Integrated Single Electricity Market

(I-SEM)

Directed Contracts Implementation Paper

Consultation Paper

SEM-17-064

4th September 2017

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ACRONYMS

CfD: Contract for Difference;

CRM: Capacity Remuneration Mechanism;

DAM: Day ahead Market;

DCs: Directed Contracts;

FCO: Forward Contract Obligation;

HHI: Herfindahl Hirschman Index;

I-SEM: Integrated Single Electricity Market;

MIC: Maximum Import Capacity;

MVA: Mega Volt Amp

RAs: Regulatory Authorities

RO: Reliability Option; and

SMP: System Marginal Price.

1. INTRODUCTION

1.1 BACKGROUND

1.1.1 The current policy underpinning the market power mitigation strategy in the Single Electricity Market (SEM) is partially based on the imposition of Directed Contracts (DCs) on the incumbent generators (ESB Power Generation "ESB" and Power NI Energy Power Procurement Business "NI PPB") with large market share. [1]

1.1.2 With reference to DC implementation, the key SEM Committee decisions that determine the current DC policy and its associated methodology for calculation include the following:

  i. SEM-10-16 – decision to keep with the models, methodology and product types for the DCs, as outlined SEM-10-005;

  ii. SEM-12-002 – decision on the treatment of horizontal integration of ESB Power Generation with other ESB generation businesses in SEM;

  iii. SEM-12-026 – decided that DCs would be offered to suppliers on a rolling basis (4 rounds per year) instead of on an annual basis;

  iv. SEM-12-118 – decided on the treatment of SEM interconnectors within the concentration model; and

  v. SEM-14-042 – DC subscription rules with fuel data sources used in the DCs.

1.1.3 Under the revised SEM arrangements arising from I-SEM Go-Live, the SEM Committee has decided through the publication of the I-SEM Market Power Mitigation decision paper (SEM-16-024) to continue with DCs, referred to as Forward Contract Obligations (FCOs), and that the DC obligation would apply to ESB (Section 8.13.2).[2]

1.1.4 The objective of this consultation paper is to consult on the SEM Committee's intended approach for the implementation of DCs for the first four DC rounds under the revised SEM arrangements, including the methodology that is applied for determining DC prices and volumes that are offered by ESB and the methodology that is used to determine supplier eligibility to such volumes.

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[1] Due to declining market share, NI PPB has not been obliged to sell DCs since 2008.

[2] Within SEM-16-024, the SEM Committee stated it would also consider if the application of DCs is required to be applied to other generators in SEM and would determine this on a case by case basis (Section 8.9.3), followed by a consultation and the necessary changes to the individual generator's licence.

1.1.5   For clarity, the SEM Committee's intended approach for DCs under the revised SEM arrangements (for the first four rounds of DCs) is one of minimal policy and methodology change.

1.1.6   The rationale for applying a minimal change approach is to facilitate the earliest possible timing of DC rounds for market participants to commence hedging in advance of the commencement of the revised SEM arrangements.

1.1.7   The minimal changes considered necessary for first four rounds of DCs under the revised SEM arrangements include the following:

   i.   the addition of a call option to the two way Contracts for Difference (CfD) to mirror the sellers obligations under the Capacity Remuneration Mechanism (CRM) Reliability Option (RO); and

   ii.   the changing of the reference price from the System Marginal Price (SMP) to the Day Ahead Market (DAM) price.

1.1.8   The SEM Committee invites respondents' feedback on its intended approach to accommodate the revised SEM arrangements, namely:

   •   the approach for the implementation of DCs for the first four DC rounds under the revised SEM arrangements (see Section 2); and

   •   the modelling methodology that is applied by the SEM Committee for determining DC prices, volumes and eligibility (see Section 3).

1.1.9   With reference to the recent Decision Paper "*Measures to promote liquidity in the I-SEM forward market*" SEM-17-015, the SEM Committee notes its decision (i.e. Decision 4: Consultation on Directed Contracts Allocation Process), which stated the following:

"The SEM Committee will consult upon alternatives to the current allocation process for Directed Contracts. During the consultation process the merits of the current process will be benchmarked against a competitive mechanism to allocate volumes…. The Consultation Paper covering this area will be published during the summer of 2017".

1.1.10   In order to meet the I-SEM Go-Live date, the SEM Committee has decided to postpone the planned consultation on the DC allocation process, and instead is consulting on the minimal changes necessary in order to meet the I-SEM Go-Live date.

1.1.11   Potential future changes to the DC process under the revised SEM arrangements will be considered in a further consultation together with other considerations outlined in the Forward & Liquidity Decision Paper (SEM-17-015). The SEM Committee intend to hold this consultation after the commencement of the revised SEM arrangements. The SEM Committee invites respondents to indicate their preferred option, from the list below, as to the timing of this consultation:

- Option 1: after 3 months of the revised SEM arrangements, Q4 2018.

