Commission for Energy Regulation
An Coimisiún um Rialáil Fuinnimh

April 2011

# CER Factsheet on the Single Electricity Market

The Commission for Energy Regulation (CER) is the independent body responsible for regulating the natural gas and electricity markets in Ireland. For further details please see our website at www.cer.ie.

This CER factsheet explains the main parts of the Single Electricity Market (SEM), both at a high level and then in some detail, showing how it works to the benefit of electricity customers across the island.

## 1. What is the SEM?

The SEM is the wholesale electricity market for the island of Ireland, regulated jointly by the CER and its counterpart in Belfast, the Utility Regulator. By combining what were two separate jurisdictional electricity markets, the SEM became one of the first of its kind in Europe when it went live on 1st November 2007. The SEM is designed to provide for the least cost source of electricity generation to meet customer demand at any one time across the island, while also maximising long-term sustainability and reliability.

The decision-making body which governs the market is the SEM Committee, consisting of the CER, the Utility Regulator as well as an independent member (who also has a deputy), with each entity having one vote. The detailed rules of the SEM are set out in the Trading and Settlement Code, which is overseen by the SEM Committee.

For detailed information on SEM, please see the regulators' website at www.allislandproject.org.

## 2. Who operates the SEM?

The SEM is operated by SEMO, the Single Electricity Market Operator, a joint-venture between EirGrid and SONI, the transmission system operators in Ireland and Northern Ireland respectively. SEMO is responsible for administering the market, including paying generators for their electricity generated and invoicing suppliers for the electricity they have bought. For further details please see www.sem-o.com.

## 3. Electricity Characteristics

Electricity markets are distinct from other markets as:

- Electricity generation cannot be easily stored in large amounts;
- The generation of electricity must be balanced with customer demand for it on a second-by-second basis, if blackouts are to be avoided; and,
- Customers tend to rely on electricity for day-to-day living and cannot replace it easily. As a result, when electricity prices increase, customer demand generally does not reduce significantly in the short-term (this may change in the future if smart meters are rolled out).

These characteristics of electricity explain many of the features of electricity markets and the SEM. For example, because electricity generation and customer demand must be matched perfectly second-by-second, and because generation cannot be stored to a large extent, cost bids from generators must be balanced with demand estimates in advance of real-time.

# 4. SEM High-Level Design

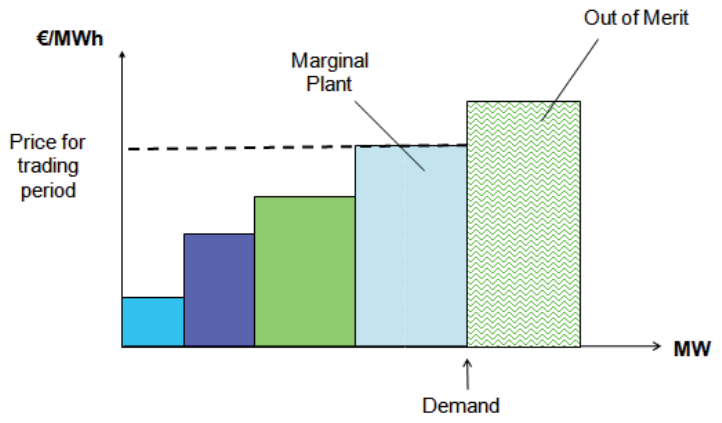
The two main aspects of the SEM design, namely energy and capacity, are summarised in this section. The energy market is then described in more detail in section 5, followed by generator dispatch principles in section 6.

The three biggest components of SEM by revenue - energy, capacity and constraints - are then put in perspective in section 7 followed by a conclusion in section 8.

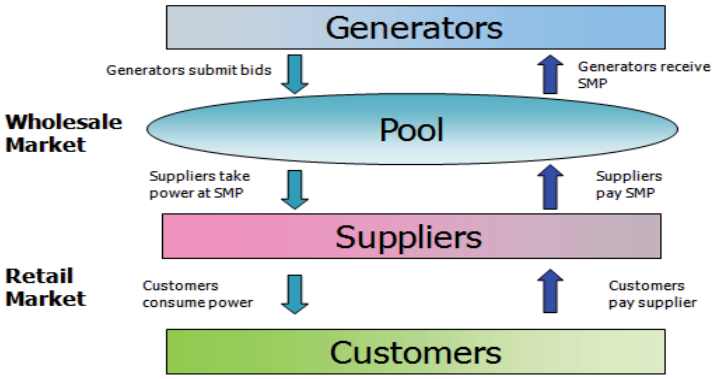
## Energy

At a high-level, the SEM design consists of a centralised and mandatory all-island wholesale pool (or spot) market, through which generators and suppliers trade electricity. Generators bid into this pool their own short-run costs for each half hour of the following day, which is mostly their fuel-related operating costs.

