

<b>Title</b>	<b>Market Incident Report</b>
<b>Version</b>	<b>1.0</b>
<b>Date</b>	<b>28th October 2010</b>

## Introduction

The purpose of this document is to inform Participants and Parties to the SEM on the Market Schedules published with Shadow Prices of zero throughout September and October 2010. This paper aims to explain why these zero price events have occurred.

## Executive Summary

This report has been written to identify the reasons behind the zero Shadow Prices and zero System Marginal Prices produced by the MSP Software in recent runs. A number of dates were identified and a detailed analysis of the market system inputs and outputs was conducted. There were three Ex Ante runs which had zero Shadow Prices, four Ex-Post Indicative runs and five Ex-Post Initial runs. The schedules produced were reviewed on a unit by unit basis to identify trends in the scheduling of units, while system load and wind generation on the day were also considered. The results are shown in the analysis below. The trends observed include the impact which increased wind generation throughout the night valley has on prices. The prevailing trend is of Hydro units setting the price at zero when other committed Price Maker Generator Units are at Minimum Stable Generation throughout the night and therefore not able to set the price in this position. Interconnector units bidding in at zero have accounted for some of the zero prices although not frequently enough to be deemed significant for the purposes of this report, these cases are analysed separately.

## Background

The table below lists the number of MSP Software runs that have had zero Shadow Prices and zero System Marginal Prices during September and October (week ending the 17th October 2010).

<i>Run Type</i>	<i>Zero System Marginal Price</i>	<i>Zero Shadow Price</i>
<b>EA</b>	<b>2</b>	<b>3</b>
<b>EP1</b>	<b>1</b>	<b>4</b>
<b>EP2</b>	<b>2</b>	<b>5</b>

A zero Shadow Price or zero System Marginal Price does not constitute a significant price event in the SEM as noted in the SEMO policy on solvers and it therefore does not prompt the running of the alternate MIP (Mixed Integer Programming) solver. Some of the runs that produced zero Shadow Prices were completed using MIP. This was due to infeasible Lagrangian Relaxation (LR) solutions<sup>1</sup> and was not because of the zero prices. For the Ex-Post Indicative (EP1) run for Trade Date 13th September 2010 and the Ex Post Initial (EP2) runs for Trade Dates the 13th September 2010 and 30th September 2010, the solution from the LR solver was infeasible which led to the running and publication of MIP.

<sup>1</sup> This will be covered in a separate report from SEMO.

The Shadow Price that is produced from a run is based on bids from the marginal generator in each Trading Period. The System Marginal Price is then calculated by taking the Shadow Price and adding an element of Uplift onto it as required, to ensure that generators recover their start up and no load costs. If there is no Uplift to be applied in a Trading Period and the Shadow Price is zero then the System Marginal Price will also be zero. If there is Uplift applied to the Shadow Price, then the System Marginal Price will not be zero. There were two Trade Dates, 13th of September 2010 and the 30th of September 2010 which had zero Shadow Prices in both the EP1 and EP2 runs. The rest of the dates had zero prices in only one run.

There was one Trade Date, the 1st of October that had zero prices in all three pricing runs. This was the result of an Interconnector Unit that bid in zero prices in their price quantity pair. This date will be reviewed separately.

## Analysis

### *Ex Post Initial (EP2) Runs*

#### September 13<sup>th</sup>, 2010

The Ex Post Initial run for Trade Date 13th of September was run on operational date the 17th of September. An infeasible solution from the LR resulted in MIP being run and chosen for publication. This Trade Date had a peak Shadow Price of €105.24<sup>2</sup> and peak System Marginal Price of €146.23. The zero prices occurred throughout the night from the Trading Periods 03.00 to 04.00 inclusive. The Shadow Price was at zero for these three Trading Periods and the System Marginal Price was at €4.64. The Uplift starts at 09.00am and is present for the entire Trading Day until the last Trading Period at 05.30am.

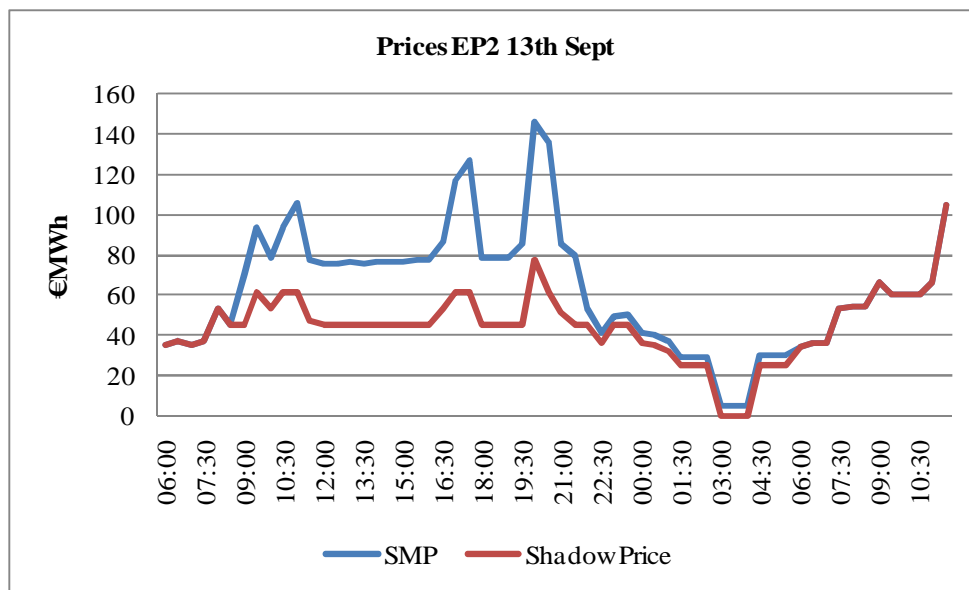


Figure 1 – Prices from EP2 13/09/2010

The load at the time of the zero prices was approximately 2,340MW, which is among the lowest of the dates reviewed and the wind generation is among the highest. The wind values over the three Trading Periods range from 885MW to 899MW and accounts for 38% of the system load at this time. The wind remains steady and relatively high over the course of the day, which has an impact during the night valley as demand drops off.

<sup>2</sup> All prices are €/MWh

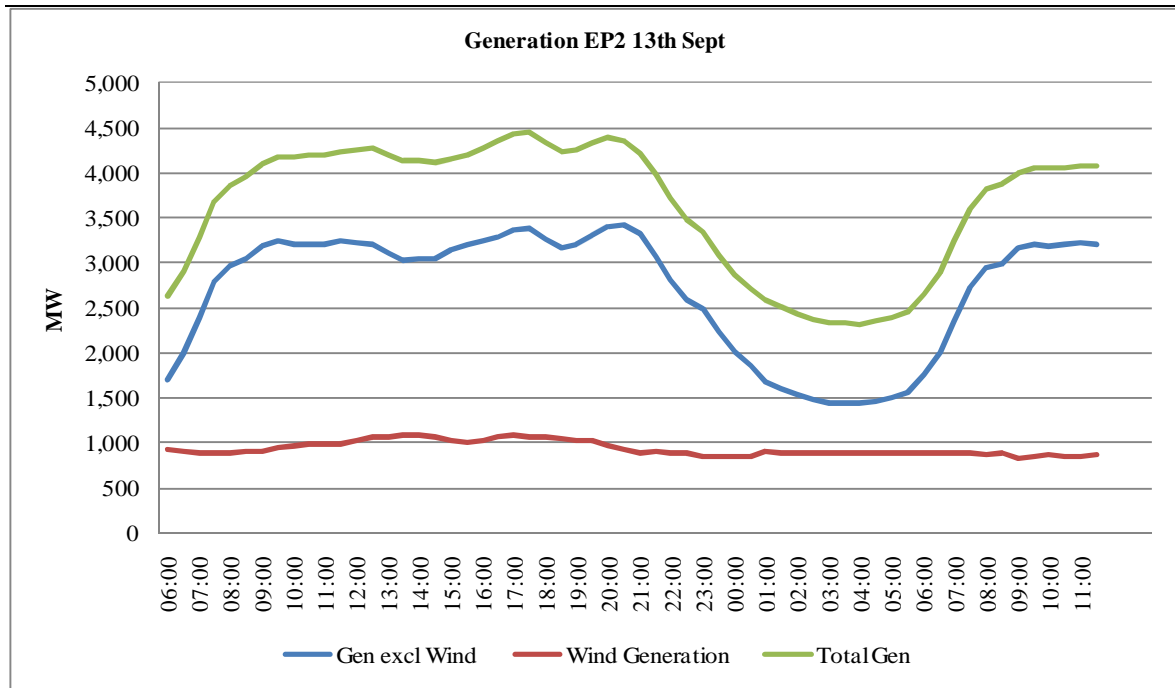


Figure 2– Generation Breakdown EP2 13/09/2010

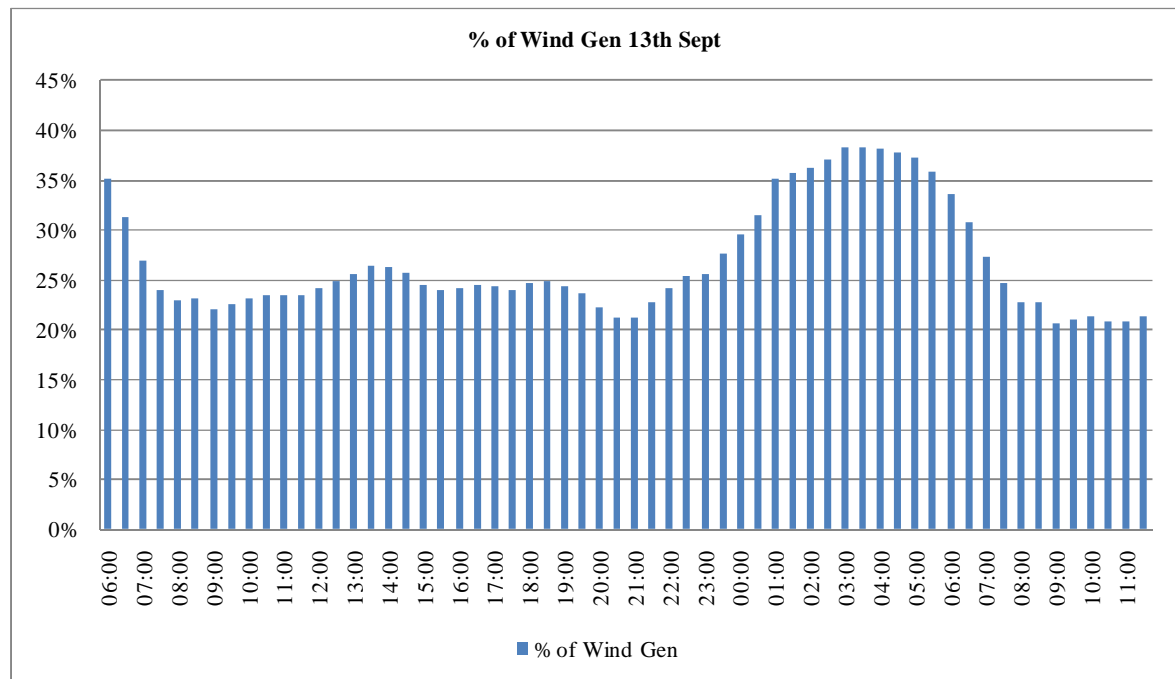


Figure 3 – % of Wind Generation of Total Demand EP2 13/09/2010

To assess whether this was simply a seasonal trend, the percentage of wind versus total demand was reviewed for same day over the past 3 years. The percentage has increased significantly from being pretty much stable in 2008/2009 ( an average of 5% in 2008 and 4% in 2009) to 27% in 2010. Overall, an increase in the wind generation throughout the night valley it is expected due to the increase in total Registered Capacity of Wind units onto the system, however in 2010 the increase is quite pronounced. The same day of the week, not Trade Date was chosen for comparison purposes i.e. the Trade Date 13th of September in 2010 was on a Monday, therefore the Monday of the same week in 2009 and 2008 were chosen for analysis. This is due to the system load profile being different on certain days of the week and to ensure we are comparing like with like. For the observed period (September through to October 17th) the average percentage of wind generation over the three years has been 5% in 2008, 2% in 2009 and 10% in 2010.

