated Capacity Credits are only available for wind generation, and therefore some focus remains with this generation technology.

In relation to specific comments received regarding the CPM, respondents were divided on whether wind generation was over remunerated in relation to other generation technologies. Some respondents noted that insufficient notice was taken of the flexibility (start up times, ramp rates, etc.) of other generation technologies within the CPM mechanism in comparison to output from wind generation. Finally, quantitative analysis was requested by several participants to support the arguments presented in the wind discussion paper.

2.2 Purpose of this Paper

Guided by comments received regarding the CPM in response to the wind discussion paper, this information note examines the evidence for the first eight months of the SEM regarding the remuneration of various technology types, including wind, under the CPM. The SEM Committee has determined that this issue is a SEM Committee matter within the meaning of the relevant legislation.

2.3 Related Documents

The following documents are of relevance to this consultation:

- SEM High Level Design: AIP/SEM/42/05
- Capacity Payment Mechanism and Reserve Charging High Level Decision Paper: AIP/SEM/53/05
- SEM Capacity Payment Factors - Decision Paper: AIP/SEM/231/06
- Methodology for the Determination of the Capacity Requirement: AIP/SEM/07/13
- Methodology for the Determination of the Capacity Requirement: AIP/SEM/07/65
- Loss of Load Probability for Capacity Payment Mechanism: AIP/SEM/07/187
- Annual Capacity Payment Sum for 2007: AIP/SEM/07/188
- Final 2008 Capacity Pot: AIP/SEM/07/458

[4]Ref: http://www.allislandproject.org/en/generation.aspx?article=5bb9b3bb-d35f-43aa-ad50-d2f0d18cc436
[5] Ref: SEM-08-127

- Fixed Cost of a Best New Entrant Peaking Plant for the Calendar Year 2009: SEM/08/083

- Harmonised All-Island Ancillary Services Policy: SEM/08/013

- Wind Generation in the SEM: Policy for Large-Scale, Intermittent Non-Diverse Generation Discussion Paper SEM/08/002

- Responses received to Wind Discussion Paper:

- Initial Response to the Comments Received on Wind Discussion Paper: SEM-08-127

- Generation Adequacy Report: 2008 -2014

- Wind Power Analytical Report, 2007 Update

2.4 Structure of this Paper

This paper is structured as follows:

- Section 3 sets out further detail on the wind discussion paper, and a summary of the comments received in relation to the CPM;

- Section 4 sets out the objectives of the CPM within the wider SEM design of the Trading & Settlement Code and Ancillary Services;

- Section 5 describes previous desk-top studies which have calculated the capacity credit of wind generation ("the Study-Calculated Capacity Credit");

- Section 6 describes the methodology to determine the CPM's valuation of different technology types ("the CPM-Inferred Capacity Credit");

- Section 7 analyses the CPM-Inferred Capacity Credit of each technology type;

- Section 8 sets out the next steps to be taken in relation to this matter, and

- Appendix A sets out in tabular form, the full set of comments regarding the CPM extracted from the published responses to the consultation paper, along with detailed responses.

2.5 Commenting on this Paper

Comments on this paper should be directed at the following individuals:

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3. The Wind Discussion Paper and CPM Comments Received

3.1 Introduction

The wind discussion paper (SEM/08/002) sets out the background against which it was published. In summary, the context for the publication of that paper is as follows:

- a potentially large number of wind projects seeking connection in Ireland and Northern Ireland;
- the announcement of EU and national renewable targets, towards which wind generation will be the prime contributor in the SEM; and
- the publication of the All-Island Grid Study, which examined the technical feasibility and the cost impacts of increasing renewable penetration on the all island system.

Interested readers are referred to Section 3 of the discussion paper for a more detailed review of the background to and context for that paper.

3.1.1 The Wind Discussion Paper

The wind discussion paper sets out several specific areas for initial comment in relation to increased penetration of wind generation in the all-island portfolio as follows:

- System Operation
    - Incentivisation of System Operators
    - The dispatch, scheduling and utilisation of wind forecasts within the dispatch and scheduling
    - Tie-breaking rules within dispatch around Priority Dispatch, Firm Access, and generators' Commercial Offers
    - The definition of "curtailment" of wind generation
    - The provision of operational and other reserves by wind
    - The creation of reserve products to incentivise appropriate forward-looking plant mix
    - Grid Code compliance of conventional generation

- Trading and Settlement Code Arrangements
    - The payment of Price Taking Generation beyond demand requirements
    - The application of the market price floor when Price Taking Generation leads to an excessive generation event
    - Tie-breaking rules for Price Takers as required within the unconstrained schedule
    - The payment of constraint payments to wind generators for "curtailment" reasons
    - The form of inclusion of Price Taking generation within the unconstrained market schedule and impact on the System Marginal Price

- Capacity Payment Mechanism
    - The valuation of wind capacity within the capacity payment mechanism now and as its penetration increases
    - If required, any potential changes to the capacity payment mechanism

Informed by comments received in relation to the Capacity Payment Mechanism, the Regulatory Authorities now publish this information note setting out initial analysis in relation to this matter. The interested reader is referred to the initial response to comments received on the wind discussion paper (SEM/08/127) for how the other elements of the wind discussion paper are being brought forward.

3.1.1 Guiding Principles

In reaching decisions regarding the matters discussed in the wind discussion paper, the SEM Committee will be guided by its legal duties and functions and by the following principles as stated in that paper:

- Equity
- Cost minimisation
- Value reflective pricing
- Competitiveness
- Transparency
- Security of supply

It is in this context that the Regulatory Authorities (the RAs) will determine, *inter alia*, the appropriateness of the level of remuneration of each generation technology under the CPM. The need to ensure that all generators are rewarded under the CPM in accordance with the objectives of that mechanism and in a manner that is reflective of a generators contribution to security of supply is also noted here.[6]

3.2 Summary of Comments Received

Comments from twenty three respondents were received in relation to the wind discussion paper. Not all respondents commented directly on the matters raised in relation to the CPM. The non-confidential comments received which are relevant to the CPM, are included in Appendix A, along with detailed responses to those comments.

The comments received can be broadly broken down areas as follows:

- wind generation is over compensated by the CPM;
- wind generation is not over compensated by the CPM, and
- broader technological considerations should be considered other than the non-diverse variability of wind generation in any CPM review.

Each of these three main areas is discussed below in turn. Comments in relation to the requirement for quantitative numbers to support any further consultation/decisions on this matter are discussed in the response to comments

[6] Readers are referred to AIP/SEM/19/05.

received in Section 3.3. Certain respondents also suggested alternatives to the current CPM arrangements to rectify perceived issues.

3.2.1 Wind Generation is Over Compensated by the CPM

A number of conventional generators stated that the CPM currently over-values wind generation relative to the amount that wind contributes to security of supply. This overpayment was argued – based on publications from the System Operator and others– to increase in materiality with increasing wind penetration. Therefore, it was stated that there is a need to address this issue. A number of approaches were proposed. For example, the System Operators suggested that payments to wind generators under the CPM should reflect their contribution to security of supply, and therefore their contribution to total CPM revenues. The System Operators set out details of an alternative CPM approach in their submission, whereby wind generation would only access those pre-calculated revenues related to their contribution to security of supply. This leads to wind generation competing amongst themselves for one pot of CPM generation, while other generators compete for the remainder of the CPM revenues. They stated that their proposal could be generalised to apply to all types of generation to ensure that the 'true contribution to capacity' is rewarded under the CPM which would result in an equitable solution. Interested readers are referred to the System Operators' response to the wind discussion paper which is published on the AIP website (SEM/08/137).

3.2.2 Wind Generation is Not Being Over Compensated

A number of other respondents expressed the view that wind is not being over compensated by the CPM. Conventional plant are rewarded on the basis of installed capacity, while wind generation is paid on the basis of actual output. Wind therefore receives approximately 30% of the value per installed MW compared with conventional plant which was not considered by the respondent to be over compensation. It was noted by a number of respondents that there is a need to pay wind for it availability on an equal basis to all other generators in the interest of non discrimination.

3.2.3 Consideration of all Generator Technology Characteristics

One respondent noted that the current CPM fails to recognise the significant flexibility of wind compared to the inflexibility of other technologies. For example, wind generation has very fast ramp down rates, and very low minimum stable generation. Another stated that some changes should be made to the CPM to tighten the definition of availability, e.g. to reflect that long cold start times, slow ramp up rates and the possibility of generator trips during start-ups impact the contribution of a generator's availability to security of supply. Wind generation, in contrast, only receives capacity payments when already generating.

General comments were received that the contribution of wind generation to security of supply was in part dependent on the technical flexibility of conventional generation within the overall generation portfolio.

3.3 Response to Comments Received

The SEM Committee welcomes the comments received to the wind discussion paper, including those relating the remuneration of wind under the CPM.