Based on this set of generator costs and on customer demand for electricity, the System Marginal Price (SMP) for each half-hour trading period is determined by SEMO, using a stack of the cheapest all-island generator cost bids necessary to meet all-island demand. It is these more efficient generators which are generally run to meet demand in the half hour in what is known as the "Market Schedule". More expensive or inefficient generators are "out of merit" and hence they are not run and are not paid SMP, keeping customers' bills down. This is illustrated below (see section 5 for more on this area).




The SMP for each half hour is paid to all generators that are needed to meet demand. Suppliers, who sell electricity direct to the final consumer, buy their electricity from the pool at this common price, as illustrated next.




Overall the SEM facilitates the running of the cheapest possible generators, determined by the stack of generation cost bids, to meet customer demand across the island.

This mandatory centralised pool model in SEM, in which all key generators and suppliers must participate, differs from most other European markets in which most trade takes place bilaterally beween generators and suppliers. In these bilateral markets only a residual amount of electricity is traded in an exchange, primarily for balancing purposes. In contrast all key players must trade in SEM, so there is much more transparancy associated with SEM prices and market outcomes.

Assisted by clear market rules and this transparency, the SEM has encouraged new efficient generators into the market (in both Ireland and Northern Ireland), helping to put downward pressure on customer prices and providing security of supply and environmental benefits.

## Capacity

Generators operating within the SEM also receive separate capacity payments which contribute towards their fixed costs, if they are available to generate. The capacity payment pot of money for generators is set ahead of time by the SEM Committee and is calculated based on the relatively low fixed costs of a peaking plant. As a result the payments generally cover only a portion of the fixed costs involved in building most plants (see section 5 for details).

Suppliers also pay for these capacity payments and any other system charges, which are typically passed through to customers.

# 5. SEM Wholesale Rules in Detail

This section provides more detail on the operation of the wholesale energy market in the SEM.

## Generator Bids

In order to sell electricity into the SEM pool, generators must submit cost bids to SEMO the day before the physical trade/generation takes place, known as D-1. The bids submitted are primarily based on a generator's running or Short Run Marginal Cost (SRMC), i.e. the cost of each extra MW it could produce excluding its fixed costs. The SRMC reflects the opportunity cost of the electricity produced, which is the economic activity that the generator forgoes to produce electricity. For example, in the case of a generator fuelled by gas, the opportunity cost includes the price of gas on the day that it is bidding in, because if the generator was not producing electricity it could sell its gas in the open market.

Generator bids also include a generator's start-up costs, which are costs it faces if it needs to be turned on after a period of inactivity, as well as generator no-load costs which are (mostly fuel) costs which are indifferent to output levels.

## SMP & Market Schedule

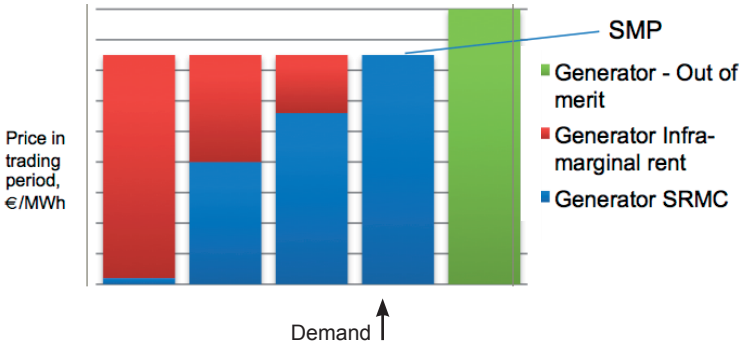
The generators submit these bids to SEMO up until Gate Closure, currently at 10:00am on D-1. Software is then run by SEMO to determine a Market Schedule which forecasts the SMP for each half hour trading period for the following day, in the manner shown in section 4 above.

However no software can predict with complete accuracy what will happen in reality: real-time factors such as a change in wind generation or customer demand, which can affect SMP, must be accounted for. For this reason, SEMO completes two more software runs reflecting the reality of what actually happened in generator dispatch (see section 6), one on the day after the trading day (D+1), and another four days after (D+4), to calculate the final SMP for each half hour of the trading day. This D+4 price is the one that is paid to generators and paid by suppliers.