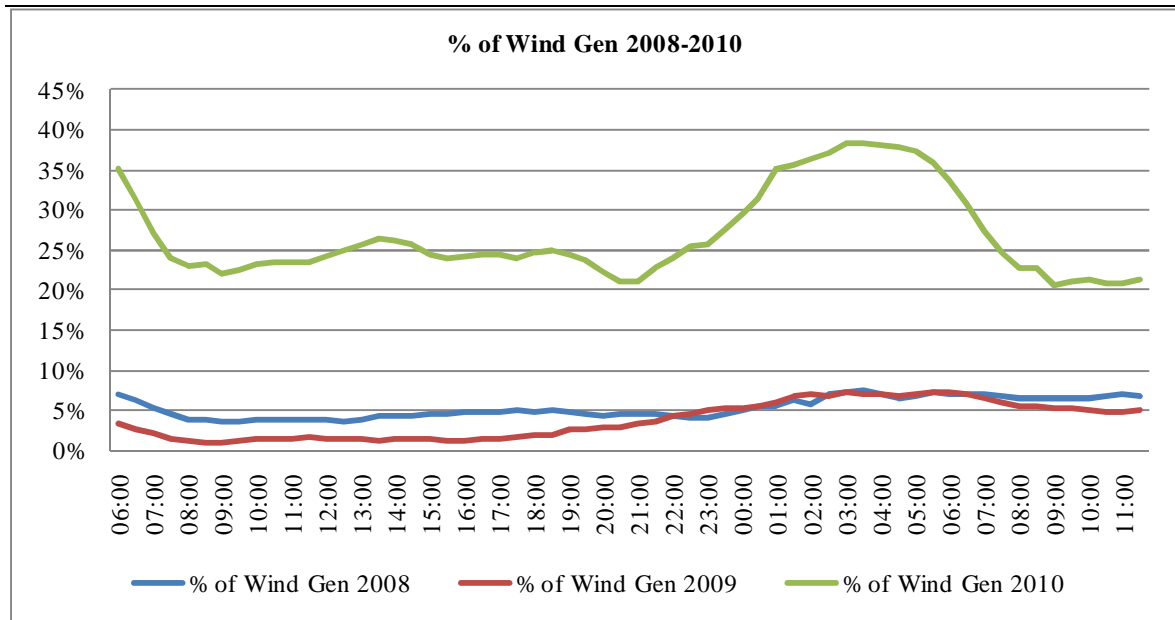


Figure 4 – % of Wind versus Total Load 13/09/2008, 14/09/2009 and 13/09/2010

The Interconnector Units are not scheduled from 1.30am as they are unavailable. There are three Hydro units scheduled from 03.30 to 04.30 inclusive. Hydro units have a Bid Price of zero. One of the Hydro units is at its minimum availability of 4MW for all three Trading Periods. One of the Hydro units is setting the price at 03.00 and another is setting the price at 03.30 and 04.00.

UNIT TYPE	03:00	03:30	04:00
HYDRO	4.12	4	4
HYDRO	4	4	4
HYDRO	23	15.53	12.61

Of the units that are on, six of them are at Minimum Stable Generation and one unit is ramping up, therefore cannot be marginal because of its ramp constraints. Also when a unit is at Minimum Stable Generation the unit cannot be marginal as while it can increase output, it cannot decrease and therefore cannot meet the requirement of the Trading & Settlement Code to respond to an increase or decrease in the Schedule Demand. The unit that is ramping has a very slow ramping rate due to the calculation of the single ramp rate<sup>3</sup>. It is difficult to say if the rate was more realistic whether this unit would be setting the price; however, as the wind is so high and the demand is relatively low, we would expect that the MSP software would have maintained this unit at Minimum Stable Generation as it would be able to ramp the generator up for the morning peak with the other units in a later Trading Period.

<sup>3</sup> The calculation of the Single Ramp Rates and their impact on the MSP software outputs will be discussed in a separate report.

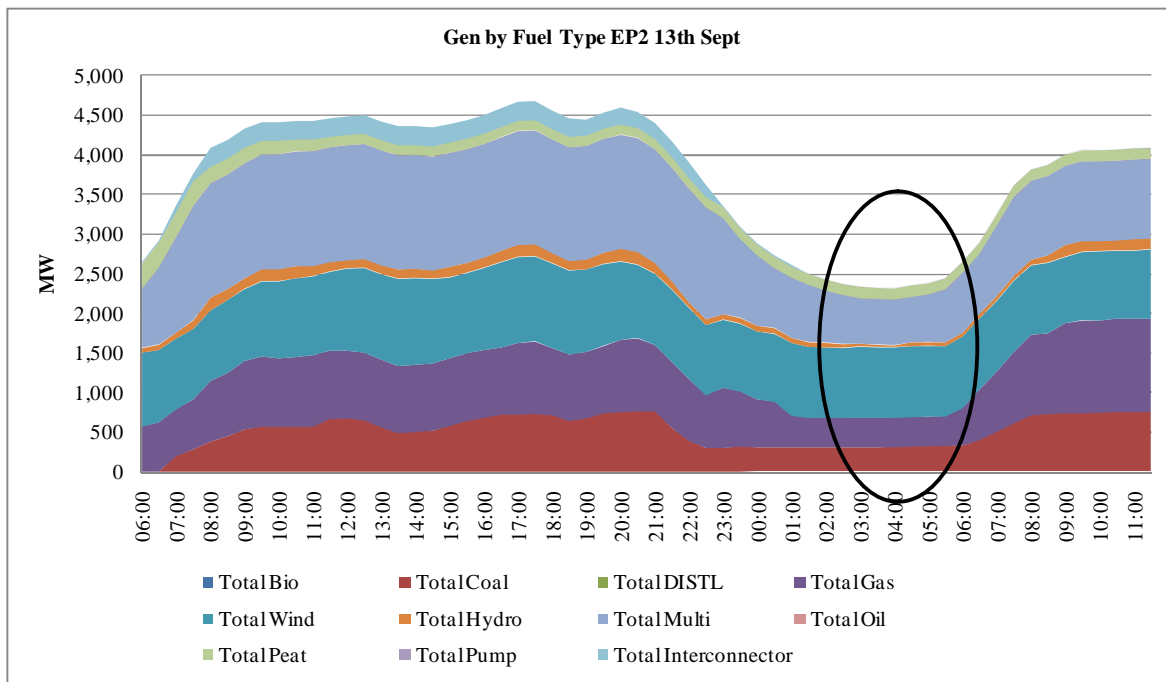


Figure 5 – Breakdown of Generation by Fuel Type EP2 13/09/2010

September 19<sup>th</sup>, 2010

The Ex Post Initial run for Trade Date 19th of September was run on operational date the 23rd of September. This Trade Date had a peak Shadow Price of €82.43 and peak System Marginal Price of €21.21. The zero prices occurred for three Trading Periods from the Trading Period 03.00 to 04.00 inclusive. The Shadow Price was at zero and the System Marginal Price produced was at €5.84. The Uplift starts at 08.00 and is present for the entire trading day until the last Trading Period at 05.30.