Comments relating to the remuneration of non wind generation under the CPM are noted and the guiding principles set out in the discussion paper and in Section 3.1.1 of this note, the objectives of the CPM and the need to ensure that all generation are rewarded under the mechanism in a manner that is consistent with their contribution to security of supply are reiterated.

Regarding the qualitative nature of the wind discussion paper, it is noted that the responses to the wind discussion paper were also qualitative. No respondents offered estimates of the materiality of the competing effects (inflexible generation, non-diverse intermittent generation, etc.) which shift the relative share of the fixed total pot of CPM revenues from one generation technology type to another. Without quantitative numbers, it is difficult to evaluate the relative materiality of the comments received to the discussion paper. This lack of quantitative detail was appropriate within the context of a discussion paper, but it is considered necessary to examine the remuneration of different technologies under the CPM at this juncture in order to address concerns raised by respondents regarding the lack of analysis and to frame subsequent work by the RAs in relation to this matter. This information note sets out the initial analysis carried out in relation to the remuneration of different technology types under the CPM and sets out further work in this area which is considered necessary in advance of further consultation.

4. The Objectives of the CPM within SEM

This section sets out the overall principles behind the CPM in the SEM, and where it sits in relation to the revenues earned in the energy market and through ancillary services. The remuneration of wind generation's "capacity" under the CPM is then explained.

4.1 The Principles of Rewarding Capacity and Energy in SEM

In an energy-only pool market, i.e. where generator market revenue comes only from the generation of energy, generators must recover both their short-run costs (e,g, fuel, staffing, maintenance, etc.) and their long-run costs (e.g. capital expenditure, etc.) through the price of energy. Therefore, peaking generation would only cover its short-run and long-run costs if energy prices were sufficiently high during those short periods (i.e. winter peak, etc.) when it runs to cover both categories of cost. It is considered that this would require spikes in energy prices. All in-merit generators would receive payments at these energy prices.

The CPM serves to reduce these spiking prices required by peaking generation to recover long-run costs, and to provide a lower-risk revenue stream for those generators to recover their costs, and therefore lowering the risk of investment. The SEM CPM primarily ensures that such peaking generation recovers its costs in a market where prices are set only by the short run cost of generation.

The SEM CPM pays for generation availability throughout the year, thus providing for a stable revenue stream for all generators. Peaking plants should earn enough revenues to cover their long-run costs through these payments. Therefore, the CPM removes a degree of volatility in energy prices arising from the running of peaking generation. Note that as part of the CPM design – as well as a market power mitigation measure – generators are required under licence not to include long-run costs in their offers to generate energy, as this would result in double payment given that these costs are recovered under the CPM and via infra-marginal energy rents.

The CPM pays out a fixed pot of money ("the total pot") to be shared amongst all generation. The total pot is tailored to ensure that it would pay a best new entrant peaker generator at a sufficient rate to cover its long-run costs, given forward looking estimates of its running and all its other revenues. The rate at which the BNE peaker is paid per installed kW is multiplied by an amount of generation capacity to maintain security of supply to normal standards. The resulting sum of money becomes the CPM total pot.

Rather than just pay all generators their relative share of the CPM total pot based on installed capacity, it was deemed appropriate during the design of the mechanism to send signals through it. These signals incentivise generators to make their capacity available as much as possible, and to make it available at more valuable times. Care was taken with these incentives not to make them as volatile and unpredictable as energy spikes in an energy only market might have been. The following balance was struck.

Firstly, the fixed pot is divided year-ahead into 12 monthly pots. Each monthly pot of money must be paid out in each relevant month. Therefore, if the majority of events where there is a lack of available generation occur in a single month, and a particular generator is out on maintenance for that month, the generator in question will still receive revenues under the CPM for the other eleven months. This reduces the risk for individual generators of "losing out" by not being available at the times when availability is most required.

Secondly, within each month, availability is priced under three "streams". The fixed stream (30% of the total pot) values the required availability using a half-hourly index profile that is calculated prior to the start of the Year. The variable stream (40% of the total pot) provides a forward-looking time-of-day signal for generators, valuing the required availability more during periods of low margin than high margin. Finally, the ex-post stream (the remaining 30% of the total pot) values each trading periods' availability based on the system conditions present at any given time. The ex-post stream comes closest to reflecting the volatility in energy prices that would be seen in an energy only market.. The fixed stream and the variable stream provide more stable revenues to generators.

The CPM values Eligible Availability within each half-hour equally from all technology sources, irrespective of start-up times, ramp rates, likelihood of tripping during start-up, or the non-diverse nature of those technologies. It only differentiates between various sources of availability by the time-value assigned to that availability through its three payment streams. For example, if two technologies differed only in that one generated during the day, and the other generated during the night, the day-generator would generally earn more CPM revenues per MW of availability than the night-generator.

4.2 The Interaction of Capacity Payments and Ancillary Services

The Harmonised All-Island Ancillary Services Policy decision paper (SEM/08/013) states the following (emphasis added):

- *"Reserve payments serve the purpose of ensuring that sufficient plants are available in the right locations, capable of providing the response required by the TSO. The issues relating to the design of the CPM (including how it interacts with the provision of AS) were consulted on previously by the RAs during the development of the CPM. The CPM does not, and was not designed to, ensure that generators offer sufficient reserve within certain geographical boundaries* ***or to particular technical specifications****."*[7]

Therefore, currently the responsibility of incentivising the *type* of availability is within the remit of ancillary service payments.

As discussed above in Section 4.1, the CPM total pot is tailored to ensure that it would pay a best new entrant peaker generator at a sufficient rate to be profitable, given forward looking estimates of all its other revenues. Its other revenues include ancillary services revenues. Consequentially, if ancillary service payments increase to a BNE peaker, the total capacity payment it will need to receive to recover its long-

[7] Emphasis added.

run costs will decrease. This has the effect of decreasing the CPM total pot, and therefore the CPM payments to all other generation.

4.3 The Remuneration of Wind Generation

Wind generation gets paid a capacity payment based on its Eligible Availability in each half-hour. Wind generation's effective availability is not the installed megawatt capacity of the wind generator, but the capability of the wind generator to generate given the prevailing wind conditions. In practice, this is calculated as the megawatt-hours generated by a wind generator in a half hour, converted to a megawatt availability figure.

This is in contrast to a conventional generator with a fuel source sufficient to generate at full capacity throughout the day. Such a generator will get paid a capacity payment for all of its installed capacity, as all of its capacity is continuously available to generate.

If a wind generator is constrained down by the System Operator, the wind generator receives a capacity payment based on what it would have generated had the system operator not issued the constrained down instruction. Even if the generator has no firm physical access, it will still get paid for what it could have generated. This is the case for all technology types.

5. The Study-Calculated Capacity Credit

This section defines a "Study-Calculated Capacity Credit", and delivers a Study-Calculated Capacity Credit for wind generation believed to be indicative of the first eight months of SEM operation. As no equivalent Study-Calculated Capacity Credits currently exist for other generation, these are not presented here. Nevertheless, Section 8.4.1 discusses the requirement for such calculations to be carried out for other generation technology types in the context of further RA consultation regarding the CPM.

5.1 Capacity Credit and Security of Supply

The 'capacity credit' is a useful concept in determining the relative values of different technologies' contribution to security of supply. A capacity credit is defined as the contribution of a single 100% available megawatt of generation to security of supply. Therefore, if a 100MW generator is 90% available, and (generally speaking) its unavailability is not correlated with tight security of supply events (e.g. times of high demand and low wind), it would have a capacity credit of 0.90 which equates to 90MW in this case.

Studies have been performed examining the contribution of wind generation to security of supply. These studies calculate a capacity credit for wind in the following manner. First, the security of an electrical system with a level of wind penetration is calculated. Then the wind generation is removed from the electrical system portfolio, and the level of security of supply is recalculated. Finally, a certain level of perfectly available generation is added to the wind-less generation portfolio in order to re-achieve the original level of security of supply. The amount of this perfect generation required to replace the wind generation becomes the measure of the wind generation's capacity credit.

So, to give an example of calculating a capacity credit for wind generation, a generation portfolio with 1000MW of wind capacity is calculated to have a LOLE of 8 hours.[8] Removing the 1000MW of wind capacity from the system increases the LOLE to 11 hours. The desk-top study determines that 200MW of perfect conventional capacity needs to be added back into the system to re-achieve the LOLE of 8 hours. The capacity credit for that wind generation is calculated as 200MW, or 0.20 as a decimal percentage of installed wind capacity. Capacity credits calculated in such a fashion are called "**Study-Calculated Capacity Credits**" in this information note. Capacity credits are always represented in decimal percentages. For the purposes of this information note, only the studies that examine the capacity credit for wind generation are considered. Study-Calculated Capacity Credits are not currently available for other generation technologies.

5.2 Study-Calculated Capacity Credit of Wind Generation

[8] Security of supply is measured in loss of load expectation (LOLE). LOLE is the number of hours during the year where a load shedding incident is expected to occur in a computer simulation.