## SMP & Infra-marginal Rent

As referred to in section 4, the Market Schedule identifies the lowest cost solution at which generation can meet demand for each half hour trading period. It ranks generators with the lowest bids first until the quantity needed for the demand is met - see blue shaded bars in the graph below. The marginal generator needed to meet the demand sets the SMP for that trading period.

The other generators who have submitted SRMC bids lower than this price are deemed to be "in merit" and will also be scheduled to run. All generators who have submitted bids which are higher than this price (SMP) are deemed to be "out of merit", and will not be scheduled to run - see the green bar in the graph. These tend to be old or inefficient plants.



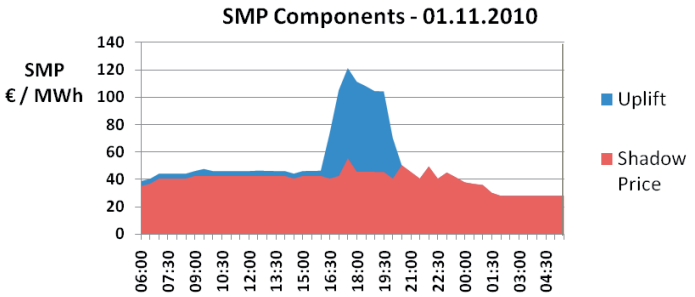

All generators who have submitted a bid which is under the SMP earn a profit, known as "infra-marginal rent", on the difference between their SRMC bid offer and the SMP. This is illustrated in red shaded bars in the above graph. The plant that sets the marginal price in a half hour, i.e. the one with the highest running costs among those that are scheduled to run, does not receive any infra-marginal rent. However this is typically a peaking plant which, while it has high short-run costs, has low fixed costs. Hence its costs are covered through the SMP and the capacity payments it receives.

Infra-marginal rent is needed for most generators that are run, including efficient modern gas plants and wind farms, because while such plants have relatively low running costs (SRMC), they have much higher fixed costs which the (relatively low) capacity payment does not fully cover. Without infra-marginal rent, it would not be economic to build modern efficient power plants or wind farms, threatening security of electricity supply and driving higher prices in the long-run.

Wind farms are an example of electricity generators that have very low SRMC - the wind is free - and so typically they receive a higher rate of infra-marginal rent than other electricity generators, which in turn is needed to pay for their much higher fixed costs.

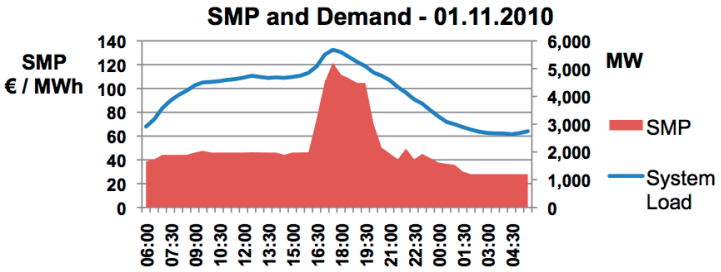
## SMP Movements - Components

Half-hourly SMP itself can be divided between the "shadow" and "uplift" price as illustrated below. The shadow price is most of the SMP and relates to the incremental SRMC bids from generators, i.e. to generators' fuel costs (explained earlier). The uplift component is paid if a generator's start-up and no-load costs are not covered by any infra-marginal rent it receives. This may happen, for example, if a generator is run for a short period of time to meet demand.



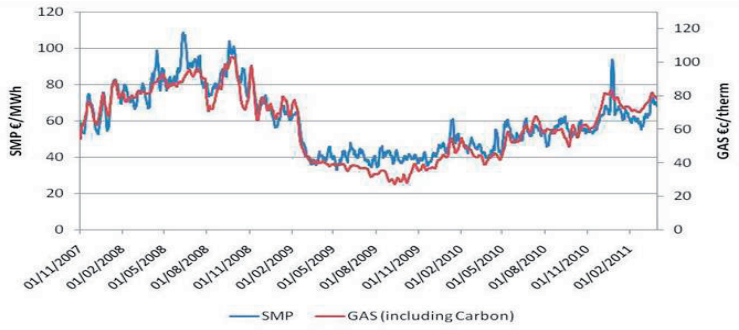

## SMP Movements - Within Day

Total customer electricity demand across the island normally varies with a noticeable trend throughout the day. It is usually lowest in the early hours of the morning and peaks generally between 17:00 and 19:00. The SMP follows this trend, as a more expensive stack of generators is needed to meet demand when it is high, whereas at low demand times demand can be met with cheaper generators. The example below shows the demand and SMP trend for a typical day.