- Option 2: after 12 months of the revised SEM arrangements, Q3 2019.

- Option 3: after 18 months of the revised SEM arrangements, Q1 2020.

1.1.12 Responses to this consultation paper should be submitted to Gonzalo Saenz (gsaenz@cer.ie) and Kevin Baron (kevin.baron@uregni.gov.uk). The deadline for receipt of comments is 17:00hrs on Friday, 29th September 2017.

1.1.13 For clarity, a parallel and separate consultation (SEM-17-064) has also been published by the SEM Committee on the specific contracting arrangements which have been proposed by ESB for the DCs for the revised SEM arrangements, the details of which are on the SEM Committee's website.

1.2 STRUCTURE OF CONSULTATION PAPER

1.2.1 The structure of the consultation paper is as follows:

- **Section Two:** outlines the intended timetable for the first four DC Rounds under the revised SEM arrangements. Additionally, this section outlines the SEM Committee's intended approach regarding product offering (i.e. baseload, mid-merit and peak product) for the first four rounds of DCs, the setting of the competition threshold for the determination of DCs and the intended DC modelling process;

- **Section Three:** outlines the DC modelling methodology that the SEM Committee intends using for determining the DC prices, volumes and eligibility for the first four rounds of DCs under the revised SEM arrangements;

- **Section Four:** presents next steps; and

- **Appendix One:** provides further detail on the workings of the Concentration Model that is used to quantify the volumes of DCs that ESB are required to offer.

2. DC IMPLEMENTATION TIMETABLE, PRODUCTS AND PROCESS FOR REVISED SEM ARRANGEMENTS

2.1 APPLICATION OF DCS FOR FIRST FOUR DC ROUNDS

2.1.1 Two entities (i.e. ESB & NI PPB) currently have a licence requirement to offer DCs to eligible suppliers. The Regulatory Authorities' (i.e. CER and UREGNI) recent consultations on licences do not propose to change this for the revised SEM arrangements.[3]

2.1.2 Following an assessment of the expected ownership concentration in the revised SEM arrangements for the period covered by the first four rounds, the SEM Committee is satisfied that only ESB is required to offer DCs to eligible suppliers and intends continuing with DC obligations on ESB for at least the first four rounds of DCs under revised SEM arrangements.

2.1.3 If new data emerges that would change this assessment, before the completion of the 4 rounds, the SEM Committee will reconsider the application of DCs, subject to the relevant licence changes as necessary (for generators other than NI PPB, any obligation to offer DCs would require a licence change).

2.2 TIMETABLE FOR FIRST FOUR DC ROUNDS

2.2.1 In SEM-12-026, the SEM Committee decided to move from annual to quarterly DC subscription windows, commencing in Q2 2012. The SEM Committee intends continuing with this format for at least the first four rounds of the revised SEM arrangements.

2.2.2 In order to facilitate the earliest possible timing of DC rounds for market participants to commence hedging in advance of the commencement of the revised SEM arrangements, the SEM Committee intends having the first round of DCs in December 2017.

2.2.3 It is the SEM Committee's intention that the first four DC rounds take place every 3 months, as outlined in Table 1 below. The first and second rounds will involve the offering of between 100% and 25% of the volume of the products for certain quarters, while the subsequent rounds will offer 25% of the volume of the products for each quarter.

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[3] On the 2nd June 2017, the Utility Regulator of Northern Ireland (UREGNI) published a "Statutory Consultation on Modifications to NI electricity generation and NI electricity supply Licences, necessitated to implement the Integrated Single Electricity Market I-SEM". On the 2 June 2017, the CER also published an "Information Paper on proposed modifications to existing Generation and Supply licences, necessitated to implement the Integrated Single Electricity Market (I-SEM)" CER/17/111.

Table 1: DC Timetable

Activity	Date	Q2-18*	Q3-18	Q4-18	Q1-19	Q2-19	Q3-19	Q4-19
I-SEM DC Round 1	Dec-17	100%	50%	50%	25%			
I-SEM DC Round 2	Mar-18		50%	25%	25%	25%		
I-SEM DC Round 3	Jun-18			25%	25%	25%	25%	
I-SEM DC Round 4	Sep-18				25%	25%	25%	25%
Total offered by DC Round 4		**100%**	**100%**	**100%**	**100%**	**75%**	**50%**	**25%**

*Q2-2018 refers to the Go-live of the revised SEM arrangements to the end of June 2018.

2.3   PRODUCTS FOR FIRST FOUR DC ROUNDS

2.3.1   Currently, there are three DC products offered by ESB to suppliers, which are as follows:

- Baseload Product: For Trading Periods at the Contract Quantity arising in all hours.

- Mid-merit Product[4]: For Trading Periods at the Contract Quantity during the hours beginning at 07:00 and ending at 23:00 on Business Days and for Trading Periods on days that are not Business Days at 80% of the Contract Quantity.