Wind generation's Study-Calculated Capacity Credit is dependent on:

- the load factor of wind. In general, the stronger the wind speed, the more energy a wind generator will produce, and the more that wind generator will contribute per megawatt of installed capacity to security of supply. Load factors are represented by percentages, e.g. 30% represents a wind generator that produces 30% of it's rated capacity on average in this paper; and

- the level of non-diversity in the wind generation. Non-diversity is where wind generators in a region act together in concert. Non-diversity of wind generation in the SEM, for example, would mean that when conditions are windy in Northern Ireland, it is statistically likely to be windy in Ireland as well. The less wind generators tend to act together in concert, the more diverse they are, and the less likely it is that all wind generators will not be available during times when there is high load. Therefore, the more diverse wind generation is, the more it contributes regularly to security of supply.

Wind generation's Study-Calculated Capacity Credit for the purposes of this information note is taken from the capacity credit of wind used for Ireland only within the 2008-2014 Generation Adequacy Report. Figures from the System Operator have indicated that 2006 wind data used to produce the data in this report had a load factor of 31.28%. Assuming an average all-island wind installation of 1088 MW (accurate early May 2008) the below graph indicates a capacity credit of 235MW, or 0.22 in decimal percentage.

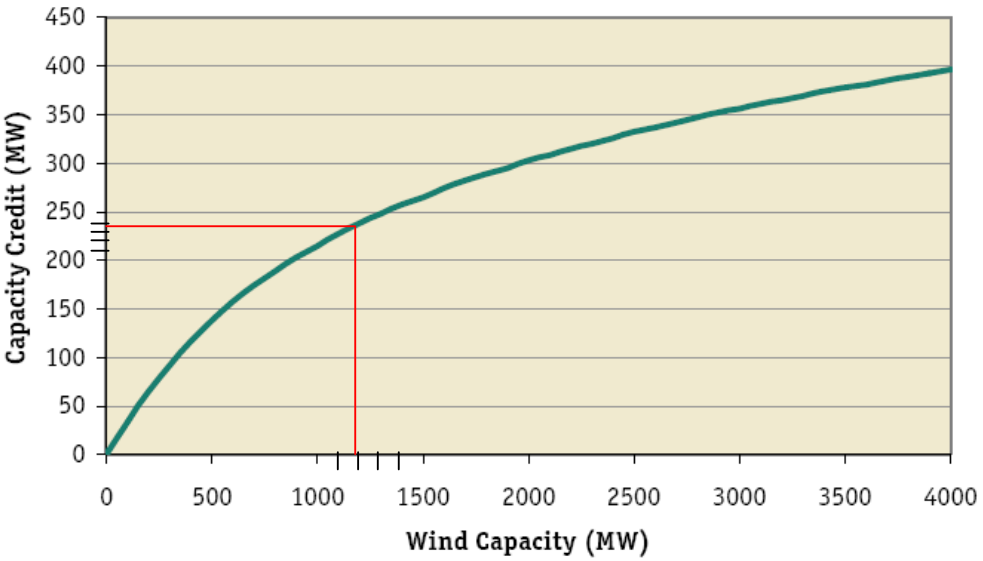

Figure 1: Figure 2-2 of the 2008-2015 Generation Adequacy Report, measurement lines added.

Actual wind load factor during the first seven months of the SEM was 33.79%. In order to facilitate more accurate comparison between real SEM behaviours and the Study-Calculated Capacity Credit, the wind Study-Calculated Capacity Credit is increased to 0.23 to reflect the inaccuracy between actual and forecasted load factor.

The utilisation of an Ireland-only wind time-series, i.e. excluding the contribution to diversity from Northern Ireland windfarms, in the calculation of an all-island Study-Calculated Capacity Credit of 0.23 is discussed in Section 7.2. The general shape of Figure 1 is also discussed in more detail in Section 7.2 of this paper.

6. The CPM-Inferred Capacity Credit

This section defines how "CPM-Inferred Capacity Credits" are calculated for each type of generation. It starts by placing a reference value (in euro per installed megawatt per hour) for a 100% available single megawatt of generation (which contributes one capacity credit as defined in the previous section). It finishes with a table giving indicative values of the CPM-Inferred Capacity Credit for each type of generator. The table also contains hypothetical CPM-Inferred Capacity Credits and changes to overall CPM revenues if the rules of the CPM were altered to only contain a fixed stream, a variable stream or an ex-post stream.

6.1 CPM Valuation of a Capacity Credit

In the previous section, a capacity credit was defined as "*the contribution of a single 100% available MW of generation to security of supply*". Therefore, the CPM valuation of a capacity credit in the SEM is calculated by the euro per megawatt per hour earnings of such a perfectly available generator.

Such a perfect generator does not exist. Therefore, the payment to such a generator needs to be inferred from the payments to some imperfect generation in the SEM.

The CPM valuation of a capacity credit is determined by:

- taking conventional generation revenue from November 2007 to June 2008 inclusive (i.e. excluding Hydroelectric Energy Limited Plant, Wind Generation, Pumped Storage, Demand Side Units, any form of Interconnector trade);
- dividing by the total capacity of that generation and half-hours within that period to determine the revenue from one imperfect megawatt of generation;
- scaling up to account for the non-perfect availability of that generation.

One megawatt of average-performing installed generation earned €7.43/installed MW/hour in the SEM. This one megawatt of generation was on average 81.59% available. Therefore, if this one megawatt had perfect 100% availability (with the availability of all other conventional generation remaining the same), it would have earned €9.16/installed MW/hour in the SEM.

Therefore the CPM values a capacity credit at a rate of €9.16/installed MW/hour.

6.2 Different Technologies' CPM-Inferred Capacity Credit

By calculating the revenues earned by different technologies under the CPM per megawatt of their installed capacities, the **CPM-Inferred Capacity Credit** for each generation type can be calculated against the revenues earned by an ideal megawatt of generation.

For example, using the €9.16/installed MW/hour of the ideal capacity credit, if a 1MW generator of a particular type earns on average €4.58/installed MW/hour, it would have a capacity credit of 0.5.

Table 1 sets out the CPM Inferred Capacity Credit for each major generation technology type in the SEM for the study period. Combined Cycle Gas Turbines

(CCGT) and Open Cycle Gas Turbines (OCGT) are examined as part of "Conventional Generation" and separately. Demand Side Units, Wind generation, Energy Limited Hydro generation and Pumped Storage generation are also considered.

Table 1 also sets out hypothetical CPM-Inferred Capacity Credits if the CPM was either based on 100% fixed stream payments, 100% variable stream payments, of 100% ex post stream payments. Currently the CPM is a combination of all three types of payment stream, in a 30% to 40% to 30% ratio respectively.

These hypothetical CPM-Inferred Capacity Credits were calculated by comparing the revenue of the idealised 100% available generator under each stream against the earnings of each technology type under that stream.

Generators will receive more or less revenues under the CPM if the CPM were changed so that it only had one of the fixed, variable, or ex-post streams. The average percentage change of revenue for each generator type is given under the generator's CPM-Inferred Capacity Credit for each hypothetical case.

6.3 General Comments on the Data Used and Interpreting the Results

6.3.1 Data Used and Excluded Generators

Table 1 is based on actual SEM CPM settlement data from November 2007 to June 2008 inclusive. Where resettlements, either scheduled or rescheduled, have been performed by mid-July, the data used is based on the resettled data. Euro values for CPM settlement prior to the application of the Annual Capacity Exchange Rate have been used throughout.

The small amount of new generation entry since the start of the SEM during the relevant period has been excluded from the analysis for the sake of simplicity.

Generators which have been on long term maintenance and have earned no capacity payments in the SEM were excluded from the analysis. The two generators were:

- GU_400360 (one of the Turlough Hill pumped storage generators); and
- GU_400322 (Poolbeg 3).

Inclusion of these generators – in particular the Turlough Hill unit which represents 25% of all Pumped Storage in the SEM, would skew the CPM-Inferred Capacity Credit calculation, as these generators earned no capacity payments for the eight months of SEM operation.

Pumped Storage availabilities were calculated by the algebraic sum of the pump's availability when pumping (negative availability) and when generating (positive availability). When not pumping, the Pumped Storage generators are assumed to be available for generation (subject to reservoir energy limits). Consequentially, Pumped Storage generators yield net positive availabilities as they are more available to generate than to pump. Capacity credits were calculated using the

Pumped Storage generation's maximum export capability, (and not the maximum pumping demand).

No results are presented for Interconnector trades. Interconnector trades, while providing valued contribution to security of supply, differ from other forms of generation for the purposes of this analysis. The availability declarations of Interconnector trades are based on BETTA commercial trading and SEM offers, rather than technical availabilities. Therefore, attempting to infer an average CPM-Inferred Capacity Credit from Interconnector trades would incorporate the commercial decisions of interconnector capacity holders to actively trade or not. The appropriateness of comparison with other forms of generation (which are required to submit technical availability for their generation) is consequentially greatly reduced, and for this reason interconnector trading has been excluded from this analysis.