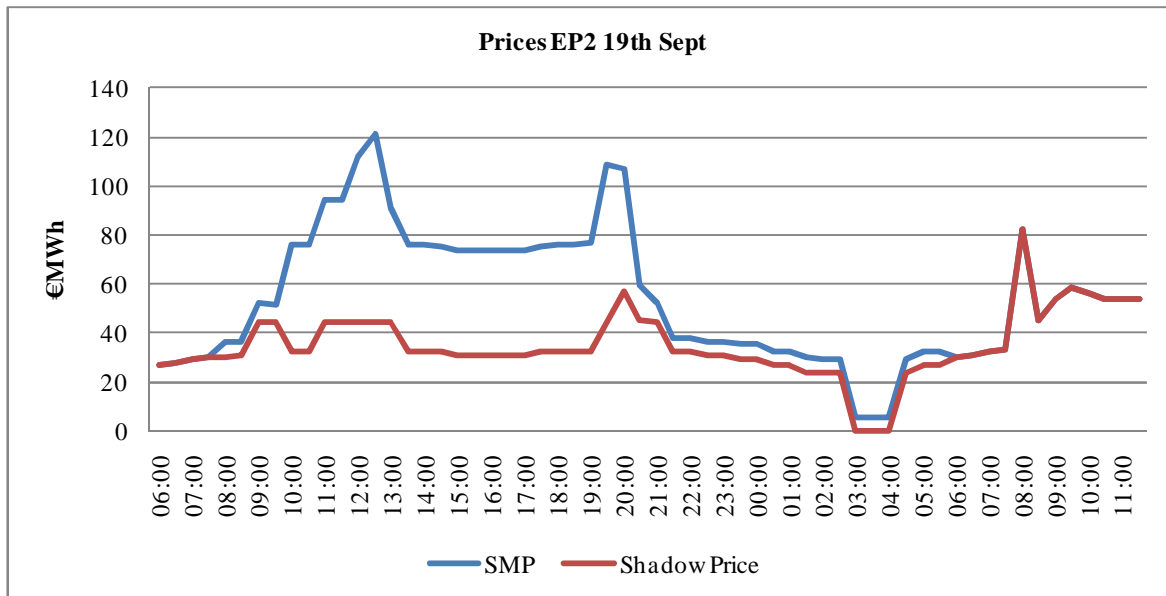


Figure 6 – Prices from EP2 19/09/2010

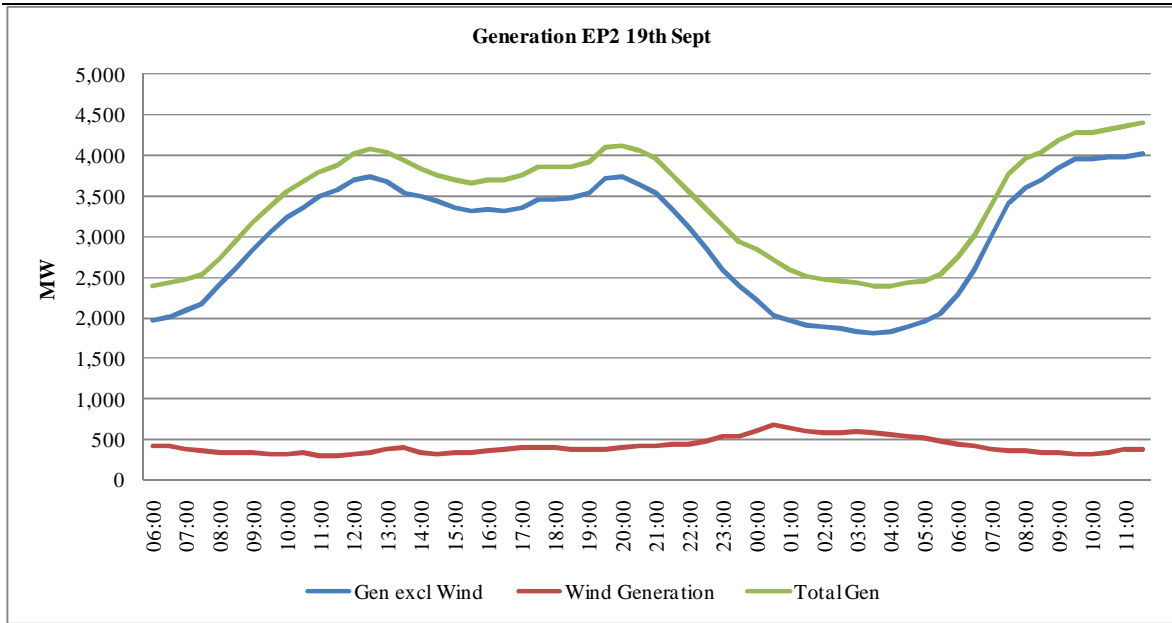


Figure 7 – Generation Breakdown EP2 19/09/2010

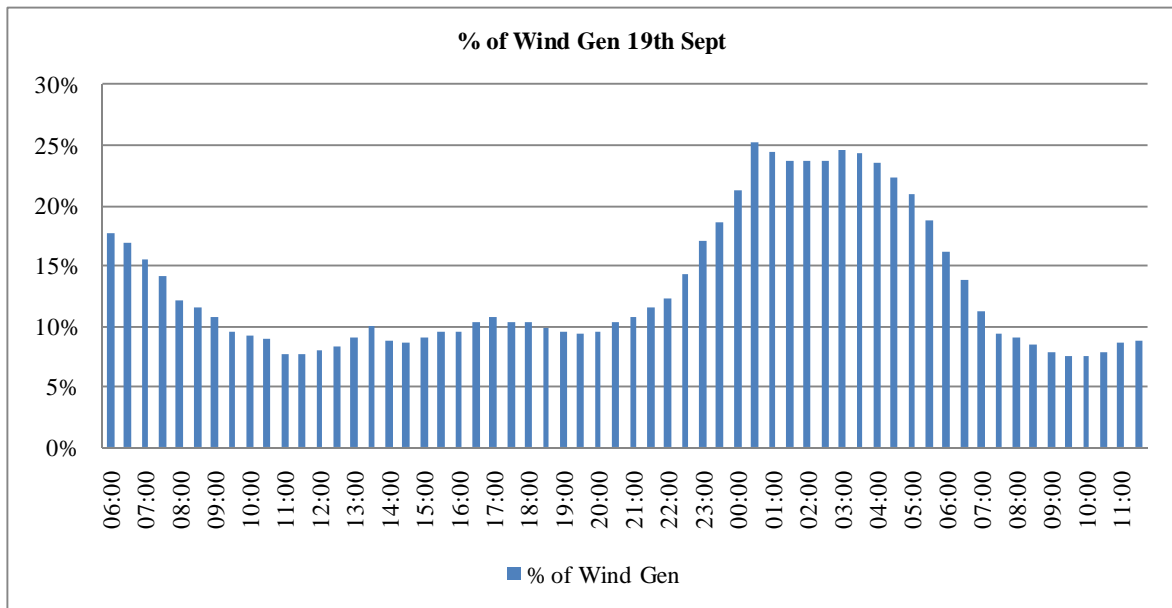


Figure 8– % of Wind Generation of Total Demand EP2 19/09/2010

The percentage of wind providing generation was quite high, between 22%-24% over the Trading Periods with zero prices. The load at the time was approximately 2,400MW. With a comparison of the same day in the past three years, the percentage of wind over the night valley is increasing steadily.

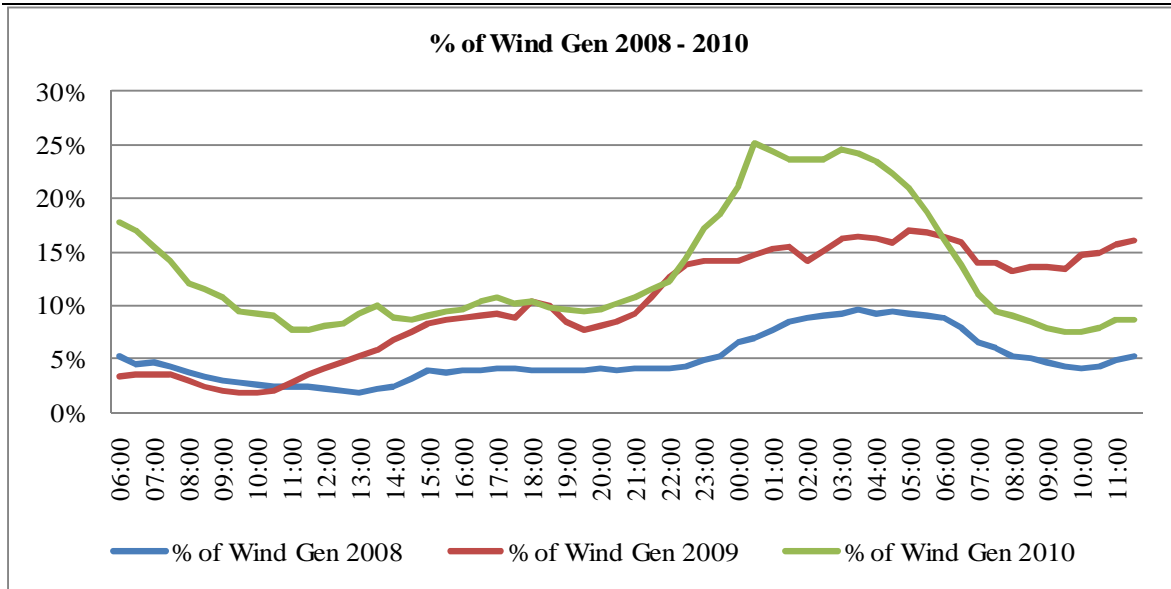


Figure 9 – % of Wind versus Total Load 21/09/2008, 20/09/2009 and 19/09/2010

As has been highlighted previously, the wind is increasing throughout the night, while other generation is scaled back. The output of the Multi-fuel, Gas, and Coal stations are all reduced throughout the night in preparation for ramping for the morning peak and in order to take advantage of the wind generation.

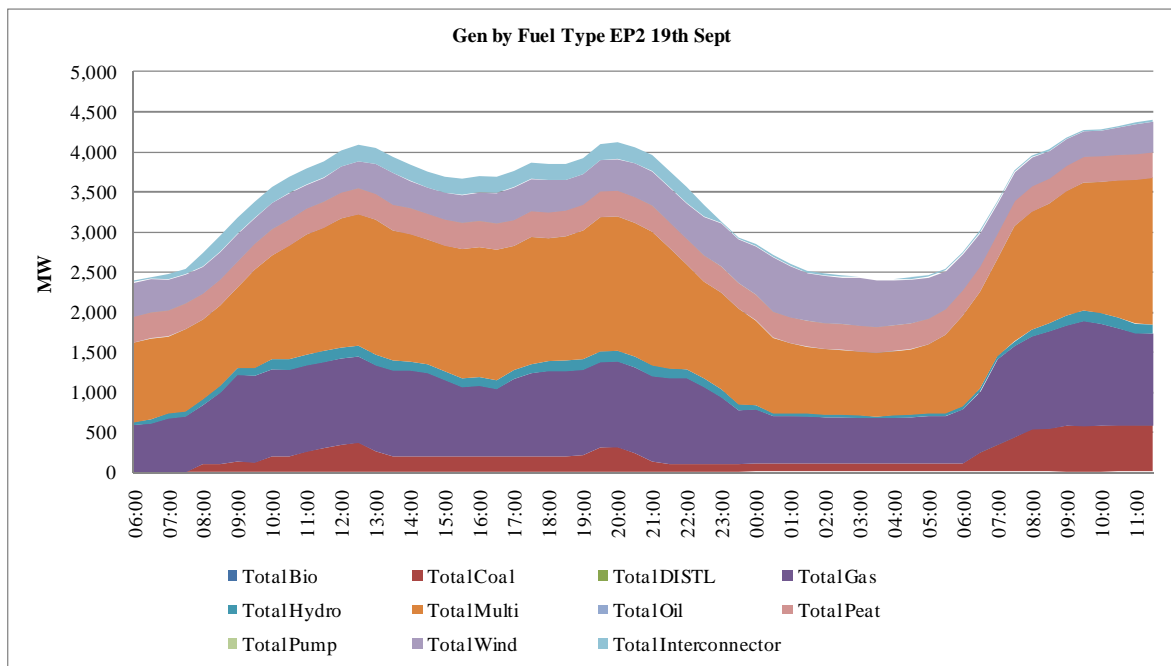


Figure 10 – Breakdown of Generation by Fuel Type EP2 19/09/2010

**September 26<sup>th</sup>, 2010**

The Ex Post Initial run for Trade Date 26th of September was run on operational date the 30th of September. This Trade Date had a peak Shadow Price of €50.33 and peak System Marginal Price of €87.74. The zero price occurs in only one Trading Period at 03.30. Both the Shadow Price and the System Marginal Price were at zero. Uplift is applied at 08.30 and is present until at 21.30.

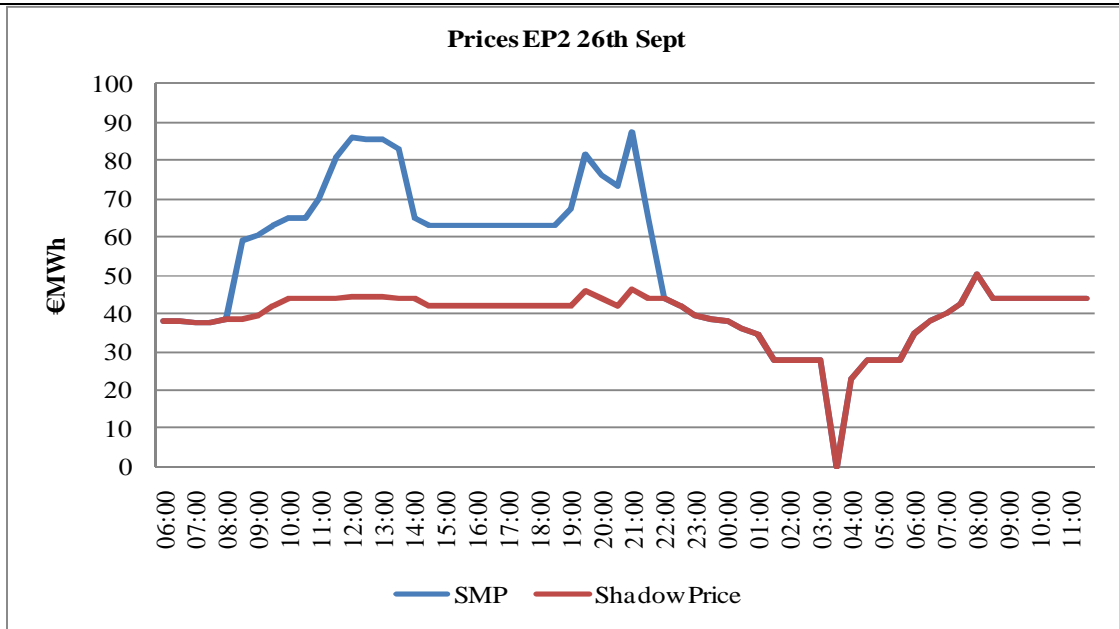


Figure 11 – Prices from EP2 26/09/2010

The wind for this particular day was relatively low, it did pick up through the night however did not exceed 500 MW at any stage throughout the day or night. At 03.30 the load was 2,300MW and 15% of this was met by wind.

