How much money can be made with a gas storage in a difficult market?

Report

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Table of Contents

1 Management summary

1.1 Purpose of the backtest

An increasing number of gas companies, utilities, energy trading companies and other market players have positions in German gas storage facilities. Positions in gas storage assets or contracts involve a considerable investment, while the income is uncertain. As an advisor to the energy industry, KYOS provides fair assessments of the gas storage value.

Apart from making forecasts about the future value, it is insightful to know how much money a storage could have earned in the past. Such a historical analysis is called a backtest. It addresses the question:

"How much money could a trader have earned in the past?"

KYOS has performed this backtest using its proprietary valuation software "KyStore". KyStore is used by a range of market players to determine the value of storage and to optimize trading decisions. The valuation methods are based on spot and forward prices, and 'optimal' trading strategies. These trading strategies can be applied to price scenarios (Monte Carlo), but can also be applied to actual market prices. KyStore contains a separate backtesting module to perform a historical analysis. For an analyst or investor, a backtest also answers a more subtle question:

"Does storage valuation software provide a fair assessment of storage value?"

In an earlier study, "A decade of Rough storage trading results in the UK NBP gas market", we analyzed 12 years of NBP trading performance. We then concluded that a combined spot and forward trading strategy is able generates a value that is in line with the predicted values from our software. The study also revealed the importance of forward hedging.

In this report we take a more detailed look in a particularly difficult year for storage owners. The study assesses the value of two gas storage facilities in the German market: Etzel and Harsefeld. The valuation is market based, assuming that the storage owner trades with the storage asset in the NCG gas market between 1 April 2011 and 1 April 2012. This period is deliberately chosen, as this represents a very difficult storage year with moderate summer-winter spreads. The difference between summer and winter was low in the forward market and eventually close to zero in the spot market.

A fair assessment of the market value of a gas storage not only looks at the intrinsic value, based on current forward prices, but also considers the extrinsic value. The extrinsic value indicates how much extra money could be earned with an active trading strategy, particularly benefiting from volatility in the spot market.

1.2 Lessons learned

The backtest results indicate that even in periods with difficult market conditions, the storages could have earned around 2 €/MWh of extrinsic value on top of the intrinsic value of 3.3 (Etzel) and 4.2 (Harsefeld) €/MWh. The total value of around 6 €/MWh for both storage facilities is the revenue of a trader following

the daily spot trading signals of the KyStore software in combination with delta hedging the exposure in the forward market. These values are in line with (Etzel) or somewhat below (Harsefeld) the assessment of the KYOS storage valuation software made at the beginning of the storage period.

The main lessons learned from this analysis are:

- An active storage trading strategy can generate premium income for a storage owner.
- This premium income requires both spot trading and active hedging in the forward market. Just spot trading is very risky and can lead to a bad performance.
- Even in a seemingly dramatic year for gas storage trading, with virtually no difference between winter and summer prices, a considerable extrinsic premium can be realized.
- Storage valuation software provides a pretty accurate assessment. However, the actual trading value can differ from the projected value due to uncertain market conditions.

2 Backtest results

The Harsefeld storage takes roughly 61 days to fill and 48 days to empty. The Etzel storage is much slower to fill (125 days), but is in 41 days depleted more quickly. For both storage assets we assume injection costs of 0.48 €/MWh. Together with the 0.20 €/MWh bid-ask spread for any spot or forward trade (0.10 €/MWh cost), are these the relevant parameters for the trading strategy backed by the storage assets.

The trading strategy starts on 1 April 2011. On that day, the storage facilities were valued at the prevailing market prices. As can be seen in figure 1, the winter period Q1-2012 traded at 28.92 €/MWh. The summer was trading at 25.15 €/MWh, with the April contract actually being the cheapest at 23.83 €/MWh. Combined, this leads to the intrinsic value of 3.28 €/MWh for Etzel and 3.71 €/MWh for Harsefeld.