Capacity payments in the SEM are paid out on transmission loss adjusted availability. When CPM-Inferred Capacity Credits are being calculated, the capacities divided into those capacity payments are not adjusted for transmission loss factors. Therefore, there is an assumption in taking the ratio of the ideal capacity credit €9.16/installed MW/hour and the revenue per installed megawatt per hour of a different technology, say €8.00/installed MW/hour, that the €9.16 and the €8.00 have had broadly equivalent transmission loss factors affecting the installed capacities' availabilities. Where a generator technology type in Table 1 is comprised of a geographically diverse generation portfolio, this assumption is reasonably strong. Care should be taken with the accuracy of the results for Demand Side Units and Pumped Storage generation, however, as these comprise single sites. Here, it is estimated that there may be inaccuracies in results for these units of the order of ± 5%. It is considered that this does not have a material impact on the conclusions drawn later in this note.

6.3.2 Interpreting CPM Inferred Capacity Credits

The next section discusses the findings in Table 1 on a technology by technology basis. The following general comments are provided in advance of the above.

- If the CPM Inferred Capacity Credit is greater than the generator's availability, the implication is that the CPM is valuing that generation's availability as particularly well timed to contribute to security of supply. For example, CCGTs which typically have constant availability throughout the day, have a CPM-Inferred Capacity Credit closely correlated to their average availability. Energy Limited Hydro generators, on the other hand, are utilised more during periods where their availability contributes greater to security of supply than other periods (see Section 7.5). Consequentially, Energy Limited Hydro plant has a capacity credit of 0.59, when it is only available 45.54% of the time.

- The fixed, variable and ex-post streams have different half-hourly weighted valuations of a generator's contribution to security of supply. Where a generation type is predominately constantly available throughout the day, these half-hourly weightings average out. Under the hypothetical 100% fixed, variable, and ex post CPM, generation that is predominately constantly available throughout the day has similar CPM-Inferred Capacity Credits in each case. Generation that is not constantly available will have higher or lower capacity credits, depending on the timing of its availability and which of

the hypothetical 100% fixed, variable or ex-post CPM payment streams is being considered.

  - For example, under the hypothetical 100% fixed, variable and ex-post CPM respectively, CCGTs have hypothetical CPM Inferred Capacity Credits of 0.87 in every case. Wind generation, which blows more during the day than at night. When wind is not generating at high-load periods, however, the need for conventional capacity is increased. Wind has correspondingly 35%, 36%, and 28% hypothetical CPM-Inferred Capacity Credit under the 100% fixed, variable and ex-post CPM scenarios respectively.

- The “Total Payment to Category Type” column gives an indication of the relative share of the capacity pot amongst different generation types.

Generation Category	Total Payment to Category type	Actual 30% Fixed, 40% Variable, and 30% Ex Post Streams CPM Inferred Capacity Credit	Study-Calculated Capacity Credit	100% Fixed Stream, (% change in overall payment rate)	100% Variable stream, (% change in overall payment rate)	100% Ex Post Stream (% change in overall payment rate)	*% Availability*	*€/MW of availability/h (Based on Total Pot)*
Generic Conventional Capacity	€339,209,226	0.82	N/A	0.82	0.82	0.82	81.59%	9.162564382
				0.82%	-0.54%	0.33%		
Wind Generation	€11,481,973	0.34	0.24	0.35	0.36	0.28	33.79%	9.085289878
				5.68%	8.28%	-16.28%		
Demand Side Unit	€417,680	0.39	N/A	0.33	0.42	0.42	25.37%	14.11507907
				-15.39%	6.59%	6.95%		
OCGT	€56,559,640	0.78	N/A	0.77	0.78	0.78	77.48%	9.224343041
				0.17%	-0.42%	0.81%		
CCGT	€144,582,535	0.87	N/A	0.87	0.87	0.87	86.94%	9.185493869
				0.79%	-0.49%	0.27%		
Energy Limited Hydro	€6,794,646	0.59	N/A	0.54	0.60	0.64	45.54%	11.95917342
				-8.39%	0.99%	7.46%		
Pumped Storage	€9,035,903	0.77	N/A	0.68	0.81	0.82	43.60%	16.24595738
				-11.03%	4.01%	6.05%		

Table 1: CPM Inferred Capacity Credits and Availability Payment Rates for Each Technology Type

7. Discussion of the CPM-Inferred Capacity Credit of Different Generation Technologies

This section examines the data in the Table 1 in Section 6 above for each individual generation type. Conclusions are drawn from these data.

7.1 Generic Conventional Capacity

Approximately 92% of the CPM revenue is earned by conventional thermal generation. As conventional generation's ~18% outage rate (comprising both planned maintenance and forced outage probabilities) is not correlated with times of electrical system stress (high demand and low generator availability), its capacity credit of 0.82 is closely linked to the average availability across all conventional generators.

A redistribution of the CPM's valuation of availability between half-hours (by moving to one of the three 100% hypothetical fixed, variable or ex post streams) has marginal effect on the revenues earned by conventional generation as a group. Increases or decreases of less than 1% of revenue occur.

It is noted that these changes in revenue are average figures across several generators. Depending on the characteristics of particular individual generator's outages, moving from the current 30%/40%/30% split of the capacity payment streams to a single 100% stream calculation may have sizeable impacts on individual generator revenues. For example, moving to a 100% ex post stream CPM may increase average generator revenues by 0.33%, but within that average it is calculated that, over the study period:

- one generator would increase its revenues by 4.6%;
- one generator would lose 6.1% revenues; and
- 30% of generators would have changes in their individual revenues by more than 2%.

Conventional generation earns the lion's share of the capacity payment revenues. If all other generation were to become unavailable overnight, conventional generation revenues could only increase by 8.7% (increasing from 92% to100% of the total capacity pot).

As a corollary, if all conventional generation were to increase their availability to a hypothetical 100%, this would increase the overall generator availability by nearly 20%. This in turn would reduce the payment rate per MW of availability to all generation. Therefore, the conventional generation that together dramatically improved their availability would only see a slight increase in their revenue (estimated to be in the region of 1%,).

An individual generator that is 80% available has a large incentive to improve that generator's availability. Greater CPM revenue can be earned at the expense of other plant which might not improve to the same extent. For example, a 100MW OCGT which improved availability by 10% of capacity to 90% would negligibly affect CPM payment rates, but would increase its own revenues by 12.5%.

7.1.1 Conclusion

The CPM earnings of single generators are much more sensitive to changes in the mechanism illustrated than they are for portfolio players, where average generator revenues are robust to considerable changes in average behaviours. This is because changes in conventional generation behaviour, being the largest contributor to system security as measured by the CPM, are the primary driver of all generators' euro per megawatt of availability payments from the total pot of the CPM.

7.2 Wind Generation

The Study-Calculated Capacity Credit for wind generation was calculated to be 0.23 in Section 5.

The CPM-Inferred Capacity Credit for wind generation is 0.34, close to the average availability of the wind generation at 33.79%. The implication of the comparison of the two capacity credit figures is that wind generation is being paid approximately 44% more than its "true" Study-Calculated Capacity Credit. This equates to a an approximate overpayment to wind generation of €3.4 million based on the analysis carried out to date.

This overpayment effect would be strengthened under the hypothetical 100% fixed stream CPM (CPM-Inferred Capacity Credit 0.35) or under the hypothetical 100% variable stream CPM (CPM-Inferred Capacity Credit 0.36). Under the hypothetical 100% ex-post stream CPM, however, this effect is reduced (CPM-Inferred Capacity Credit 0.28) to a 29% potential overpayment. These trends are explained below.

7.2.1 CPM Design and the Difference Between Study-Calculated and CPM-Inferred Capacity Credit

The fixed and variable streams of the CPM (70% of the total CPM revenue) value availability in each half-hour based on forecast fixed ex ante estimates of the requirement for generator availability. The fixed stream of the CPM values capacity using a half-hourly index profile that is calculated prior to the start of the Year. The variable stream of the CPM values capacity more during day-time on week days than at other times. Neither stream values capacity based on actual events occurring on the electrical system. Therefore, as wind on average blows more during the day time than at night, the fixed and variable streams will reward wind generation based on this average behaviour. In contrast, the Study-Calculated Capacity Credit specifically captures the relationship between the patterns of wind generation and the patterns of high load.

Prior to large wind penetration on the electrical system, high-load days would invariably be the days which contributed most to LOLE. With large wind penetration, however, days with high-load *and* low-wind will contribute the most to LOLE. The marginal benefit of each further installed megawatt of wind generation begins well as it reduces the LOLE during windy high-load days. This is reflected in the steeper slope of increasing capacity credit at low wind penetrations in Figure 1 in Section 5.

The marginal benefit begins to decrease, however, as the benefit of reduced LOLE on windy days has been already achieved, and further non-diverse wind capacity

does not improve the security of supply during the high-load low-wind days. Increasing the installed capacity of non-diverse wind does not improve security of supply on high-load low-wind days. This is reflected in the shallower slope of increasing capacity credit at higher wind penetration in Figure 1.