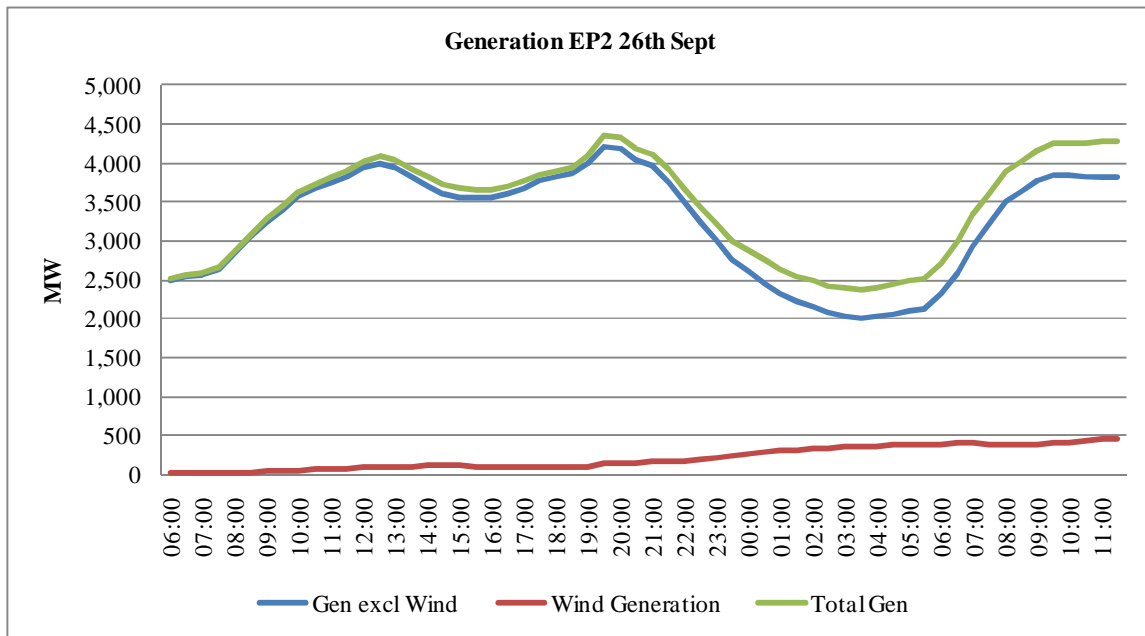


Figure 12 – Generation Breakdown EP2 26/09/2010



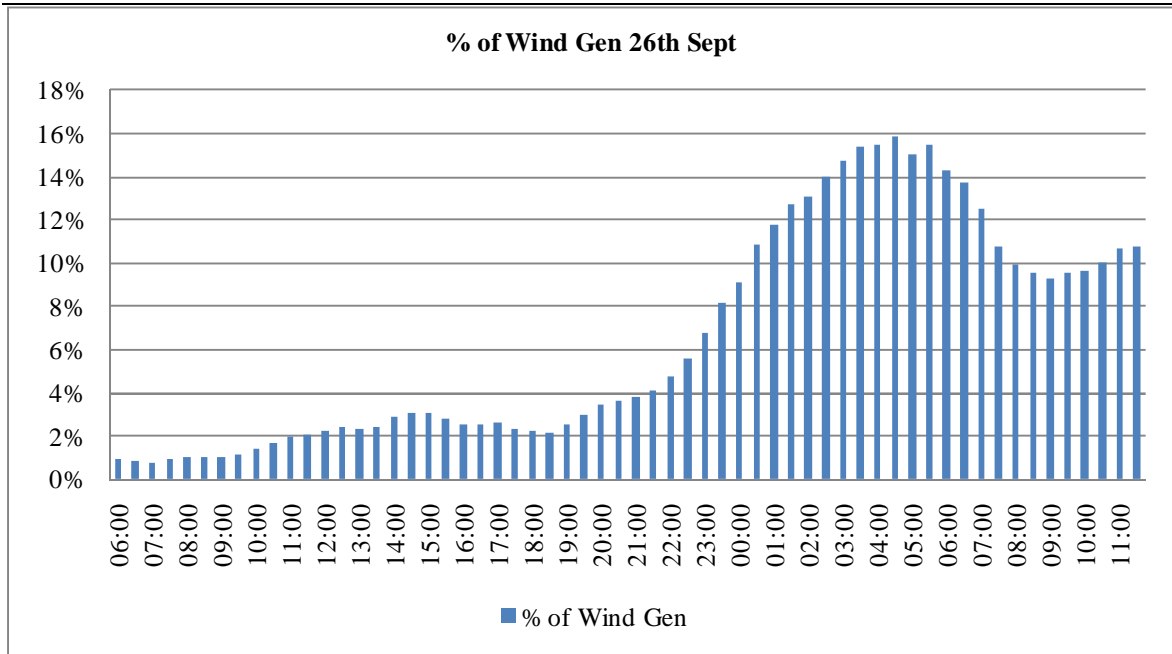


Figure 13 – % of Wind Generation of Total Demand EP2 26/09/2010

The Interconnector was available but was not scheduled. A Hydro unit is again setting the price for this Trading Period. The other price maker units that are on are all running at Minimum Stable Generation. These eight units are a mixture of Coal, Gas and Multi fuel units.

UNIT TYPE	03:30
HYDRO	8.45

**September 30<sup>th</sup>, 2010**

The Ex Post Initial run for Trade Date 30th of September was run on operational date the 4th of October. An infeasible LR solution resulted in MIP being run and chosen for publication. This Trade Date had a peak Shadow Price of €153.02 and peak System Marginal Price of €310.34. The zero prices occurred from the Trading Period 03.00 to 04.00 inclusive. The Shadow Price was at zero for the three Trading Periods and the System Marginal Price was also at zero. Uplift is applied from 15.00 until at 21.30.

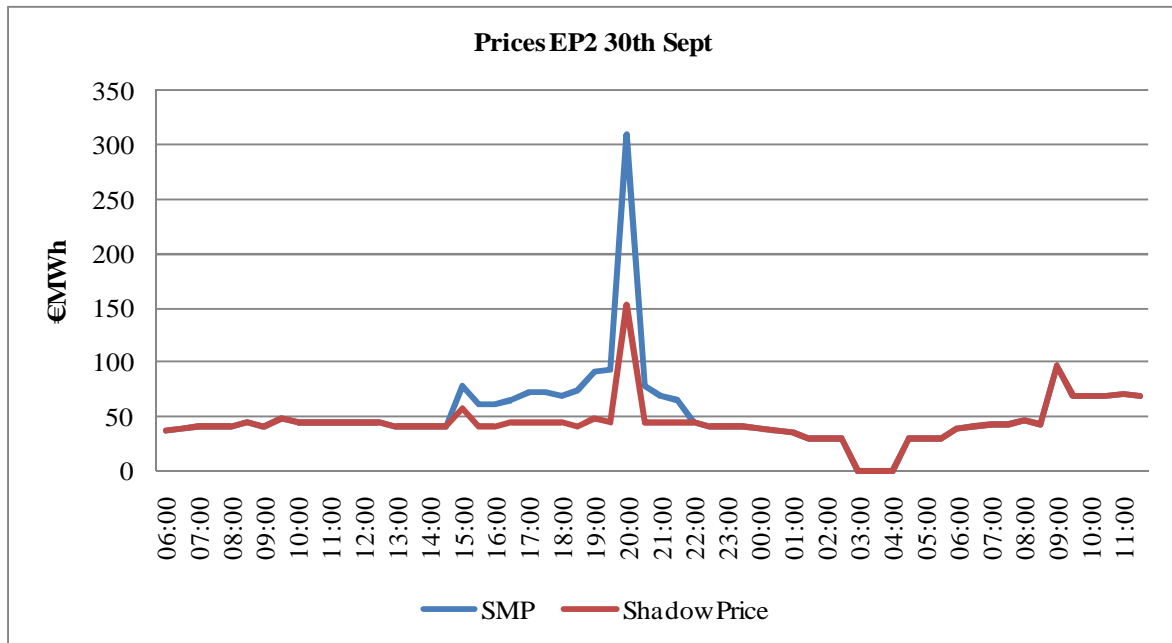


Figure 14 – Prices from EP2 30/09/2010

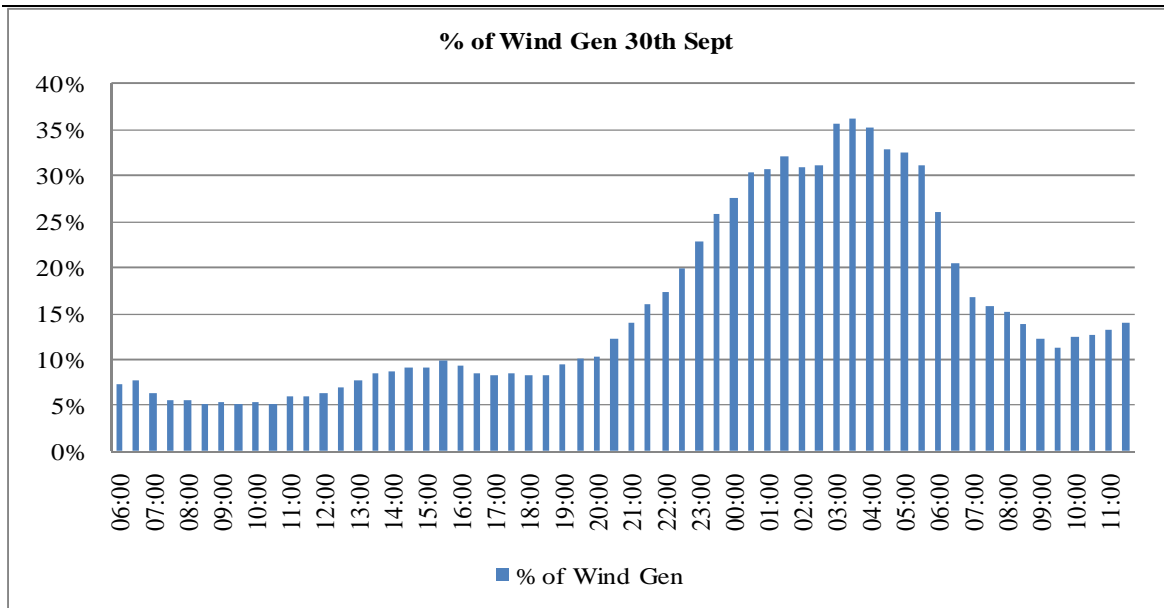


Figure 15 – % of Wind Generation of Total Demand EP2 30/09/2010

The percentage of wind of total demand is at 36% for the Trading Period 03.00, 36% at 03.30 and 35% at the Trading Period 04.00. Over a third of the demand is being covered by wind generation at this time. A comparison of the same day in 2008 and 2009 shows a similar pattern to the other Trade Dates in that the percentage of wind over the night valley has increased significantly.