- Peak[5]: For Trading Periods arising during the hours beginning at 17:00 and ending at 21:00 on all days during October, November, December, January, February and March at the Contract Quantity.

2.3.2   Given the new capacity market provisions in the revised SEM arrangements (e.g. RO), an addition requirement needs to be added to the DC products to reflect the additional obligation on generators successful in the capacity auction to pay back revenues earned above the strike price.

2.3.3   To account for the possession of ROs associated with the volume offered by ESB for each of the above DC products, it is intended that a call option will accompany the two way CfD, which will net off any payments above the RO strike price.[6]

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[4] Mid Merit DCs offered for 2007-2008 was defined as 07:30 to 23:00.

[5] Peak DCs offered for 2007-2008 was defined as 16:30 to 20:00.

[6] A generator with an RO is required to make a difference payment to the central capacity buyer (i.e. System Operators) whenever the reference price is above the RO strike price, which is in effect a call option provided by the generator (see CRM Detailed Design Decision Paper (SEM-15-103).

2.3.4   This obligation on suppliers to sell a call option to ESB when purchasing DCs is required to mitigate the exposure of ESB from having to pay twice above the RO strike price.

2.3.5   Any payments a supplier makes to ESB under the call option are netted off income the supplier receives from ESB under the two way CfD. For clarity, suppliers will not be liable for a net payment to ESB when the call option is used.

2.3.6   Suppliers in the revised SEM trading arrangements are not subject to prices above the RO strike price, due to the presence of the RO. Therefore they do not require any hedge above the RO strike price from DCs.

2.3.7   The call option component of the DC products does not require any forecasting or modelling (from a regulatory perspective when determining DC prices and volumes) as both the reference price and the RO strike price will be determined ex-post.

2.3.8   The reference price for both the two way CfD and the call option in the DCs will be the Day Ahead Market (DAM) price in the revised SEM arrangements.

2.3.9   Notwithstanding the intended introduction of the RO, the SEM Committee is not proposing any change to the range or definition of DC products on offer for the first four rounds of the revised SEM arrangements.

2.4   COMPETITION THRESHOLD FOR THE DETERMINATION OF DCS

2.4.1   As previously applied, the SEM Committee intend using the Herfindahl Hirschman Index (HHI) to set DC quantities and continue to use a target HHI level of 1,150 for the first four DC rounds under the revised SEM arrangements (applying for the period Q2-2018 to Q4-2019).

2.4.2   See Section 3 for further details on HHI.

2.5   DC PROCESS FOR FIRST FOUR DC ROUNDS

2.5.1   For the purposes of determining the volumes of DCs to be sold by ESB, the SEM Committee intend using the DC Concentration Model (see section 3 for more details).

2.5.2   The SEM Committee's Concentration Model will be run every quarter. Each box in table 1 (see Section 2.2.3) identifies percentage share of the outturn volume of DCs for the relevant quarter from the relevant DC round. In the initial round, Round 1, the DC Concentration Model will be run for the four quarters from Q2 2018 to Q1 2019. For Q2 2018 the full outturn volume of DCs will be allocated. For Q3 and Q4 2018, 50% of the outturn volume of DCs will be allocated, and for Q1 2019 25% of the outturn volume of DCs will be allocated.

2.5.3   Similarly for Round 2, the DC Concentration Model will be run for the four quarters from Q3 2018 to Q2 2019. For Q3 and Q4 2018, 50% of the outturn volume of DCs will be allocated, and for Q1 and Q2 2019 25% of the outturn volume of DCs will be allocated.

2.5.4   For every subsequent quarterly DC round, the Concentration Model will be run again for four quarters, starting two quarters ahead, and 25% of the outturn DC volume will be allocated to each quarter. The same applies for the supplier eligibility model which will also be run quarterly (see Section 3 for further details regarding the DC implementation models).

2.5.5   The price of DC products sold by ESB will be determined by the SEM Committee's DC Pricing Formulae, in conjunction with the relevant commodity and foreign exchange rates from the day they are sold.

2.5.6   The DC Pricing Formulae will be derived every second quarter. For the quarters in which new formulae are not newly derived, the formulae constants will be adjusted so that the formulae outturns match the results of a new PLEXOS run. This will help ensure that formulae apply over a reasonable timeframe and are therefore reasonably accurate.

2.5.7   The Primary Window will generally be over three working days in one week, followed by a one-day Supplemental Window the following week.

3. DC IMPLEMENTATION MODELS

3.1   OVERVIEW

3.1.1   The SEM Committee utilises several models (developed as part of the market power work stream for SEM) for the determination of DCs. The SEM Committee intends applying these models for the first four rounds of DCs under the revised SEM arrangements.