The fixed and variable streams of the CPM cannot capture this interaction between half-hourly wind and load. Therefore they will not reproduce the falling capacity credit with greater levels of wind penetration (through reduced CPM revenues) seen in wind Study-Calculated Capacity Credits.

The ex-post stream of the CPM, however, is based on actual system half-hourly load and wind generation. The 100% ex-post stream hypothetical CPM-Inferred Capacity Credit of wind (0.28) is lower than the availability of the wind generation (33.47%). This indicates that the ex-post stream recognises that wind, even though it blows more during the day, is not contributing to those certain days and hours where more generation availability is required. Consequentially, weighting the CPM more towards the ex post stream has the impact of bringing the CPM-Inferred Capacity Payment in line with the Study-Calculated Capacity Credit, reducing overpayments to wind generation.

It should be noted that paying out all of the CPM pot under the 100% ex-post stream of the CPM will not capture the full reduction of the benefit of the marginal megawatt of wind generation to security of supply. The CPM settles monthly, paying out a fixed amount of money each month. If all of a year's high-load low-wind days occur in a single month, wind generators will earn little under the ex post stream of the CPM in that month only. For the remaining eleven months, the wind generator may earn high payments under the ex post stream. The CPM-Inferred Capacity Credit will therefore reflect that the wind generators have only lost one twelve of total ex post stream revenue.

In contrast, the Study-Calculated Capacity Credit is calculated over an entire year. It does not matter if the high-load low-wind days occur consecutively or distributed throughout the entire year. Each of those days will contribute to a single calculation of LOLE for the year, and wind generation's Study-Calculated Capacity Credit will reflect its unavailability during the most important days of the entire year.

7.2.2 Other Reasons for the Difference Between Study-Calculated and CPM-Inferred Capacity Credit

There are other reasons why the Study-Calculated and CPM-Inferred Capacity Credits might not align apart from the reasons of the fixed-stream payment, the variable-stream payment and monthly settlements cited above. These relate not to the design of the CPM mechanism but rather to the nature of the analysis on which the findings presented in this note are based.

- Diversity of Wind Time Series in Study: The Study Calculated Capacity-Credit Figure 1 in Section 5 was based on Ireland-only 2006 wind time series, i.e. it does not take account of the diversity in the 2006 wind time series arising from Northern Ireland wind generation. Using an Ireland-only wind time series yields less diversity in the wind generation time-series. This decreases the calculated value of wind's capacity credit in the Study-Calculated Capacity Credit. In 2006, circa 20% of the 600MW installed all-island wind capacity was located in Northern Ireland. By May 2008 this had

fallen only slightly to 16.5% of the 1088MW installed all-island wind capacity. It is likely therefore, that the 0.23 Study-Calculated Capacity Credit represents a lower bound to the value of wind's all-island true capacity credit.

- The short period of analysis (eight months) combined with the monthly settlement means that the low-wind high-load days might not have occurred in sufficient statistically strong numbers in the SEM to-date to accurately reflect the year-long CPM-Inferred Capacity Credit under the Ex-Post stream in particular.

7.2.3 Conclusion

Consequentially, while the caveats in this analysis would not leave one in a position to definitively state the exact degree to which wind generation is being paid more than it contributes to security of supply, given the nature of the analysis carried out to date, the CPM-Inferred Capacity Credit of 44% is of a sufficiently high order than the Study-Calculated Capacity Credit for wind to indicate that the degree of overpayment warrants correction. However, it is considered appropriate that further analysis is completed in order to more fully inform the RAs in relation to this matter. This is discussed in Section 8.2 below.

7.3 Demand Side Units

Demand Side Units are the least available of all Units at 25.37% availability, but gain the second highest payment rate per megawatt of availability when available. This is reflected in the CPM-Inferred Capacity Credit of 0.39 which is much higher than the percentage availability. This is because the relevant Unit is only available during higher system demand periods when load is being consumed on site.

The hypothetical 100% variable and ex post stream CPM-Inferred Capacity Credits are higher again at 0.42 in both cases. This is due to the higher weighting of availability value under these streams during the day when the Demand Side Unit is available. This would represent an increase in revenue of around 7% for Demand Side Units, if the CPM were altered in such fashions.

It is considered that it calculation of a Study Calculated Capacity Credit for Demand Side Units would be useful such that it could be compared to the findings here. It is considered that the availability or otherwise of Demand Side Units at times of peak demand would be influential in this regard.

7.3.1 Conclusion

Demand Side Units perform well under the CPM, given their natural increase in availability with times of increased load on the system.

7.4 CCGTs and OCGTs

CCGTs are just under 87% available, more available on average than the total set of conventional generation. The CPM-Inferred Capacity Credit of 0.87 reflects a reasonably constant level of availability.

The same can be said of OCGTs which have a lower CPM-Inferred Capacity Credit of 0.78 closely in line with their lower availability of 77.48%. Indeed, this effect is further reflected in the lack of difference under the hypothetical 100% variable or 100% ex post stream CPM-Inferred Capacity Credits.

In some of the responses to the wind discussion paper, it was noted that the inflexibility of certain conventional generation was an equivalent and complimentary issue to the non-diverse nature of wind generation.

Finally, it is noted that this analysis is carried out on group average behaviours. Individual OCGTs or CCGTs may experience different results compared to the average figures provided.

7.4.1 Conclusion

CCGTs and OCGTs both have CPM-Inferred Capacity Credits in line with their percentage availabilities.

7.5 Energy Limited Hydro and Pumped Storage

Energy Limited Hydro generation and Pumped Storage have availability of 45.54% and 43.60% respectively due to the energy-limited nature of their operation. In the case of Pumped Storage generation, this is further reduced by the netting off of the pumping load from the generation availability.

Nevertheless, the CPM-Inferred Capacity Credits for these generators are quite high at 0.59 and 0.77 respectively, higher than these generators' availabilities. This is caused by the higher value of capacity during the subset of periods in which these units are available. In addition, the rules with the Trading and Settlement Code which determine how the availability of such units is distributed throughout the day may be a factor in this regard.

The Trading and Settlement Code rules, described in the next subsection, follow the principle that the market values energy-limited capacity on an ex-post optimised basis, independent of system operator dispatch or scheduling.

7.5.1 The SEM T&SC and Energy Limited Availabilities

Energy Limited Hydro generation and Pumped Storage generation are first scheduled in the energy market along with all other forms of generation by the SEM Market Schedule Program software. This scheduling meets actual demand served (less wind generation) in each half-hour. The scheduling is described as "unconstrained" in that it has perfect foresight, running after real-time, and does not take into account transmission constraints, or the requirements for the system

operator to hold reserve. Every generator receives a half-hourly Market Schedule Quantity through this scheduling process. Energy Limited Hydro generators are scheduled on a commercial merit order basis based on their submitted commercial offer, and are set to run if within economic merit during the half-hours which minimises the cost of production, subject to their energy limit. Pumped Storage plant are scheduled to pump and generate so as to maximise energy arbitrage revenues throughout the day, filling its reservoir during times of low-price energy, and generating during times of high-price energy.

The net result is that the Energy Limited Hydro and Pumped Storage Market Schedule Quantities, and hence their availabilities for capacity payments, are scheduled to occur during the periods where energy prices are highest. While not always the case, typically, energy prices are highest when demand (net of wind generation) is high, and therefore when the value of capacity is also high.

Once scheduled, the market systems then take any remaining unscheduled availability from Energy Limited Hydro generation and Pumped Storage generation not reflected in the Market Schedule Quantity, and place it into the Trading Periods where capacity is at its most valuable. This happens during the capacity settlement process.

The overall effect is to treat these generators with an effective perfect foresight in the allocation of their availability. The SEM rules only give this automatic allocation of availability to Energy Limited Hydro and Pumped Storage. Other generation such as CCGTs and OCGTs which are not energy limited, have full availability, and therefore such calculations are unnecessary.

It can be seen that if the CPM were to move to a hypothetical 100% ex-post stream, both Energy Limited Hydro and Pumped Storage would likely earn more revenues, given a the greater range of capacity valuations in each half-hour under the ex-post stream (in comparison to the fixed or variable stream).

7.5.2 Conclusion

It is accepted that Energy Limited Hydro and in particular Pumped Storage have well documented properties which are beneficial to system security. The SEM TSC rules, however, schedule Energy Limited Hydro and Pumped Storage with a degree of perfect foresight while in practice, the System Operators must rely on forecasts. Therefore, it would be beneficial to run year-long capacity credit calculations, similarly to those run for wind generation, to understand whether the CPM-Inferred Capacity Credit is appropriately valuing the practical benefit to the System Operators of Energy Limited Hydro and Pumped Storage to system security

8. Next Steps

Given the findings presented regarding the payments to various technologies, including wind generation, under the CPM, it is considered that sufficient evidence exists to conclude that wind generation is being overpaid by the CPM and that whilst the analysis to date indicates that this is not currently having a material impact on other generation types being rewarded by the CPM, with increasing wind penetration the level of underpayment to others will become more pronounced. In addition, the guiding principles set out in Section 3.1.1 and the objectives of the CPM are noted here. The need to ensure that all generators are remunerated under the CPM in accordance with their contribution to security of supply is re-iterated in this context. Therefore, it is deemed appropriate that this must be addressed.