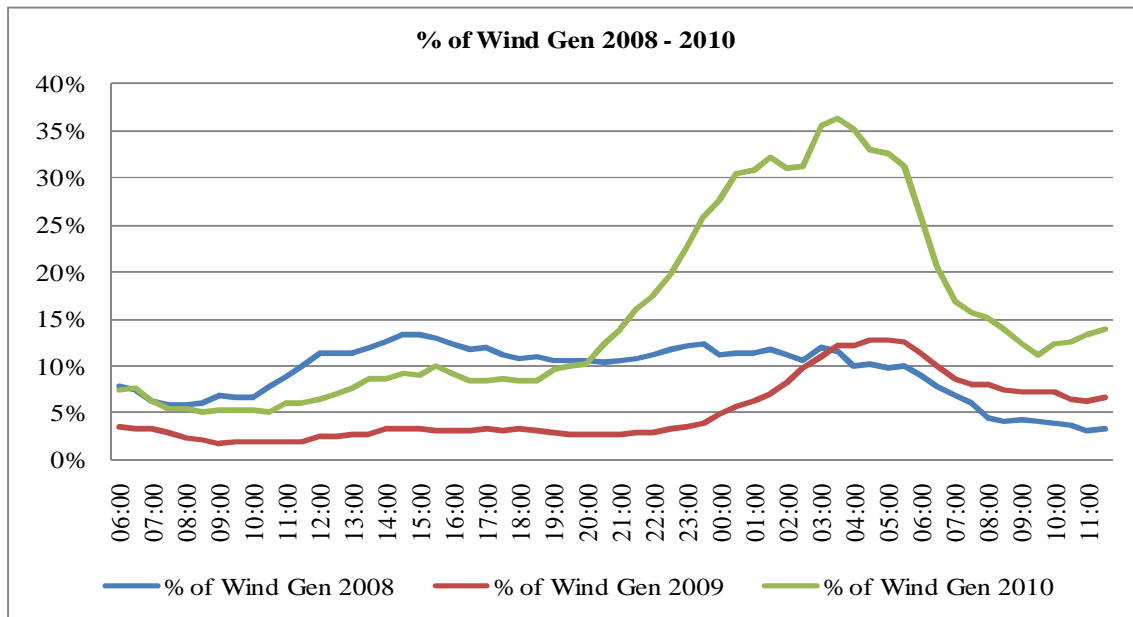


Figure 16 – % of Wind versus Total Load 02/10/2008, 01/10/2009 and 30/09/2010

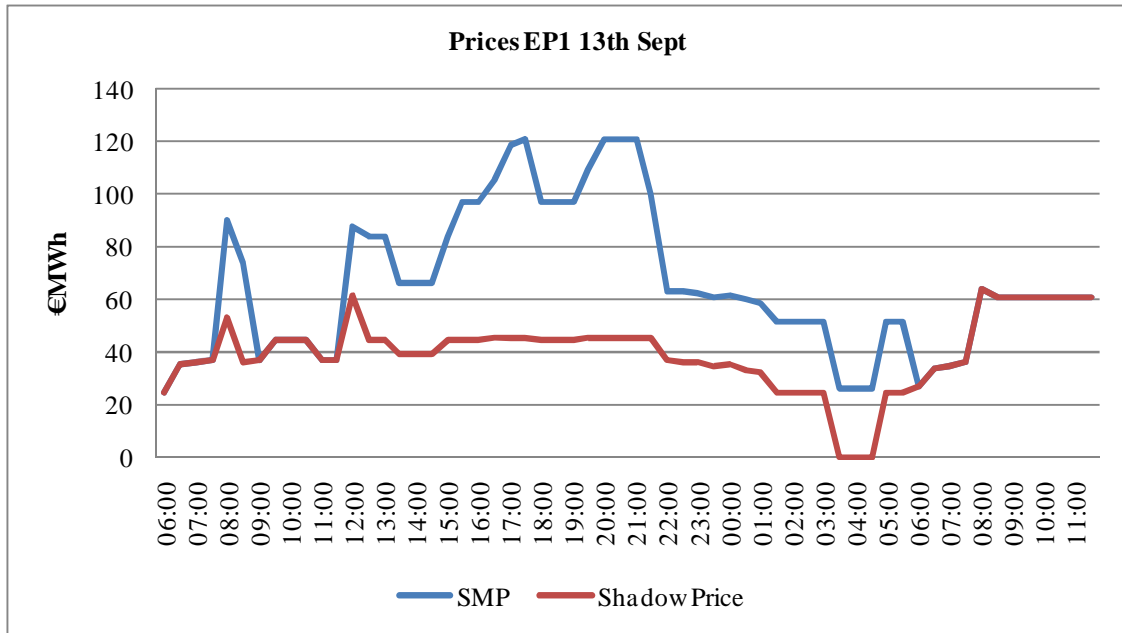
The units setting the price over these three Trading Periods are below. An Interconnector Unit is at its maximum availability at 03.00, therefore cannot set the price. Hydro units are setting the price at 03.00 and 03.30 and the Interconnector sets the price at 04.00.

Fuel Type	03:00	03:30	04:00
Interconnector	24.68	0	10.75
HYDRO	10	7.8	10
HYDRO	13.09	5	5

**Ex Post Indicative (EPI) Runs**

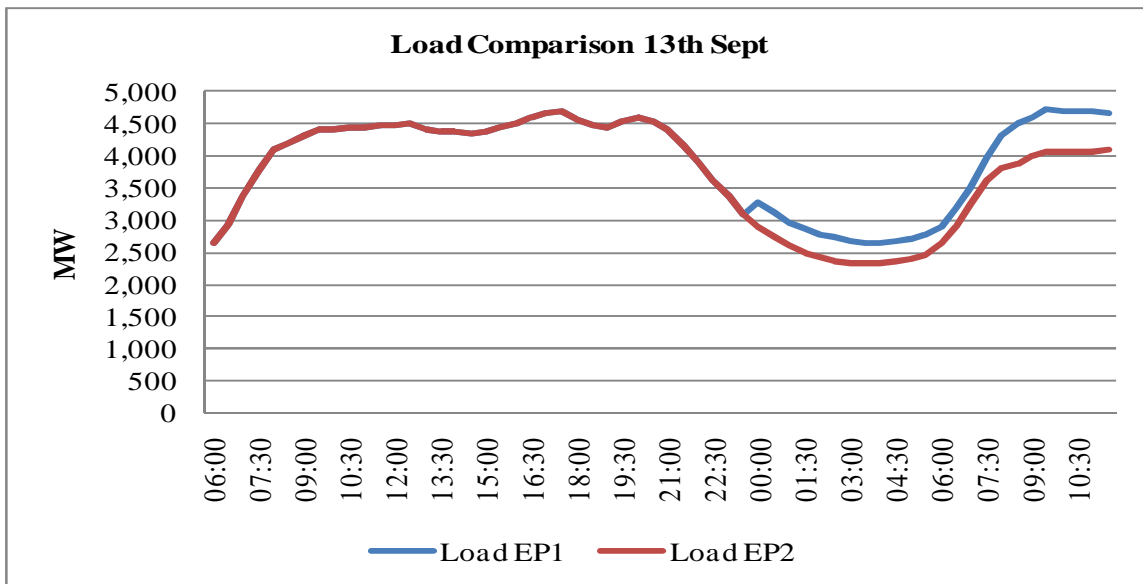
**September 13<sup>th</sup>, 2010**

The Ex Post Indicative run for Trade Date 13<sup>th</sup> of September was run on operational date the 14<sup>th</sup> of September. Events occurred in the LR run that resulted in MIP being run and chosen for publication. This Trade Date had a peak Shadow Price of €64.12 and peak System Marginal Price of €121.34. The zero prices occurred during the night from the Trading Period 03.30 to 04.30 inclusive. The Shadow Price was at zero for the three Trading Periods and the System Marginal Price was at €26.38. There are two periods of Uplift from 08.00 to 9.00 when one unit was brought on for two Trading Periods and then again from 12.00 until the last Trading Period at 05.30.



**Figure 17 – Prices from EP1 13/09/2010**

The system load at these Trading Periods is around 2,650MW and the wind is relatively high at 820MW. This works out as wind generation at 31% of total load. The Interconnector units are not available throughout the night. Hydro appears to be setting the price for the three Trading Periods as all other units are at Minimum Stable Generation.



**Figure 18 – Load Comparison EP1 and EP2**

The fact that forecast data is used in the EP1 schedule and actual data is used in the EP2 has an impact on the schedules. Higher load at the end of the day results in more units being committed to meet this load. This is why the same results are not seen in both runs.

**September 30<sup>th</sup>, 2010**

The Ex Post Indicative run for Trade Date 30th of September was run on operational date the 1st of October. This Trade Date had a peak Shadow Price of €169.37 and peak System Marginal Price of €239.11. The zero prices were at 04.00 and 04.30 inclusive. The Shadow Price was at zero for the two Trading Periods and the System Marginal Price was at €2.05. There is Uplift over the course of the entire trading day.

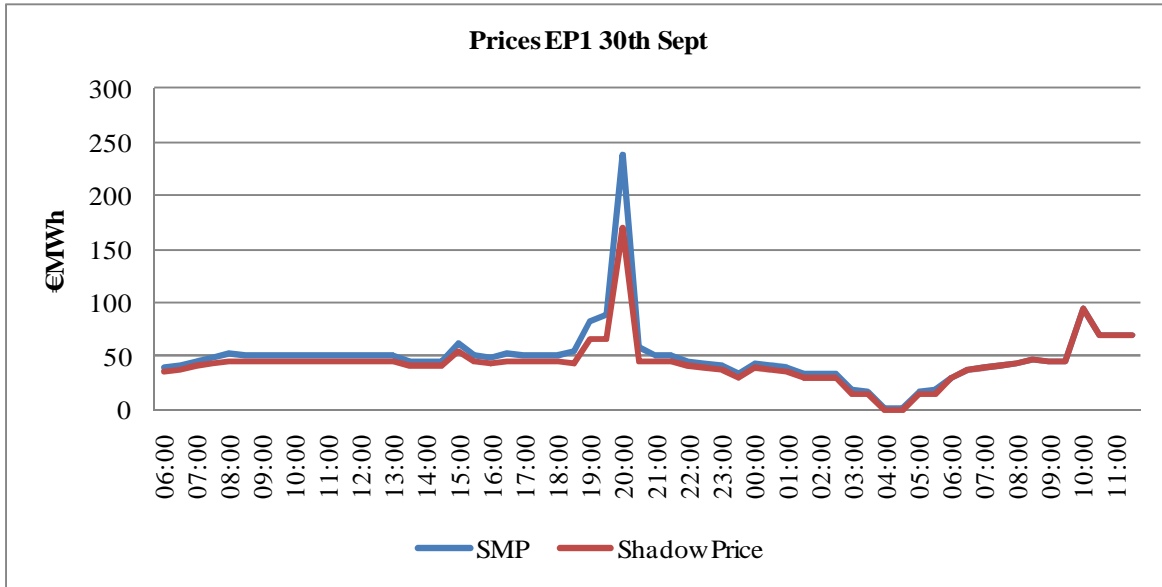


Figure 19 – Prices from EP1 30/09/2010

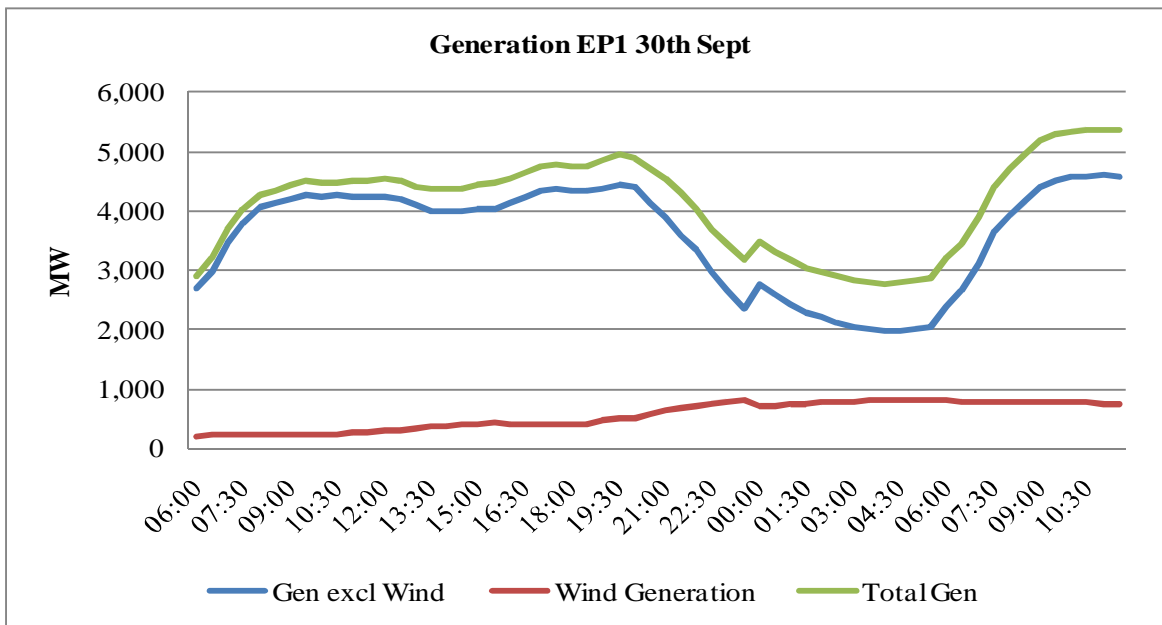


Figure 20 – Generation Breakdown EP1 30/09/2010

Looking at the units setting the price, it is evident that an Interconnector Unit is setting the price at 04.00, due to bidding in a zero price quantity pair. In the next Trading Period this Interconnector Unit is at its maximum availability therefore a Hydro unit is setting the price.