3.1.2   The models are as follows:

1. **Production Simulation Model (PLEXOS).** Under the revised SEM arrangements, the SEM Committee intends that DCs will be priced based upon a forecast of DAM price. This will be performed with a production simulation model (i.e. PLEXOS), which will be independently validated.

   A validated PLEXOS model is a key input to other models used to determine the quantities and prices of DCs. The Market Concentration Model and Econometric Pricing Model in particular will require input data developed from the validated production simulation model. For clarity, it should be noted that the SEM Committee has initiated a project to validate PLEXOS for the day ahead market in the revised SEM arrangements, for a period ranging from post Go-Live (11pm 22nd May 2018 SEM) to the end of 2019. This work is expected to take place from September to November 2017.

2. **Market Concentration Model.** This model determines the quantity of DCs that will be required to mitigate the market power of ESB.

3. **An Eligibility Model.** This model takes Maximum Import Capacity (MIC) data and historical load and energy data from the Meter Data Providers and output from the Market Concentration Model, and produces tables of DC eligibility by supplier. The model takes as an input half-hourly and/or quarter hourly load data aggregated by customer type in order to determine MW eligibilities for each type of DC (baseload, mid-merit, peak) for each load group.

4. **Econometric Pricing Model.** This model creates the DC Pricing Formulae that specify the strike prices for DC transactions as a function of forward fuel and carbon prices. The DC Pricing Formulae are designed to determine for each quarter a unique price for baseload transactions, mid-merit transactions and peak transactions. The Econometric Pricing Model uses PLEXOS outputs, from a variety of bounding fuel price scenarios as an input.

5. **A PLEXOS interface model.** This model is used to interface between PLEXOS and the Market Concentration and Econometric Pricing Models to ensure smooth transfer of data and accuracy of results.

3.1.3 Each model, with the exception of the PLEXOS production simulation model, is described in turn below.

3.2 MARKET CONCENTRATION MODEL

3.2.1 The Market Concentration Model ("Concentration Model") calculates the quantity of DCs that ESB[7] will be required to make available to eligible suppliers. The DC quantities are set such that market concentration in the SEM (as calculated by the model) is below a certain HHI threshold.

3.2.2 HHI is a tool used by economists to measure market concentration. The HHI indicator is equal to the sum of the squares of the market shares of firms in the industry. The maximum value for HHI in an industry in which a single firm has 100 percent of the market is therefore 10,000. The HHI threshold used since 2007 in setting the DCs was 1,150.

3.2.3 The SEM Committee intends keeping the HHI threshold at 1,150 for the first 4 rounds of the revised SEM arrangements but reserve the right to choose a different threshold. The market share calculations that underlie the HHI analysis in the Concentration Model are based on potentially competitive capacity. The "market" in the model is defined as the total amount of capacity that is relevant to competition in any given hour.

3.2.4 Potentially competitive capacity – that is capacity that is relevant to competition – is calculated hourly for the various generation owners based on the cost of each generation owner's units. In a given hour, a unit's capacity is considered potentially competitive so long as its cost is less than or equal to the DAM Price * (1.05).

3.2.5 Further, wind and hydro units have custom criteria in the Concentration Model to determine their quantity of potentially competitive capacity. Units that are considered fully competitive, such as imports over the interconnectors, and units that have no incentive to raise the market price are treated as fully competitive supply in the HHI calculation.

3.2.6 In the Concentration Model, capacity under DCs is treated as fully competitive supply since this capacity would not benefit directly from increases in market price. In effect, the capacity under DC is treated like a large number of very small competitors, and this is how DCs lower the HHI of the SEM. DCs are allocated to ESB[8] until the HHI is reduced below its target level.[9]

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[7] The model allows the application of DCs to two companies and further modification would be required to add a third or more companies to the allocation of DCs.

[8] When there are two or more companies subject to offering DCs each marginal allocation is given to the company with the largest residual market share – that is, the largest market share after allocated DC volumes have been subtracted.

[9] Appendix One provides further details on how the Concentration Model works.

3.3 ELIGIBILITY MODEL

3.3.1 Each supplier with DC eligibility has an eligibility calculated separately for each quarter and each product-type – peak, mid-merit, and baseload. The calculations are performed in a simple MS Excel model.

Eligibility Matrix

3.3.2 The first step is to fill in the Eligibility Matrix. This Matrix establishes, by customer class, DC eligibility per MW of MIC, calculated separately by quarter and DC product. For example, one MW of MIC serving the Industrial Customer Class might translate into eligibility in Q1 2019 of 0.05 MW of baseload DC, 0.04 MW of mid-merit DC and 0.06 MW of peak DC. The Eligibility Matrix is calculated as follows:

- Step 1: Start with the total MW of DC, by quarter and product type that ESB is required to make available, as calculated by the Concentration Model.