However, it is recognised that further analysis is required in advance of consulting further on correction of this overpayment. To this end, the following are the next steps that the RAs will carry out.

Further analysis as follows:

- calculation of Study-Inferred Capacity Credits for wind generation on the island based on actual data for the first twelve months of the SEM;

- calculation of Study-Inferred Capacity Credits for all other generation types on the island, including Demand Side Units, based on actual data for the first twelve months of the SEM, and

- completion of analysis regarding the remuneration of all generation types and Demand Side Units for the first twelve months of the SEM similar to that completed for the first eight months of the SEM, the findings of which are presented here.

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The above analysis will be carried out in Quarter 2 2009 and the RAs will further engage with industry on these matters in Quarter 4 of 2009.

Appendix A

Respondent	Comment	Response
SWS	SWS recognises the decreasing capacity credit of wind with increased penetration in a power system. As to whether the capacity payment mechanism is appropriate, once again we go back to the guiding principles. Is the market really going to try to use the capacity payment mechanism to ensure the right number of MW of wind is put on the system? In the face of a 33% target, this appears to be pretty pointless. Once again it is indicative of a market designed for thermal plant, and now the designers are wondering how to patch it up for wind. From a wind developer perspective, capacity payments are not fixed, and thus not bankable, and thus not as much value as they may seem at face value. We would not be particularly upset if they were removed from wind entirely, as long as there was balancing in the revenue stream elsewhere (for example to cover the curtailment, reserve or constraint costs which are perceived to be attributed to wind).	Governmental support mechanisms are outside of the remit of the Regulatory Authorities and the SEM Committee. Excluding wind generation from the CPM would be distortionary and discriminatory for commercially traded wind generation not availing of support mechanisms.
VPE	VPE acknowledge that at times of high atmospheric pressure in the winter there can be a confluence of high demand created by cold icy ambient temperatures and low wind resource. It is reasonable for a TSO to be conservative in calculating the amount of non-wind capacity needed for such situations. VPE therefore consider that the system operator is best positioned to determine the capacity contribution of wind in calculating the size of the capacity pot. This is consistent with principle 5 set out above.	No comment.

VPE	When any generator is providing energy to the system they are also providing capacity. Wind generators should not be paid capacity when there is no wind. It follows however that when a wind generator is providing energy to the system that it should be paid a capacity value equal to all other generators. To treat wind generators otherwise would be to discriminate unfairly in how capacity is remunerated in the market and would breach the principle 3 set out above. VPE recognise that because wind is paid out on its utilisation but calculated based on its security of supply contribution. Capacity payments to wind generators will thus dilute the value of capacity payments to other generators needed to maintain security of supply when the wind is not blowing. VPE suggest that the RAs may need to address this effect when setting the capacity pot.	Examination of the calculation of different capacity payment streams for different technology types is not considered here.
VPE	VPE understand from a symmetry perspective it would be attractive to pay out to wind generators what was calculated as their benefit to the system when calculating the capacity pot. We note that the pot calculation is set up on a theoretical basis but paid out against actual performance, and the two do not have to align.	No comment.
BGE	All generation including, if not especially, wind generation should be entitled to capacity payments commensurate to their reliability contribution in providing system capacity. The reliability factor must be assessed in this context (in the same way that if a generator contracts for reserves and subsequently does not provide it, they should be penalised).	"Quality" of availability is not currently rewarded under the CPM.
BGE	While conventional generation, in aggregate, can compensate for shortfalls i.e. generator trips can by and large be covered through additional conventional generation; this is less clear in the case of wind generation which by its nature is intermittent and by the Island's geography can be highly non-diverse. How diverse and intermittent it is should be rigorously examined and assessed but should the capacity contribution of a sector as a whole decrease as its percentage of total capacity	The argument that wind generation should be paid in line with its Study-Calculated Capacity Credit needs to be offset by how true that is for other forms of generation given the design of the CPM with monthly settlement of fixed and variable payment streams.

	increases then there is a legitimate and fair argument to examine if the sector is entitled to the same capacity payments.	
IWEA	Conventional capacity is rewarded on the basis of installed capacity, while wind is rewarded on the basis of actual output, wind therefore receives approx 30% of value per installed MW compared with conventional plant and is not over-renumerated.	International and domestic forward looking system studies have indicated a fall in capacity credit for wind, beyond that earned from its load factor.
IWEA	The current capacity mechanism fails to recognise the significant flexibility of wind compared to the inflexibility of other technologies.	“Quality” of availability is not currently rewarded under the CPM.
IWEA	Renewable technologies tend to be characterised by higher capital costs and lower operational costs. As renewable penetration levels increase it is expectd that the total installed capacity on the system will also need to increase. This will be compensated for by a fall in energy prices. It would therefore be appropriate to reflect the rebalancing of total energy costs with increased levels of capacity payments. It is noted that the current framework for setting the annual capacity payment pot recognises this linkage.	Comment already captured in CPM total pot calculation methodology with the inframarginal rent earnings of the BNE peaker.
Synergen	8. The CPM revenues to thermal generation will fall as the pot is allocated across increasing volumes of generation. Note, wind contributes relatively little to assumed generation availability, but takes out of the CPM on actual availability. In short, a fixed pot is going to be more thinly spread.	Wind contributes its Study-Calculated Capacity Credit to assumed generation availability. Currently wind appears to draw revenues above what it contributes in security of supply. It is not certain that wind generation is the only technology that shares this characteristic, as Study-Calculated Capacity Credits are not available for other capacity types.
Synergen	9. If the existing CPM pot calculation is followed, the CPM pot is determined by the monies that the BNE peaker does not recover from pool revenues. A peaker may actually do quite well in a market with very high levels of wind generation – thus its need for CPM revenues may be low. This would reduce the CPM pot size – regardless of how that is then split up.	No comment

Synergen	Plant that is supported by out-of-market subsidies should not automatically be fully eligible for CPM payments as this double counts revenue. Therefore, the eligibility for the CPM should be re-evaluated to ensure that the signal that it provides is effective and appropriate.	The SEM in general cannot as a matter of practicality, and should not as a matter of principle, anticipate out-of-market subsidies.
Synergen	In section 3, Synergen outlined the principles associated with the CPM.	No comment
Synergen	However, SEM/08/002 does not consider whether the BNE calculative methodology is appropriate under increasing levels of wind new entry. The present determination of the CPM annual pot size broadly assesses generation availability against a margin requirement to determine a "volume" of capacity required, and the revenue requirements from a CPM mechanism to ensure that a BNE covers its costs. The assumption is that the BNE in this calculation is an OCGT. Depending on how the schedule would operate with increasing levels of price-taking generation, it is possible that peaking plant may be scheduled to considerably higher levels of running than the present modelling assumes.	The choice of BNE technology is outside the scope of this consultation. If a BNE OCGT started frequently in the market schedule, presumably due to its greater levels of flexibility, this would indeed reduce the capacity payment for all inflexible generation types; the BNE OCGT revenues would remaining constant and sufficient to cover its costs. The SEM Committee does not consider this to be an inappropriate outcome.
Synergen	This would increase pool revenues for the BNE peaker, and thus reduce its requirement for CPM revenues. This would reduce the €/MW value of capacity – potentially reducing the overall level of the annual CPM pot. Synergen believes that further consideration is needed on this question.	See response immediately above.
Synergen	A similar argument would apply regarding CPM eligibility – new entrants would know that if they do not receive direct subsidy relating to fixed costs, then they would be eligible – and be able to decide between receiving CPM revenues or such payments.	The SEM in general cannot as a matter of practicality, and should not as a matter of principle, anticipate out-of-market subsidies.
Synergen	In principle, Synergen does not favour "grandfathering arrangements".	See comment immediately below.