The system load for these two Trading Periods is 2,770MW and the percentage of wind generation versus total demand at these times is 29%. Again comparing the load in the EP1 and

EP2 runs, the forecast data used in EP1 is higher than the actual which would impact scheduling and commitment decisions.

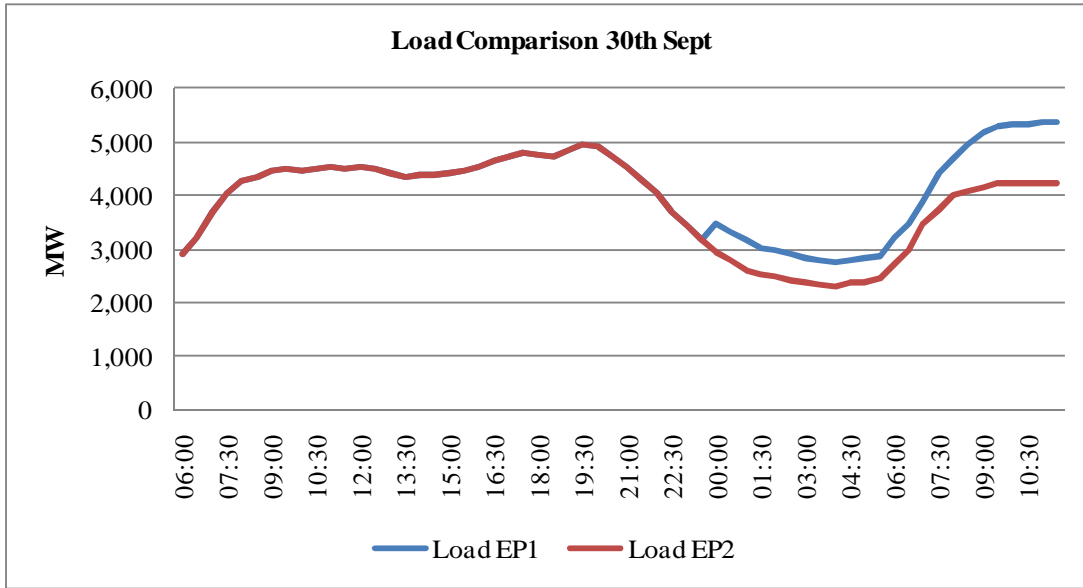


Figure 21 – Load Comparison EP1 and EP2

**October 5<sup>th</sup>, 2010**

The Ex Post Indicative run for Trade Date 5th of October was run on operational date the 6th of October. This Trade Date had a peak Shadow Price of €70.24 and peak System Marginal Price of €117.63. The zero prices were at 03.00, 03.30 and 04.30 inclusive. The Shadow Price was at zero for the three Trading Periods and the System Marginal Price was at €2.92. There is Uplift from 06.30 until the end of the trading day at 05.30.

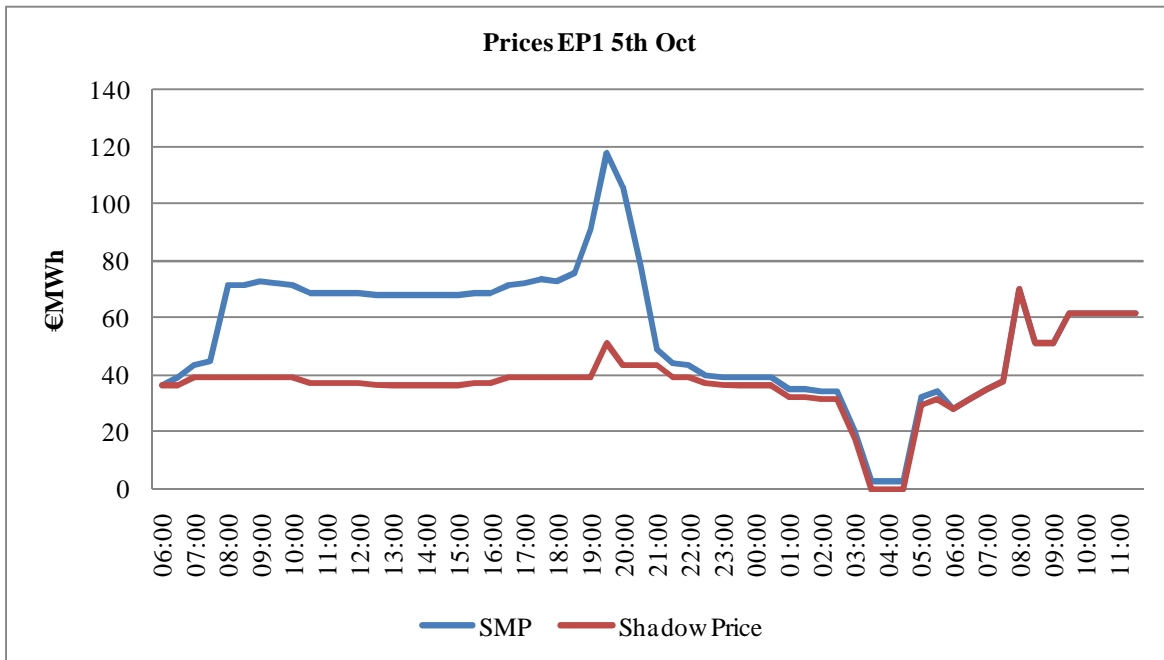


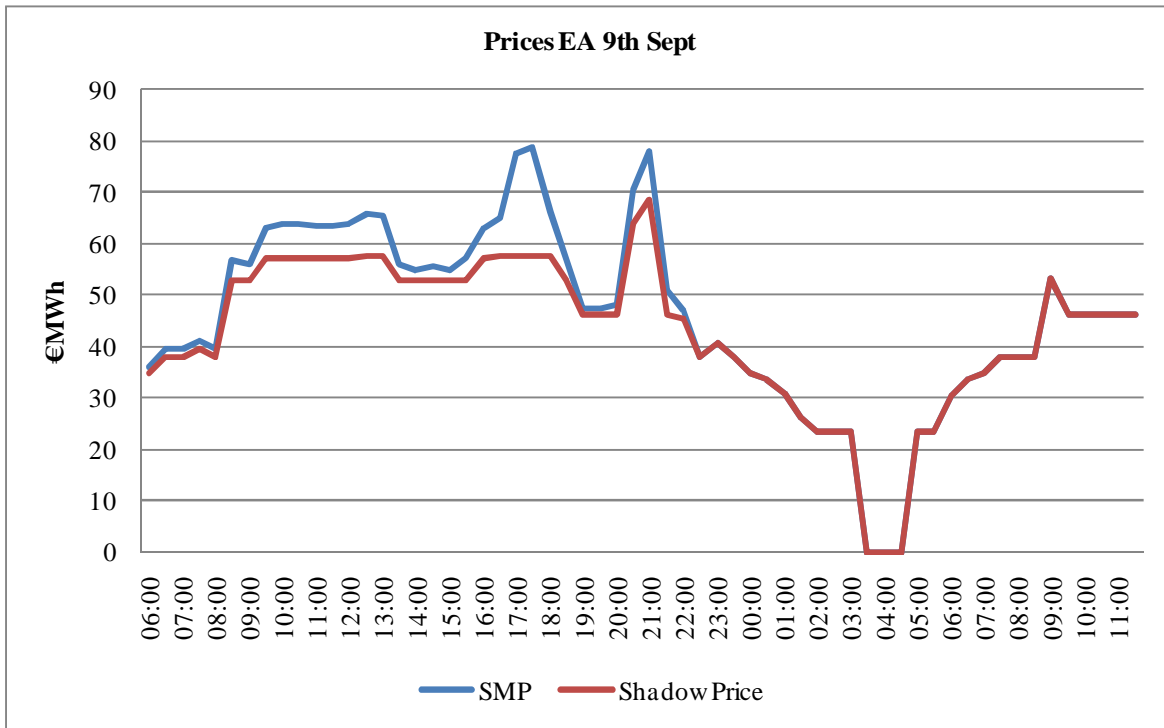
Figure 22 – Prices from EP1 05/10/2010

All Interconnector Units have been scheduled to zero for all three Trading Periods. There are six units at Minimum Stable Generation at this point. There is one Hydro unit setting the price at 03.30, another setting it at 04.00 and the original Hydro unit again at 04.30. The load is approximately 2,500MW and the wind is around 500MW – resulting in a percentage of total generation of 20%.

**Ex Ante (EA) Runs**

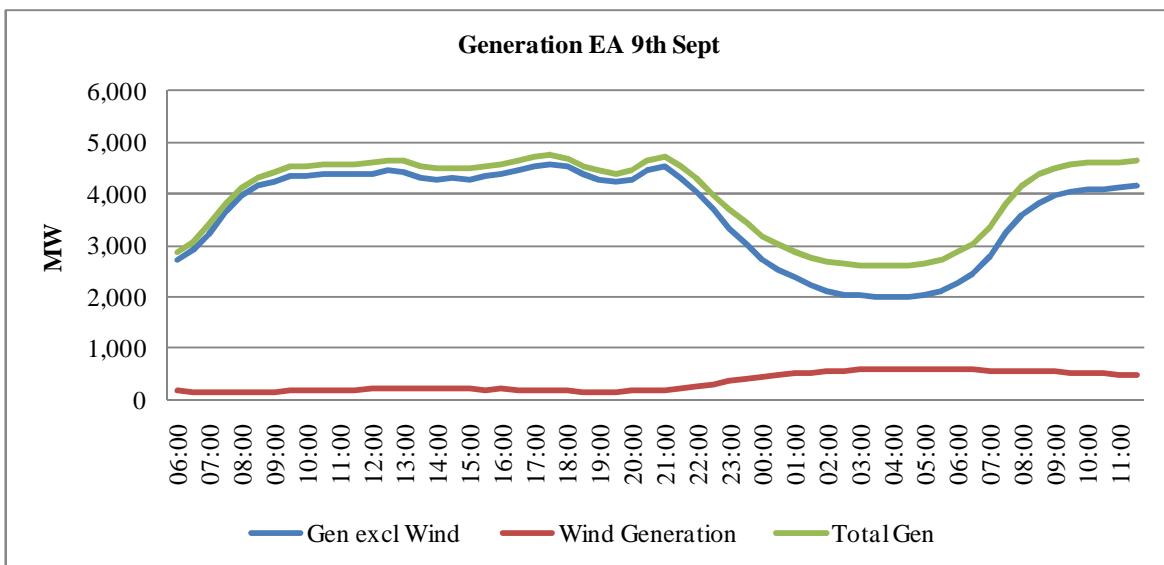
**September 9<sup>th</sup>, 2010**

The Ex Ante for Trade Date the 9th of September was run on operational date the 8th of September 2010. The day appeared to follow the usual trends for this time of the year, peak Shadow Price was €68.68 and peak System Marginal Price was €78.70. There were zero Shadow Prices and System Marginal Price for three Trading Periods from 03.30 to 04.30 inclusive. There is no Uplift on the prices from 22.00 onwards. There were no zero prices in the schedules for the subsequent EP1 or EP2 runs for this Trade Date.