- Step 2: Across all suppliers, the total MW of DC eligibility due to a customer class is calculated separately for each quarter and product type. For example, the calculation for the Q1 2019 peak DC eligibility due to the domestic customer class is calculated as follows. Start with the Q1 SEM Peak DC MW from Step 1; multiply by the Q1 "deemed" average peak-hour load for the domestic customer class; divide by the Q1 "deemed" average peak-hour load for all customer classes.[10, 11]

- Step 3: Start with the total DC MW eligibility by quarter and product due to a particular customer class, as calculated in Step 2. Divide by the total MW MIC for that class.

3.3.3 The Eligibility Matrix is made from the ratios calculated in Step 3.

Directed Contract Eligibility by Supplier

3.3.4 The Eligibility Matrix is used to calculate a supplier's DC eligibility. DC eligibility for the supplier is calculated for each customer class to which a supplier supplies power. This quantity is a simple multiplication and can be described as follows:

- The supplier's DC eligibility is the sum of its eligibilities due to the various customer classes it serves. The sum is performed separately by quarter and

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10   Deemed average load for a customer class is the average of a year of historical load data for that class, constructed as follows. For classes that are not metered in quarter-hourly or half-hourly increments, a year of load data is built by multiplying that class's load profile shape for the year by its total consumption for the year. For customer classes that are metered quarter-hourly or half-hourly, their actual consumption by period is used.

11   For the calculation of "deemed" average load by load-period type, each hour is designated as one (and only one) of baseload, mid-merit, and peak. The designations should be the same ones used to calculate Directed Contract Quantities in the Concentration Model.

product type. A DC seller will not be eligible to subscribe to DC should they possess MIC readings.

- [DC MW / MW of MIC, from the Eligibility Matrix, for that customer class, quarter, and DC product] * [The customer class's MIC from the supplier]

MVA vs. MW

3.3.5   MIC is measured in MVA, as it was previously decided to convert MVA to MW for the purposes of allocation. The preceding description assumes that MIC numbers were converted.

Data Sources

3.3.6   The following data sources are used for the Eligibility Model:

- The total DC Quantities for the entire SEM is the sum of the DC quantities for ESB as determined in the Concentration Model;

- A year of half-hourly load by customer class comes from the Meter Data Provider; and

- MIC data for each customer class for each supplier comes from the Meter Data Providers.

3.4   ECONOMETRIC PRICING MODEL

3.4.1   The pricing formulae chosen for DCs recognises that forward market prices for electricity are dependent on forward market prices for fuel and emissions (specifically, CO_2). This DC pricing formula expresses the forward market price for electricity in a given calendar quarter and for a given product (baseload, mid-merit or peak) as a function of the forward fuel and emissions prices. This approach to pricing ensures that the strike prices for DC transactions entered into during the initial and Supplemental Subscription Period will appropriately reflect the contemporary market prices of fuel and emissions markets.

3.4.2   The Econometric Pricing Model is used to estimate the relationship between fuel and carbon prices and electricity prices and hence to derive the DC pricing formula. The Econometric Pricing Model is complementary to PLEXOS, which also analyses the relationship between fuels and carbon prices and electricity prices.

3.4.3   The DC pricing formula enables participants to understand how DC strike prices will change within the Subscription Period as a result of changes in underlying fuel and carbon prices. The DC pricing formulae will represent a view of price formation that is appropriate for establishing forward contract prices.

Derivation of the DC pricing formula from the Econometric Pricing Model

3.4.4   The derivation of the DC pricing formulae comes from a set of regressions. The dependent variable in these regressions will be the mean of the DAM Price; the relevant independent variables are fuel and emission cost inputs. The regression will be run on pseudo data, i.e., a number of runs of the model at a variety of conditions will be run to give the regression the necessary variation to yield, after linear regression, proper conditional prices which reflect the mean DAM Price under different input price conditions. Mean DAM prices will be calculated by quarter and product type – with the means being weighted averages with weights to match the delivery requirements for each product type.

3.4.5   The results of the regression will enable the SEM Committee to publish the regression formulae coefficients. To the extent that analysis of the relevant data implies that a different formula is appropriate, then the parameters specified will change.

Fuel Data Sources for Regression

3.4.6   The main fuel and exchange rate data currently used in determining the pricing formulae are from the following sources:

- **Gas** is the price (in pence sterling per therm) for quarterly Intercontinental Exchange Natural Gas Futures for the relevant quarter, as published on http://data.theice.com the "ICE UK Natural Gas Futures – NBP - (Quarters)".

- **Coal** is the price (in US dollars per tonne) for quarterly ARA Coal Futures as reported on www.theice.com as "Rotterdam Coal Futures – ARA".

- **CO2** is the settle price (in Euro per tonne of Carbon Dioxide) for the December month Intercontinental Exchange ECX EUA Carbon futures as reported on http://data.theice.com as "ICE ECX EUA Futures – EUX - (monthly)" for the given calendar year. The December price for a given year will apply to all quarters falling within that year.