Synergen	However, if there needs to be major changes in the ability of intermittent generation to receive some payments and thus signal their value to the system, then there should be explicit consideration of whether existing generators, or those on-line before a set future date, would receive some preferential treatment.	The Trading & Settlement Code treats all generation equally, and consequentially cannot deliver preferential payment for one MW of availability over another without alteration of its principles.
Synergen	All generation has a statistical probability of not being available. Under the existing arrangements, wind is assumed to make a significantly lower contribution to the calculation of availability for CPM purposes than it recovers from the CPM based on its actual availability. Capacity has a particular value at times when margin is tightest, and this may not correlate wholly with times of maximum demand as a result of unscheduled outage patterns. However, periods of peak demand in the SEM may occur when temperatures are low, but wind speeds are low - in such circumstances, useable wind availability will be low.	As demonstrated in section 7.2, and caveated in sections 7.2.1 and 7.2.2 wind generation appears to be over remunerated by approximately 44% based on the analysis to date.
Synergen	Synergen's assumption is that the existing Eirgrid/SONI methodology for valuing wind is robust as it has only recently been developed and agreed.	No comment
Synergen	Moving forward, Synergen's understanding is that the present methodology would be likely to over-value the capacity value of wind. This arises as the percentage of wind increases and the reliance that can be placed on it diminishes per MW installed. There is therefore a need to re-visit the methodology on a regular basis as the amount of wind generation (and other intermittent price-taking generation e.g. tidal) increases.	The EirGrid/SONI methodology for valuing wind, the Study-Calculated Capacity Credit, captures the effect referred to. See Section 5 and Section 7.2 for further discussion.
Meitheal na Gaoithe	Fossil plants are highly inefficient with regard to their use of expensive and polluting input fuel, many have very poor availability, and very large blocks of power can drop off the system at a moments notice, causing great difficulties for the system and other generators (such as wind) and demand users.	"Quality" of availability is not currently rewarded under the CPM. Conventional generators are more liable for trip penalties than wind generation.

Meitheal na Gaoithe	The RAs' paper seeks to review the way capacity for wind is paid. They would like to apply a theoretical capacity factor to wind, using LOLE type analysis that shows declining capacity credit with wind penetration, in setting ex-ante capacity payments. The most accurate estimate of wind capacity is what it presents to the market on a live basis, and thus that element of the capacity payment is the most accurate - we are paid to the degree we are available on a live basis.	The respondent's comments appear to advocate paying wind generation (and therefore all generation) under the ex-post stream of the capacity payment mechanism. It also rejects the concept of a separate stream of capacity payments just for wind, based on forward looking studies. These comments have been taken on board.
Meitheal na Gaoithe	We would therefore prefer that the proportion of capacity that is paid on capacity actually presented be increased, so that that based on assumed capacity is less, since it is less correct.	See comments immediately above.
EirGrid / SONI	As noted in the discussion paper, the incremental capacity value of wind power decreases as the amount on the system increases. In line with our view of value reflective pricing and payments, EirGrid and SONI believe that the payments to wind power units through the capacity payments mechanism should be reflective of their contribution to capacity.	The SEM Committee agrees that the payments to wind power units should be comparable to their contribution to capacity to the same measurable extent as conventional generation is remunerated for its contribution to capacity, and that this does not breach the principles of the CPM (stability in revenues), and the SEM Committee's duties towards non-discrimination.
EirGrid / SONI	Furthermore, since the capacity payments mechanism is based on a fixed capacity payments pot, determined in advance, if wind is being over paid in respect of its contribution towards capacity, then other forms of generation (which potentially contribute more) are being paid less for their contribution. This, in our view, represents a risk to the long term security of supply.	As the CPM pays out on a fixed pot, the over-remuneration of any technology will be to the detriment of other technologies. At current levels of wind penetration, this has been calculated at €3.5million, which is less than 1% of the capacity pot.

EirGrid / SONI	In the Appendix, we outline details for an alternative, value reflective system of capacity payments. EirGrid and SONI would be pleased to discuss this option in more detail if required. This mechanism takes into account the actual value of wind generation to security of supply and would be consistent with the methodology already employed to determine wind power's capacity value for use in the calculation of ex-ante capacity payments as prescribed in Appendix M of the trading and settlement code. It is also consistent with the measure of wind capacity credit used in the determination of the capacity payments annual pot. Thus, the process to determine the capacity value of wind already exists is used in the capacity payments mechanism already and is in keeping with best international practice.	On first inspection, it appears to value a MW of availability from two different technologies differently in a single half-hour, which has discriminatory implications. Furthermore, it assumes that the capacity credit calculation is appropriately applicable to the CPM, which has a degree of protection (CPM, monthly settlement, and fixed and variable streams) for all generators who are not available during those few periods throughout the year where capacity is required most.
EirGrid / SONI	Suggested Alternative: Currently, the CPM pot size is determined in accordance with the following formula; Capacity Requirement = Time Weighted Plant Total + Surplus /Deficit in RP terms + WCC for Wind in Market, Where WCC = Wind Capacity Credit WCC declines as a percentage of installed capacity as the amount of wind installed increases. See Figure 4-8 from GAR 2008-2014. Therefore the pot size (and amount of money available for payment) is a function of the capacity credit of wind which in turn is a function of wind penetration levels.	See comment immediately above.
EirGrid / SONI	Suggested Alternative: Currently the division of the capacity payment in any hour is a function of wind's availability in that hour. There are a number of issues with using the availability of wind to determine capacity payments: 1. The availability of wind power does not reflect accurately (i.e. it overstates) its security of supply contribution 2. The availability of wind power does not necessarily decline as wind penetration increases.	See comment immediately above.

EirGrid / SONI	Suggested Alternative: An alternative method of allocating capacity payments would be to change the payment formula so that for every hour the capacity payments made to wind are adjusted according to the ratio of its true capacity value to its capacity factor. For low levels of wind this will not be much less than unity (current system of payments), but as wind penetration increases this factor will reduce – more accurately reflecting the security of supply contribution of wind. Again the degree to which an average or incremental approach would be adopted would need to be considered.	See comment immediately above.
EirGrid / SONI	Suggested Alternative: This approach would be consistent with the methodology already employed to determine wind power's capacity value for use in the calculation of ex-ante capacity payments as prescribed in Appendix M of the trading and settlement code and with the measure of wind capacity credit used in the determination of the capacity payments annual pot. Thus, the process to determine the capacity value of wind already exists is used in the capacity payments mechanism already and is in keeping with best international practice.	See comment immediately above.
EirGrid / SONI	Suggested Alternative: The calculation could also be generalised to take account of the long term availability of all units, thus resulting in an equitable solution where all plant types are rewarded based on their true contribution to capacity.	See comment immediately above.
Scottish Power	The current capacity payment mechanism does not recognise the falling value of wind in supporting network resilience and the increasing cost of providing reserve from conventional generation as the penetration of wind generation increases.	The CPM does recognise the "falling value of wind" in the calculation of the total pot, and under the ex-post payment stream. The CPM also recognises the increasing cost of providing reserve (should wind specific products be designed and paid for) from conventional generation through the setting of capacity pot.

Scottish Power	Any change in the capacity payment mechanism must be stable, predictable and transparent to enable developers to make informed economic decisions on the construction of new renewable generation sites. A sliding scale which moves the value of capacity payments from wind to conventional generation as the level of renewable penetration increases could be modelled and made available to market participants.	On first inspection, this appears to value a MW of availability from two different technologies differently in a single half-hour, which may have discriminatory implications. Furthermore, it assumes that the capacity credit calculation is appropriately applicable to the CPM, which has a degree of protection (CPM, monthly settlement, and fixed and variable streams) for all generators who are not available during those few periods throughout the year where capacity is required most.
ESBPG	Does the current mechanism reflect the value of wind or does it need to be revised? If so, how? The Capacity Payment Mechanism (CPM) design objective is to fairly pay all generators for the long-term fixed capacity costs of investing. The short-term running costs are then separately recovered from bidding into the pool. This ensures a theoretical level of revenue adequacy and price stability, and as such is a core feature of the electricity market. In determination of the capacity requirement, the installed capacity of wind and conventional plant are modulated by the capacity credit and a combination of forced and scheduled outage rates respectively. In this way a capacity payment is identified for all plant on the system.	The CPM design ensures that a BNE peaker recovers its long-run marginal costs at equilibrium. It does not ensure that all generation recover their long run marginal costs, irrespective of technology types.
ESBPG	The actual payments to ALL plant are on the basis of availability: this will inevitably lead to a variance between actual payments and budget depending on performance against forecast of forced and scheduled outage (conventional plant) and capacity credit (intermittent plant). The capacity payment is fixed and if one generator performs better than assumed its follows that he will get more from the fixed pot and than the other generators.	No comment.