## SEM & SMP - Overall

Approximately 80% of the island's electricity generation comes from imported fossil fuels, with the majority of this in the form of gas-fired generation plants, though the amount of renewable generation (especially wind) is increasing. This means that one would expect the wholesale gas price to be a key driver of electricity prices - i.e. SMP - in the SEM. In other words the higher the gas price, the higher the SMP and vice versa. This has been the case since the start of the market in November 2007 as shown in the following chart.




Therefore, by closely reflecting customer demand and the underlying fuel costs associated with power generation, wholesale electricity prices in the SEM have been as would be expected in an efficient and competitive market.

The SEM is ensuring that the most efficient plants are run and, through the SMP, provides a clear price signal for new more efficient generators to enter the market as needed. Daily SMP and other data can be found on SEMO's website at www.sem-o.com.

## 6. Generator Dispatch & Constraints

In the SEM generators are dispatched centrally, which means that SONI and EirGrid decide which generators will run and for how long. This ensures that the supply of electricity is secure and that the most efficient generators are dispatched.

The system operators produce the Indicative Operations Schedule the day before the trading day (D-1). It is similar to the Market Schedule (see section 5) but involves a higher level of technical information and predicts how each generator will be dispatched to meet demand. On the trading day itself SONI and EirGrid instruct generators to run to meet the demand of a given trading period in the most economic way possible. It is this data which feeds through to SEMO to reach the final SMP on D+4, discussed in section 5.

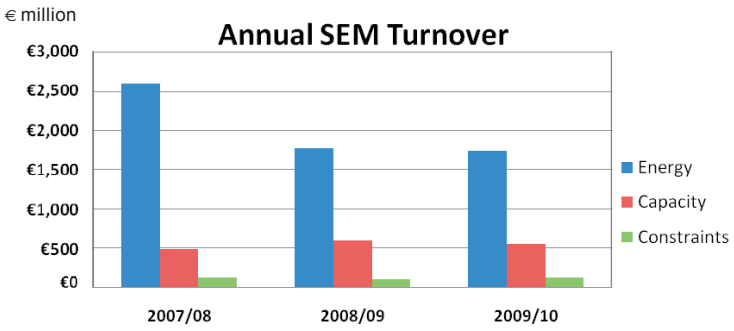
Constraint payments are made to generators to compensate for the difference between the level they were due to run at in the Market Schedule, based on a stack of cheapest generator bids, and the extent to which they were actually dispatched by EirGrid and SONI, if there was a difference for reasons outside of the generator's control.

If a generator was dispatched more than it was scheduled to in the Market Schedule, for example to compensate for another (cheaper) generator not being brought online due to a network failure or "constraint", it is "constrained on". This means it receives its bid cost to compensate for the extra MW it has to produce, though it doesn't receive infra-marginal rent. Generators who were originally included in the Market Schedule, but not actually run for reasons outside of their control, for example due to a network fault, are said to be "constrained off". They receive the SMP less their bid, i.e. the infra-marginal rent they would have received in the market had they been run.

Constraints costs also cover costs associated with "reserve". This is where, in order to ensure the continued security of the system, for example in the event of a generator tripping, some generators are instructed to run at lower levels than indicated in the Market Schedule. This means there is spare generation capacity available (reserve) which can be quickly brought online if needed. To maintain the demand-supply balance, this reserve means that some generators will be constrained down while others may be constrained on/up, again leading to the actual dispatch deviating from the Market Schedule.

## 7. SEM Components

To provide perspective, the following chart illustrates the annual turnover in the SEM between its three main components described above. This shows that the wholesale energy market component, which is SMP multiplied by demand, is by far the biggest, though its size changes as fuel and SMP prices change (explained in section 5).




Putting this further in context, these total SEM costs represent over half of a typical customer's electricity bill. For further information on this please see the CER's factsheet on "Electricity Prices in Ireland".

## 8. Conclusion

Since its establishment on 1st November 2007, the SEM has delivered transparent and efficient

wholesale electricity prices and has provided for the dispatch of the cheapest generators across the island to meet demand. This has helped to attract new investment in modern generation capacity, for example gas-fired plants and wind farms. Overall the SEM has helped to keep electricity prices competitive, ensure security of supply and provide environmental benefits.

In the future the SEM is expected to continue to develop through incremental changes, with the SEM Committee working to address the key challenges such as accommodating increased levels of intermittent renewable generation and further integration of the European electricity market.

## Contact Information

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