- **Foreign Exchange Rates** are the daily euro foreign exchange reference spot rates from the European Central Bank as set out on its website: http://www.ecb.int/stats/exchange/eurofxref/html/index.en.html.

3.4.7   The SEM Committee intends using the same fuel data sources for regression under the revised SEM arrangements.

3.5   PLEXOS INTERFACE MODELS

3.5.1   Both the Concentration Model and the Econometric Pricing Model require input data from PLEXOS runs in order to produce their results.

PLEXOS Interface with Concentration Model

3.5.2   Under the revised SEM arrangements, the Concentration Model will require the following inputs from PLEXOS:

1) hourly DAM prices;

2) hourly aggregate generation for Wind and Hydro;

3) Average Costs/MWh for each unit; and

4) Unit capacities. where a unit is to come on-line or will retire mid-contract year.

3.5.3   The last item, unit capacities and any changes in on-line status, come from PLEXOS input data. All the other items come from PLEXOS output data. DAM prices and hydro & wind generation will be transposed into the Concentration Model. The calculation of average costs/MWh for each unit requires manipulation of PLEXOS outputs. Average costs include start-up and "generation costs", the latter of which include no-load costs. All costs will continue to include emissions taxes. Average costs are calculated as a unit's total generation and start-up costs in a quarter divided by its total generation in that quarter. These quarterly averages are inputted into the Concentration Model.

PLEXOS Interface with Econometric Pricing Model

3.5.4   The Econometric Pricing Model is a regression model, where the dependent variable is average DAM price in the SEM. The DAM price data come from PLEXOS. There are ten regressions to forecast average DAM prices by quarter for each DC product type (bearing in mind that there are no peak products in Q2 and Q3 2018). The interface works as follows:

1) Start with a series of indicative price combinations of Natural Gas, Coal, Gasoil, LSFO, and Carbon. These indicative prices are hypothetical combinations of the index prices that will ultimately set the strike prices of the DC.

2) Each combination of index prices must be translated into PLEXOS input fuel and carbon prices for the units in the SEM.

3) PLEXOS is run for each combination of hypothetical prices. The hourly DAM prices are the relevant outputs.

4) For each series of DAM price outputs, calculate ten relevant average DAM prices. The ten prices are the weighted average DAM prices for each quarter and DC product. The weights match how DC products are applied.

   a) Baseload products have an equal weight in all hours.

   b) Mid-Merit products have an equal weight in all mid-merit & peak hours on business days, but have a uniformly reduced weight in those same periods on non-business days. The non-business day weight is 80% of the business day weight. Mid-merit products have no weight in hours that are not mid-merit or peak hours.

c) Peak products have an equal weight in all peak hours, and zero weight in all other hours.

3.5.5   The ten regressions are run with the following data. The independent variables are the hypothetical index-fuel-price combinations from Step 1). Note that, within a quarter, the same index values are used in each of the baseload, mid-merit, and peak regressions. The dependent variables are the associate average DAM prices calculated in Step 4). The regressions may be expanded if it is found that reflecting fuel price relationships as independent variables significantly reduces the standard error and its variance.

4. NEXT STEPS

4.1.1 Interested parties are invited to respond to this consultation and the intended approach to be taken by the SEM Committee for the first four rounds of DCs under the revised SEM arrangements.

4.1.2 Additionally, interested parties are invited to respond regarding their preferred timelines for the SEM Committee to consider potential future changes to the DC process, namely:

Option 1: after 3 months of the revised SEM arrangements, Q4 2018;

Option 2: after 12 months of the revised SEM arrangements, Q3 2019; and

Option 3: after 18 months of the revised SEM arrangements, Q1 2020.

4.1.3 Responses to this consultation paper should be submitted to Gonzalo Saenz (gsaenz@cer.ie) and Kevin Baron (kevin.baron@uregni.gov.uk). The deadline for receipt of comments is 17:00hrs on Friday, 29th September 2017.

4.1.4 Please note that the SEM Committee intends publishing all responses unless marked confidential. While respondents may wish to identify some aspects of their responses as confidential, we request that non-confidential versions are also provided, or that the confidential information is provided in a separate annex. Please note that both Regulatory Authorities (RAs) are subject to Freedom of Information legislation.

5. APPENDIX ONE: HOW THE CONCENTRATION MODEL WORKS

5.1.1   As a first step, the Concentration Model determines DC quantities for ESB by product type (baseload, mid-merit, and peak) for each month. Quarterly DC quantities are determined in the Concentration Model to be the maximum monthly DC quantity occurring in that quarter.

5.1.2   The Concentration Model calculates DC quantities for ESB using an HHI approach. Market share is calculated based on each generation owner's potentially competitive capacity.