ESBPG	Conventional plant availability can be lower or higher than the assumption used in the capacity pot calculation forecast. However it is systematically biased lower because best practice availability is assumed. In the case of wind, the alternative is the case as the actual load factor of wind, given its current level on the system, is always higher than capacity credit assumed in the calculation of the capacity pot. In the light of this the current capacity mechanism needs to be reviewed to ensure its meets its design objective to fairly pay all generators for the long-term fixed capacity costs of investing. In the event that it does not it must be revised.	See comment preceding that directly above.
NIE PPB	It is clear that as the capacity of wind generation increases, the average capacity factor will reduce since the best sites will tend to be developed first. Hence the capacity credit will reduce steadily as the capacity increases.	The respondent is referring to capacity factor, which is different to capacity credit. Even with constant levels of capacity factor, as more wind is developed, its capacity credit falls. It is also noted that the best locations for wind development tend to be smaller windfarms on the top of hills, while larger windfarms tend to spread over wider, and hence less optimal areas. Combining this with the issues around connection to the higher locations, and planning permission, it is not a 'given' that all the best capacity factor locations have been developed.
NIE PPB	We believe the current capacity payment mechanism (CPM) is likely to be distorted even by the current level of wind penetration. This distortion occurs at a number of levels. Since the capacity pot is fixed, the volatility and unpredictability of wind means that the share of the capacity pot that may be captured by wind capacity could be more or less than would be due if the generation delivered in accordance with the longer term assessed capacity credit that is used in the determination of the pot. Hence there will be revenue volatility for both wind generators and conventional generators proportionate to the deviation in actual wind generation output from the long term average. It also distorts the value of the LOLP signals for short term availability since it makes the reward for making conventional generation available to meet a future shortfall more uncertain and to the extent a generator has control over	The CPM has many design features (12 monthly pots, fixed capacity price, ex-ante variable fixed capacity price together constituting 70% of the payment) which reduces a great degree of volatility for all generation. Wind is argued to be paid approximately 44% more than its contribution to the fixed pot based on the analysis to date. It is noted that moving to one form of resolution of overpayment (a 100% ex-post pot) increases revenues to conventional generation by less than 1% (with a range for individual generators of +4% to -6%). Wind generation should distort the short-term LOLP signals for all generation. This does make decisions more difficult, but this is a matter of scale not principle in comparison to the unexpected trip of conventional generation (which is less likely to occur, but more difficult to respond to, unlike wind generation which has a

	outages (by a delay in taking an outage or committing resources to return earlier), it makes decision making much more difficult.	degree of forecastability).
NIE PPB	We have previously argued that such distortion could be overcome by dividing the capacity payment pot into two sub-pots, one of which is reserved for intermittent generators and the other for controllable generators. This would ensure more stable revenue streams for all generators over a year and although it would result in different payments to intermittent and conventional generators in any settlement period, we consider the longer term stability (which is a key requirement for the CPM) to be more desirable.	On first inspection, this appears to value a MW of availability from two different technologies differently in a single half-hour, which may have discriminatory implications. Furthermore, it assumes that the capacity credit calculation is appropriately applicable to the CPM, which has a degree of protection (CPM, monthly settlement, and fixed and variable streams) for all generators who are not available during those few periods throughout the year where capacity is required most.
Airtricity	Yes. The capacity mechanism works adequately the way it is. It is based on the principles of energy output and available capacity. Thes are concepts that can apply fairly to all generation technologies.	It is agreed that it is an established principle that the value of a MW of capacity in one half-hour is valued equitably across all generation, assuming identical commercial availability. Changes to the CPM, for example, having a different separate capacity pot for wind generation, would require re-evaluation of that principle.
Airtricity	Some changes should be made to the existing mechanism to tighten in on the definition of available capacity. I.e. if a unit is cold and has a cold start time of more than 12 hours, it should not qualify for capacity payments. In this way capacity payments would be allocate fairly to those units that are actually providing meaningful capacity and availability to the system.	“Quality” of availability is not currently rewarded under the CPM..
Saorgus	Valuation of wind in the capacity payment mechanism; Wind must be treated equally in the calculation of capacity payments. In common with other forms of generation, these payments should be based on the actual availability of capacity on the system at times of significant demand.	It is agreed that it is an established principle that the value of a MW of capacity in one half-hour is valued equitably across all generation, assuming identical commercial availability.

Bord Na Mona	The system of administered "Capacity Payments" which underpins the existing market arrangements undoubtedly provide an element of increased certainty with regard to revenues, and are a welcome element in the market design. However, issues such as infra marginal rent deduction from the calculation of the fixed cost of a BNE peaking plant and the current approach to the determination of the capacity requirements, which are key elements in determining the annual capacity pot, are currently adding a significant level of uncertainty to this process. This uncertainty has the potential to create a significant barrier to investment in "flexible" generation plant. Given that the "flexible" generation plant required will inevitable have a lower capacity factor than most of the existing thermal plant on the system, capacity revenues will thus provide the bulk of the margin for such plant. As such this plant will rely heavily on capacity payments for a return on that investment, and therefore face a higher level of regulatory risk than other types of generating plant. If this level of risk is seen as significant it will have the effect of distorting investment decisions with regard to the type of plant to build. This may lead to investment in plant which will not be particularly complimentary to increased levels of wind generation on the system, and as a result act as a barrier to the delivery of the full potential of installed wind capacity.	It is not proposed to readdress the required €/installed MW/year calculation of the BNE peaker at the start of each year. It should be noted that the inframarginal rent subtractor from the capacity pot is negligible under the 2009 Capacity Pot calculation, although it is accepted that this might not be the case year-on-year.
Bord Na Mona	In terms of market design, and the guiding principles of value reflective pricing, it is apparent that the current market rules may well over compensate wind generators, and under compensate other generators, as their contribution to the deemed capacity requirement is based on the capacity credit of wind, whilst payments are based on out turn generation, (hence proportional to the average annual load factor for wind generation). This point is made in the context that the market should be based on the principles of remuneration based on the value of the capacity offered, as to do otherwise will result in distortions to the signals for investment in the	The CPM has many design features (12 monthly pots, fixed capacity price, ex-ante variable fixed capacity price together constituting 70% of the payment) which reduces a great degree of volatility for all generation. Wind is argued to be paid approximately 44% more than its contribution to the total pot in this paper, based on the analysis to date. It is noted that moving to one form of possible resolution of overpayment (a 100% ex-post pot) increases revenues to conventional generation by less than 1% (with a range for individual generators of +4% to -6%). Other forms of generation (Demand Side Units, Energy Limited Hydro and

	correct mix of plant required for the system.	Pumped Storage) appear to be more greatly affected by an overpayment to wind generation.
Bord Na Mona	It could well be argued that as renewable penetration levels increase the deemed capacity requirement under the existing arrangements will also increase, lifting the potential revenues for all generating technologies. However, this increase in system capacity costs will likely be balanced by a decrease in the energy component of the final wholesale price, as renewable penetration increases. Given the importance of energy revenues, as well as capacity revenues, to mid-merit plant operating with an annual capacity factor of 20-60%, this may well provide one element of a number of significant barriers to investment in flexible plant capable of operating in this space. The majority of this plant will be "flexible" gas fired plant that needs to be capable of multiple starts per week as well as considerable levels of cycling, and this plant is already disadvantaged by the inability to recover the costs of gas transmission tariffs through the existing electricity market structures.	Evidence has been shown at Irish industry gatherings of the lowering of SMP from wind generation. This is to be welcomed. It is also noted that the mid-merit plant described below will earn energy revenues specifically around the times when the wind is not blowing. Consequentially, the loss in SMP revenues for such mid-merit plant can be qualitatively argued not to be as severe as indicated. Ultimately, the relative strengths of such qualitative arguments require quantitative modelling to resolve.
ESBI	The current mechanism remunerates wind capacity in proportion to the annual load factor of the windfarm which will equate to approximately 30% of the payments received for a conventional generation plant of similar rated capacity. This is a simple straightforward mechanism which is transparent and easy to implement. All in all it is a reasonable compromise which has attempted to approximate the value of wind capacity at a point in time.	Please refer to Section 4 through to Section 6 of this paper.
ESBI	The fall off in capacity value for wind with increasing penetration levels is in effect a projection of the future which will be influenced by many factors, including the performance of conventional plant, as noted in the consultation paper. It would seem to be inappropriate to be make explicit provisions for the revision of the mechanism, with what would inevitably be a more complex formula based on projection, before the effects of increased wind penetration have been quantified.	The effects of increased wind penetration have been quantified. See Section 5 on the Study-Calculated Capacity Credit, and also Section 7.2 which caveats that study's findings.
AES Kilroot	As things stand however, the SEM	The CPM has many design features

rules over-reward wind for capacity. The value of wind capacity is equal to its “capacity credit” as calculated in accordance with the methodology set out by Eirgrid in its GAR reports. Wind capacity payments should not therefore be based on the energy produced by wind. The problem is made worse by the fact that this “hidden” subsidy to wind is paid for, not by customers, but by thermal generators, given that the capacity “pot” is capped. So this simply amounts to an unfair distribution of the capacity pot. In the longer term, customers will see reduced security of supply (ironically the capacity payment was meant to facilitate security of supply) because thermal new entry is not adequately rewarded.

(12 monthly pots, fixed capacity price, ex-ante variable fixed capacity price together constituting 70% of the payment) which reduces a great degree of volatility for all generation. Wind is argued to be paid approximately 44% more than its contribution to the total pot in this paper, based on the analysis to date. It is noted that moving to one possible form of resolution of overpayment (a 100% ex-post pot) increases revenues to conventional generation by less than 1% (with a range for individual generators of +4% to -6%).

Other forms of generation (Demand Side Units, Energy Limited Hydro and Pumped Storage) appear to be more greatly affected by overpayment to wind generation.

It is noted that the CPM is designed to ensure a BNE peaker is adequately rewarded at equilibrium, not thermal generation in general.