**Figure 23 – Prices from EA 09/09/2010**

Over the periods of zero prices, the forecast load is around 2,600 MW. The wind is approximately 600 MW. Between 03.30 and 04.30 the percentage load being met by wind generation is 23%. It is evident from the graph below that over the course of the trading day the wind rises significantly during the night.



**Figure 24 – Generation Breakdown EA 09/09/2010**

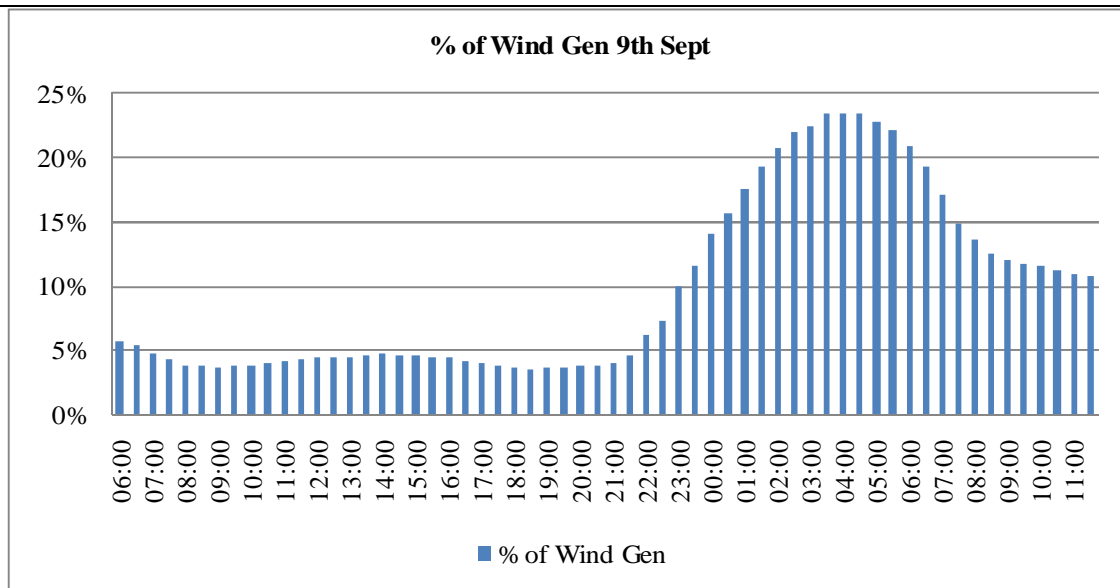


Figure 25 – % of Wind Generation of Total Demand EA 09/09/2010

Looking at the units that were scheduled at the times of zero prices, it has to be noted that the Interconnector units are unavailable at this time. There are 16 units scheduled over the three Trading Periods from 03.30 to 04.30. Of these units three are Hydro units. The remaining 13 units are a mixture of Coal, Gas, Multi and Peat and all are sitting at Minimum Stable Generation. The units that appear to be setting the price are two of the Hydro units (one for the first two Trading Periods and another unit setting the price for the third Trading Period). Up until this point in the schedule these Hydro units were both at their maximum availability. As the wind generation increases, the Multi units are reduced slightly, all at Minimum Stable Generation and the Hydro units are reduced significantly, causing them to be marginal over the three Trading Periods.

FUEL TYPE	03:00	03:30	04:00	04:30	05:00
Total Peat	320	320	320	320	320
Total Pump	0	0	0	0	0
Total Wind	590.73	607.03	609.8	610.63	604.97
Total Multi	1093.75	1067	1067	1067	1109.52
Total Oil	0	0	0	0	0
Total Interconnector	0	0	0	0	0
Total DISTL	0	0	0	0	0
Total Gas	378	378	378	378	378
Total Hydro	43	27.63	29.68	40.38	43
Total Coal	198	198	198	198	198

**Trade Date: 01/10/2010**

### Ex Ante Run

The Ex Ante for Trade Date the 1st of October was run on operational date the 30th of September 2010. This Trade Date had a peak Shadow Price of €46.53 and peak System Marginal Price of €90.92. The jump in Uplift was due to one unit being brought on for one Trading Period (19.30) only. There were zero Shadow Prices and zero System Marginal Price for five Trading Periods from 03.30 to 5.30 inclusive. There is no Uplift on the prices from 21.00 onwards.

There were zero prices in the schedules for the subsequent EP1 or EP2 runs for this Trade Date.

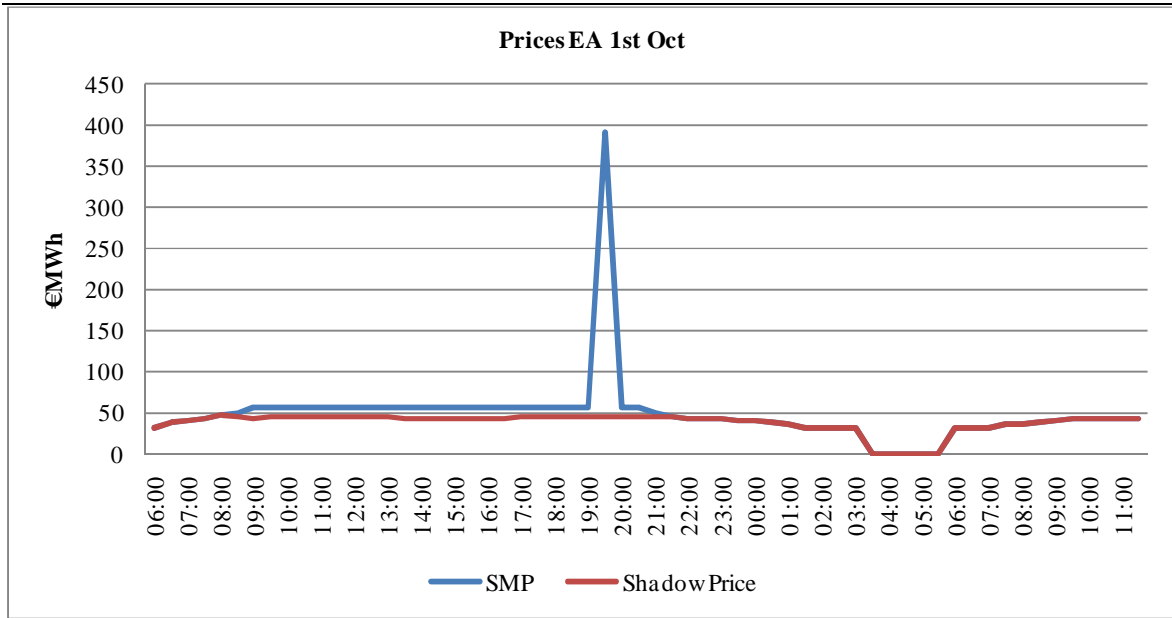


Figure 26 – Prices from EA 01/10/2010

The load is around the 2,600 MW mark for these Trading Periods. The wind generation is ranging from 560 MW to 595 MW, accounting for approximately 22%-23% of the load at this time.

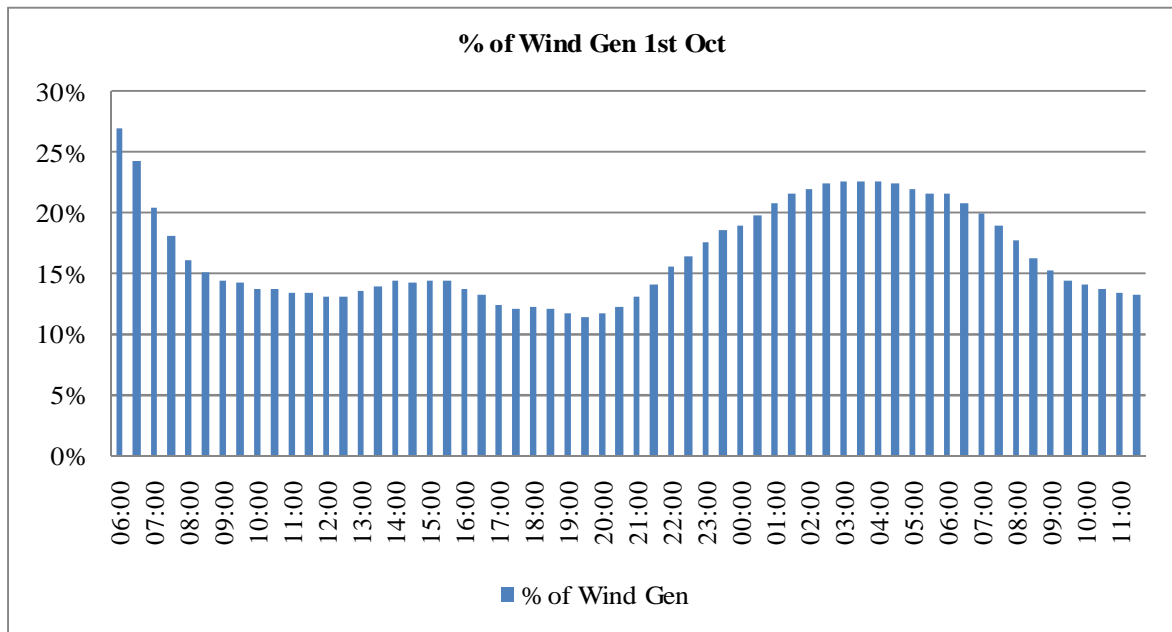


Figure 27 – % of Wind Generation of Total Demand EA 01/10/2010

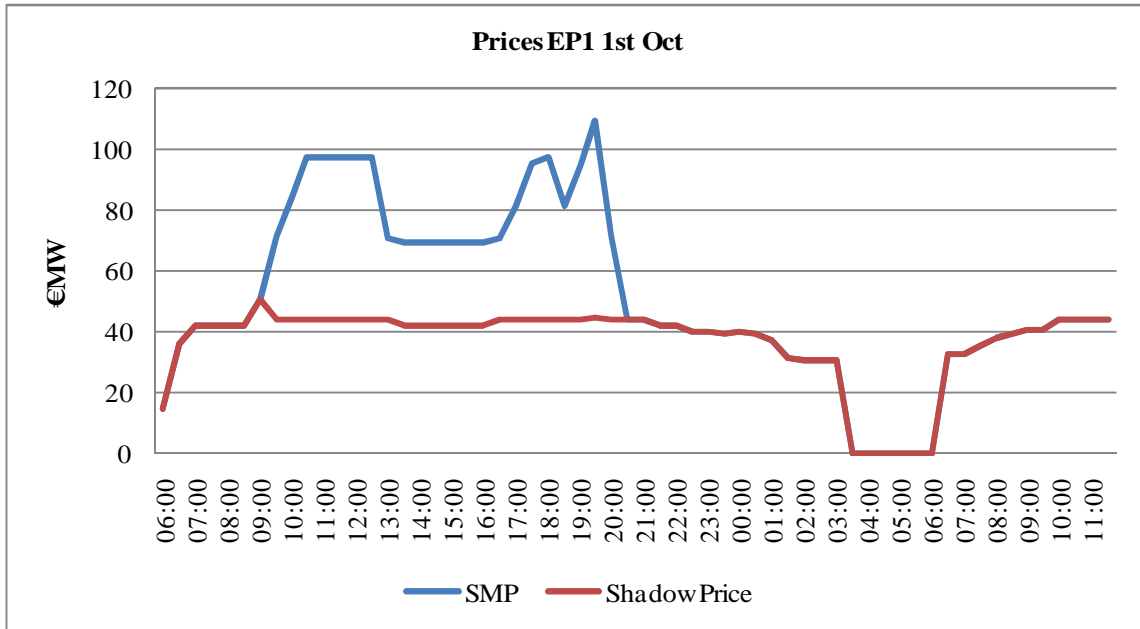
There is one Interconnector unit scheduled from 03.30 to 05.30. There are two Hydro units scheduled, one which is at its maximum availability for all five Trading Periods. There are 13 other units scheduled at their Minimum Stable Generation. The Interconnector unit is at its maximum availability for the first (03.30) and last Trading Period (05.30) and it appears that one of the Hydro units is marginal for both of these Trading Periods. The Interconnector unit is setting the price in the three Trading Periods in between (04.00 to 05.00). This is due to the fact that this Interconnector bid in zero prices for these Trading Periods and was the cheapest unit at this time. It could not set the price at 03.30 and 05.30 as it was generating at its maximum.