5.1.3   The Concentration Model relies on PLEXOS inputs and outputs. Hence, a validated PLEXOS model is required before the Concentration Model can be used.

Baseload, Mid-Merit and Peak Products

5.1.4   DC allocations to ESB are determined separately for peak, mid-merit, and baseload products, and are initially determined separately for each month.

5.1.5   Note that there are two uses for the terms "peak", "mid-merit" and "baseload" with respect to the DCs themselves and with respect to the Concentration Model:

- The terms "peak", "mid-merit", and "baseload" are defined terms in the DCs. In this context, they describe the hours in which a given transaction will apply. For example, if the transaction is a peak transaction, it will only apply in those hours that are defined to be peak hours in the DC.

- For purposes of calculating DC quantities, the Concentration Model designates each hour of the year as being one (and only one) of baseload, mid-merit, and peak. The hours that are exclusively baseload are designated as such in the Concentration Model. Hours that would be considered both baseload and mid-merit, but not peak, in the DC are considered for modelling purposes as exclusively mid-merit. Hours that would be considered baseload, mid-merit and peak in the DC are considered for modelling purposes as exclusively peak. The practical result of this is that each load period is treated independently – concentration in mid-merit and peak hours does not affect the calculation of baseload DC quantities.

5.1.6   The definitions of baseload, mid-merit, and peak for purposes of calculating DC quantities will be consistent with those used up to the commencement of the revised SEM arrangements. These definitions are as follows:

- **Peak.** In the Winter months (October to March, inclusive) there will be four peak hours per day in the Concentration Model: the hours that fall between 17.00 and 21.00. In the Spring, Summer and Autumn months (April to September, inclusive) there are zero peak hours per day. The peak DC product applies in these same peak time periods.

- **Mid-Merit.** In the winter months (October to March, inclusive) there are twelve mid-merit hours per day in the Concentration Model: the ten hours that fall between 07.00 and 17.00 plus the two hours that fall between 21.00 and 23.00. In the summer months (April to September, inclusive) there are sixteen mid-merit hours per day: the hours that fall between 07.00 and 23.00. In contrast, the mid-merit DC product applies in both peak and mid-merit hours, with mid-merit DC product set to 100% of the mid-merit DC MW on business days and 80% on non-business days.

- **Baseload.** There are eight baseload hours every day in the Concentration Model; the seven hours that fall between midnight and 07.00 plus the one hour between 23.00 and midnight. In contrast, the baseload DC product applies in all hours – peak, mid-merit, and baseload.

Step-By-Step Procedure to Determine DC Quantities

5.1.7 The initial monthly DC quantities are calculated for ESB as follows:

1. The aggregate market share of each of each generation owner is calculated in each baseload hour.[12] Aggregate market share for generation owners is based on their total potentially competitive capacity.

2. The HHI is calculated in each baseload hour for the generation ownership market shares calculated in the step above. An average baseload HHI is then calculated for the month as the simple average of all the baseload hour HHIs in the month. Any DC quantity a company has already been allocated is excluded from the numerator in the calculation to determine that company's HHI contribution – that is, DC are "atomised".[13]

3. If the monthly average baseload HHI calculated in the previous step exceeds a threshold level, Y, ESB is allocated 1% of that company's monthly average baseload market share, as calculated in Step 1, as a DC quantity. In determining the company with the largest baseload market share in that month, DC quantities already allocated to ESB are first subtracted from their monthly average baseload market share.

4. Steps 2 & 3 are repeated, until the monthly average HHI first falls to Y or less. The baseload DC quantities determined at this point are the final baseload DC quantities for that month. The baseload DC apply in all hours – baseload, mid-merit, and peak – though they are determined based on baseload-hour HHIs alone.

5. Steps 1 to 4 are repeated, this time for mid-merit hours. Note that mid-merit contracts are applied at reduced MW amounts on non-business days,

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[12] In this context, baseload, mid-merit, and peak hours are mutually exclusive.

[13] In this context, "atomised" means that this capacity is in effect split up into many very small pieces to be owned by a very large number of companies. In practice, atomized capacity only appears in the denominator of the HHI calculation.

compared to business days, currently an 80% reduction in the model. For every 1% DC allocation on business days, allocation for non-business days is 0.8%. Baseload DC quantities calculated in Step 4, as well as any already determined mid-merit DC quantities, are allocated before making the mid-merit HHI calculation in Step 2. The mid-merit DC apply in mid-merit and peak hours, though they are determined based on mid-merit-hour HHIs alone.

6. Steps 1 to 4 are again repeated, this time for peaking hours. Baseload and mid-merit DC quantities calculated in step 4 & 5, as well as any already determined peak DC quantities, are allocated before calculating the peak HHIs in Step 2.

7. The DC quantities (in MW) allocated to ESB for each of the three product types and in each month are reported in a summary table.