UNIT TYPE	03:30	04:00	04:30	05:00	05:30
Interconnector	24.68	21.99	11.43	23.49	24.68
HYDRO	10	4	4	4	10
HYDRO	9.57	4	4	4	18.97



**Ex Post Indicative Run**

The EP1 run for the Trade Date the 1st of October was run on operational date the 30th of September 2010. In this run the Trade Date had a peak Shadow Price of €50.63 and the peak System Marginal Price dropped to €109.67 from the EA run of €390.92. As per the EA, there were zero Shadow Prices and System Marginal Prices for the Trading Periods 03.30 to 05.30.



**Figure 28 – Prices from EP1 01/10/2010**

UNIT TYPE	03:30	04:00	04:30	05:00	05:30
Interconnector	17.24	2.99	0	4.49	24.52
HYDRO	4	4	4	4	6.13
HYDRO	23	23	15.43	23	23

The Interconnector is setting the price for four of the five Trading Periods and one of the Hydro units is setting the price in the Trading Period at 04.30 as the Interconnector is not scheduled. Of the other eight units that are scheduled over these Trading Periods, all eight are at Minimum Stable Generation.

**Ex Post Initial Run**

The EP2 run for the Trade Date the 1st of October was run on operational date the 5th of October 2010. In this run the Trade Date had a peak Shadow Price of €3.04 and the peak System Marginal Price was €6.94. There was only one occurrence of the zero Shadow Price and zero System Marginal Price at 03.30 compared to five occurrences in the EA and EP1. The load was only 2,300MW in the EP2, compared to 2,500MW in the EP1 and 2,600MW in the EA.

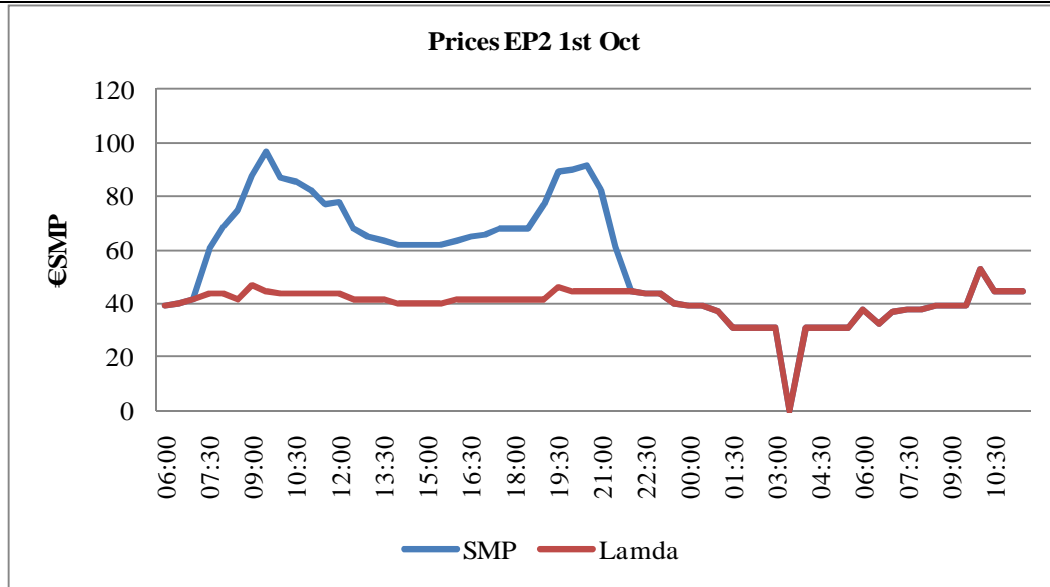


Figure 29 – Prices from EP2 01/10/2010

The wind was approximately 630MW which is 27% of the load at that time, compared to the EP1 which was at 19% and the EA which was at 23% for this Trading Period.

In the EP2 run, the difference in commitment decisions meant that the Interconnector was marginal for the Trading Period (03.30), the Trading Period with the zero price. However, the other periods that were affected in the previous runs had a Shadow Price of €30.94, which was based on a bid by a Multi-fuel unit that was marginal at those times.

UNIT TYPE	03:30
Interconnector	20.86

Trade Date: 02/10/2010

**Ex Ante Run**

The Ex Ante for Trade Date 2nd of October was run on operational date the 1st of October. This Trade Date had a peak Shadow Price of €73.23 and peak System Marginal Price of €13.22. The zero price was seen in the first Trading Period of the day at 06.00, the System Marginal Price has a small amount of Uplift at €1.72.

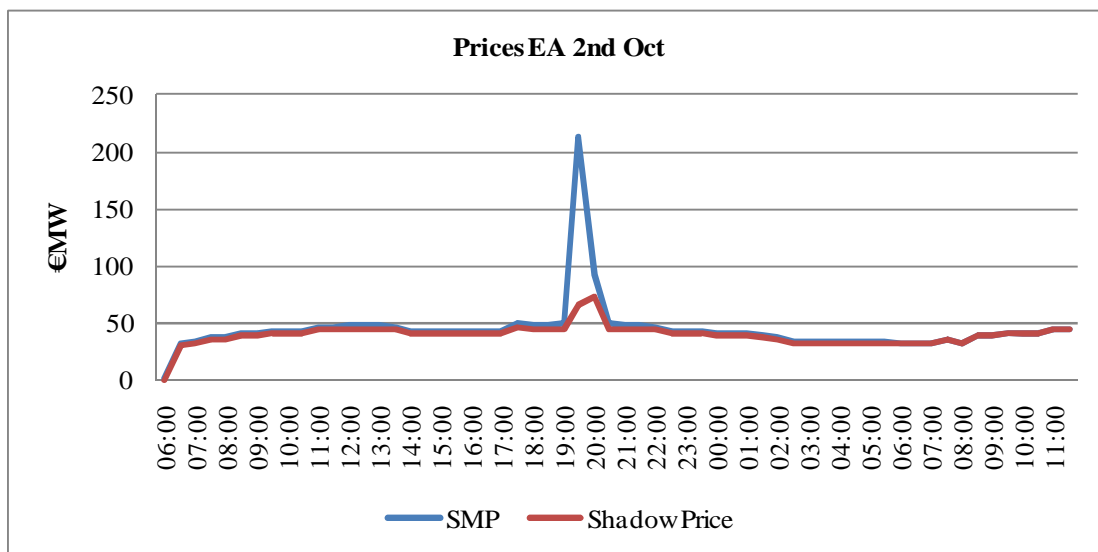


Figure 30 – Prices from EA 02/10/2010

Going back to the EA of the 1st of October, one of the Hydro units set the price for the last Trading Period of the day. This seems to have fed into the Trading Day for October 2nd through

the initial conditions. It appears to be the same Hydro unit that is setting the price at 6am on the 2nd.

**1<sup>st</sup> October 2010 EA Marginal Units**

UNIT TYPE	03:30	04:00	04:30	05:00	05:30
Interconnector	24.68	21.99	11.43	23.49	24.68
HYDRO	10	4	4	4	10
HYDRO	9.57	4	4	4	18.97

**2<sup>nd</sup> October 2010 EA Marginal Units**

UNIT TYPE	06:00
HYDRO	10
HYDRO	15.46

The Interconnector has been scheduled to 0 and the other eight units a mixture of Gas, Coal and Multi fuel units are all at Minimum Stable Generation. The wind at this Trading Period was around 640MW, which is covering approximately 24% of the load at the time. This zero price was not produced in the subsequent EP1 and EP2 runs for this Trade Date.

## Conclusions

It is important to note that all of the occurrences of zero Shadow Prices happened during the hours of 03.30 and 05.30. During the night the demand is low; however, to ensure that sufficient generation is available to meet the system load at all times, the MSP software will schedule the required generation even during the night valley guaranteeing that there is enough generators to ramp up for the morning peak. This is the reason that many of the Price Maker Generator Units are kept at Minimum Stable Generation during this time.

The percentage of wind generation is having a clear impact and will continue to do so as more wind is installed. It is varying from 15% up to 36% of total load during the night valley. The Interconnector units were unavailable on some of these days so that would also have an impact on flexibility within the schedule. Hydro units are frequently setting the price at this time of the night with a bid price of zero.

It should also be noted that the Pumped Storage units were not available during these Trade Dates. This would have reduced the system load during the night valley as the units are not consuming energy while pumping. As the load is reduced, this would have an impact on prices and the number of units scheduled.

The 1<sup>st</sup> and 2<sup>nd</sup> of October were dates when an Interconnector unit had been bidding in at zero, and have for this reason been discounted from the general trends that were observed. There was also a ramping issue (slow single ramp rate) for one unit which may have impacted on one of the Trade Dates; however, this and the Interconnector zero bids are not deemed to have impacted significantly on the findings.

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**Appendix 1 - List of Trade Dates**

<i>Run Type</i>	<i>Solver</i>	<i>Trade Date</i>	<i>Delivery Hour</i>	<i>Delivery Interval</i>	<i>Time</i>	<i>System Marginal Price</i>	<i>Shadow Price</i>
EA	LR	09-Sep-10	4	2	03:30	0	0
			5	1	04:00	0	0
			5	2	04:30	0	0
EA	LR	01-Oct-10	4	2	03:30	0	0
			5	1	04:00	0	0
			5	2	04:30	0	0
			6	1	05:00	0	0
			6	2	05:30	0	0
EA	LR	02-Oct-10	7	1	06:00	1.72	0
EP1	MIP	13-Sep-10	4	2	03:30	26.38	0
			5	1	04:00	26.38	0
			5	2	04:30	26.38	0
EP1	LR	30-Sep-10	5	1	04:00	2.05	0
			5	2	04:30	2.05	0
EP1	LR	01-Oct-10	4	2	03:30	0	0
			5	1	04:00	0	0
			5	2	04:30	0	0
			6	1	05:00	0	0
			6	2	05:30	0	0
EP1	LR	05-Oct-10	4	2	03:30	2.92	0
			5	1	04:00	2.92	0
			5	2	04:30	2.92	0
EP2	MIP	13-Sep-10	4	1	03:00	4.64	0
			4	2	03:30	4.64	0
			5	1	04:00	4.88	0
EP2	LR	19-Sep-10	4	1	03:00	5.84	0
			4	2	03:30	5.84	0
			5	1	04:30	5.84	0
EP2	LR	26-Sep-10	4	2	03:30	0	0
EP2	MIP	30-Sep-10	4	1	03:00	0	0
			4	2	03:30	0	0
			5	1	04:00	0	0
EP2	LR	01-Oct-10	4	2	03:30	0	0