How the Concentration Model Measures the Contribution of Capacity Resources to Market Share

5.1.8 As discussed above, a generation owner's market share is based on each generation owner's potentially competitive capacity. The calculation is as follows. For thermal units, a unit's capacity is considered "*potentially competitive capacity*" in a particular hour so long as that unit's cost/MWh is less than or equal to DAM price * (1.05)

- Consider a DAM price of €50.00/MWh. Then the threshold for units is €52.50/MWh.

- A unit's cost/MWh is its average cost. Average cost is calculated quarterly based on cost and generation outputs from PLEXOS. The costs considered are generation costs and start-up costs, inclusive of the opportunity costs of carbon emissions.

5.1.9 The RAs decided in December 2006 that "e*nergy limited resources such as hydro, pumped hydro and wind will be recognised considering their energy limits and maximum production*."[14] This rule is applied in practice in the Market Concentration Model as follows:

- **Hydro, including Pumped Storage**: In a given hour, the amount of hydro capacity that is considered available is simply the amount of hydro that actually generated in the PLEXOS run associated with the Concentration Model run.

- **Wind:** Wind capacity is treated the same as traditional hydro, i.e., actual PLEXOS generation.

Exclusion of Units that do not Benefit from Execution of Market Power

5.1.10 As decided in Directed Contract Quantification Methodology Decision Paper (AIP/SEM/208/06) published on 8th December 2006, units that because of regulation do not benefit from the execution of market power are excluded from the HHI calculation

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14   *Market Power Mitigation in the SEM: Directed Contract Quantification Methodology: Decision Paper*" [AIP/SEM/208/06], page 20.

(see pg. 16-19). The units excluded from the HHI calculation are the three peat units: West Offaly, Lough Ree, and Edenderry. These units will be atomised – meaning they will be included in the denominator but not the numerator of the HHI calculation. Tynagh, Aughinish and NI PPB will be included in the HHI calculation.

5.1.11 SEM-12-118 outlined the treatment of SEM interconnectors in the Concentration Model. The two interconnectors are modelled separately to take account of the variance in losses across them. The modelled competitive capacity of each interconnector is atomised in the calculation of the HHI.

Ownership Groups for the HHI Calculation

5.1.12 Table 2, below, shows the ownership groupings that are considered in the Concentration Model.

Table 2

Owner	Generation Units (PLEXOS ID[15])
ESB PG	AA1, AA2, AA3, AA4, AD1, ADC, AT1, AT2, AT4, CGT8, CPS CCGT, DB1, ER1, ER2, ER3, ER4, LE1, LE2, LE3, LI1, LI2, LI4, LI5, MP1, MP2, MP3, MRC, NW5, PBA, PBB, TH1, TH2, TH3, TH4.
AES	B4, B5, BGT1, BGT2, K1 COAL 220, K2 COAL 220, KGT1, KGT2, KGT3, KGT4.
SSE	GI CCGT, RH1, RH2, TB1, TB2, TB3, TB4, TP1, TP3.
Power NI PPB	B10, B31, B32.
Viridian	HN2, HNC.
Aughinish	SK3, SK4.
Bord Na Mona	ED3, ED5.
Bord Gais Energy	WG.
Tynagh	TY.
iPower	iPower AGU.
Covanta	Dublin.
Maydown	Lisahally.
Indaver	IW1.
Full Circle Generation	Belfast Waste.
Contour	Contour AGU.

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[15] Taken from the SEM-17-056 - Baringa SEM PLEXOS Forecast Model for 2017-18, https://www.semcommittee.com/news-centre/sem-17-056-baringa-sem-plexos-forecast-model-2017-18

5.1.1 In addition to the above, the ownership of the following units is treated as follows:

- Wind units not owned by ESB. It is assumed in the Concentration Model that the output from these units is divided equally between five different generation owners. While this is an approximation, it is reasonable for the purposes of calculating market concentration;[16]

- The Moyle interconnector is atomised; and

- The three peat PSO units are atomised,

Calculation of Quarterly Volumes

5.1.2 The DC volumes that will ultimately be required are set quarterly. The Concentration Model calculates quarterly volumes by taking the maximum of the monthly volumes. The Concentration Model calculates the quarterly maximum volumes for each quarter and product type.

Where Input Data Comes From

5.1.3 All input data for the Concentration Model come from the PLEXOS input and output databases. In general terms,

- The price series that determines whether a unit is "*potentially competitive capacity*" is hourly DAM price from PLEXOS output data;

- The unit costs are average costs, inclusive of generation, start-up, and emissions cost, as calculated from PLEXOS output data;

- Unit capacities are from PLEXOS input data;

- Wind and hydro half hourly generation patterns are from PLEXOS output data.

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[16] The model takes in total wind generation as an input and divides that generation between ESB and non-ESB wind units in proportion to the total capacities of the ESB and non-ESB wind units.