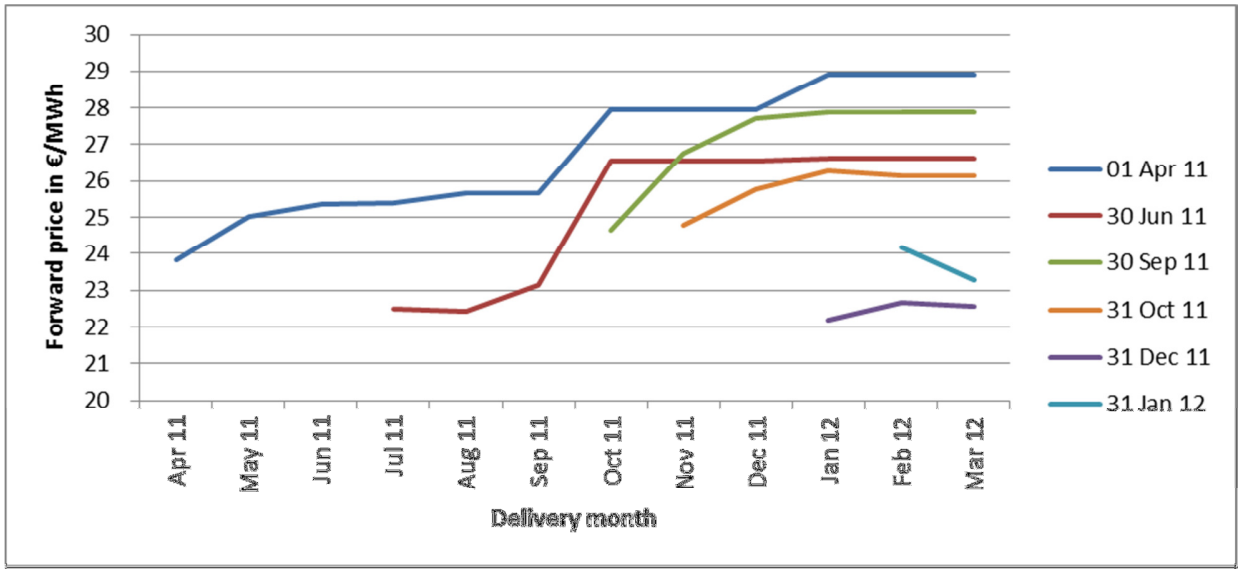

Figure 1: Forward prices on 1 April 2011 (top blue line) and a number of later dates

The total value of the gas storage assets is estimated at 5.71 and 7.20 €/MWh for Etzel and Harsefeld respectively. The estimation is based on the least-squares Monte Carlo approach with 2,000 forward and spot price simulations. The total value represents an extrinsic premium of 74-94% on top of intrinsic value. Harsefeld has a higher intrinsic and extrinsic value because it can inject gas more than two times faster than Etzel (though withdrawal takes slightly longer).

	Etzel	Harsefeld
Days to inject	125	61
Days to withdraw	42	48
Intrinsic value on 1 April 2011	3.28	3.71
Expected value (intr + extr) on 1 April 2011	5.71	7.20
Realized value with spot trading and delta hedging	5.60	5.61

Table 1. Main storage characteristics and main valuation results in €/MWh

These intrinsic and extrinsic values are all assessments made on 1 April 2011. The actual value a trader realizes, can be quite different. However, a trader can limit its exposure by trading in the forward market. That reduces the exposure to movements in the forward curve (see Figure 1).

If a trader would have adjusted its delta hedge at the beginning of each month, the profit by the end of the year was 5.60 and 5.61 €/MWh for Etzel and Harsefeld respectively. For Etzel this is almost equal to the original assessment. For Harsefeld, the realized value is 1.60 €/MWh lower than expected, though still clearly above the intrinsic value of 3.71 €/MWh.

Note that forward hedging is indispensable, because over this time window the Q1-2012 price came down by 4-5 €/MWh: without a forward hedge, a spot trader would have made less than 2.50 €/MWh for both storage assets.

3 Trading strategy explained

A trader would like to secure at least part of the expected storage value. At the same time, he would like to keep flexibility to benefit from variations in the spot market. In our strategy, this leads to the following transactions, taking Etzel as an example, and using a storage bundle with 50,000 MWh capacity.

3.1 Step 1: initial delta hedge

First, the trader implements the delta hedge for the months starting in May. This involves amongst others buying 8,233 MWh of the May contract, and selling 33,041 MWh of the Q1-2012 contract (see figure 2). Note that alternative strategies, e.g. with more frequent adjustments of the forward positions, are possible as well.

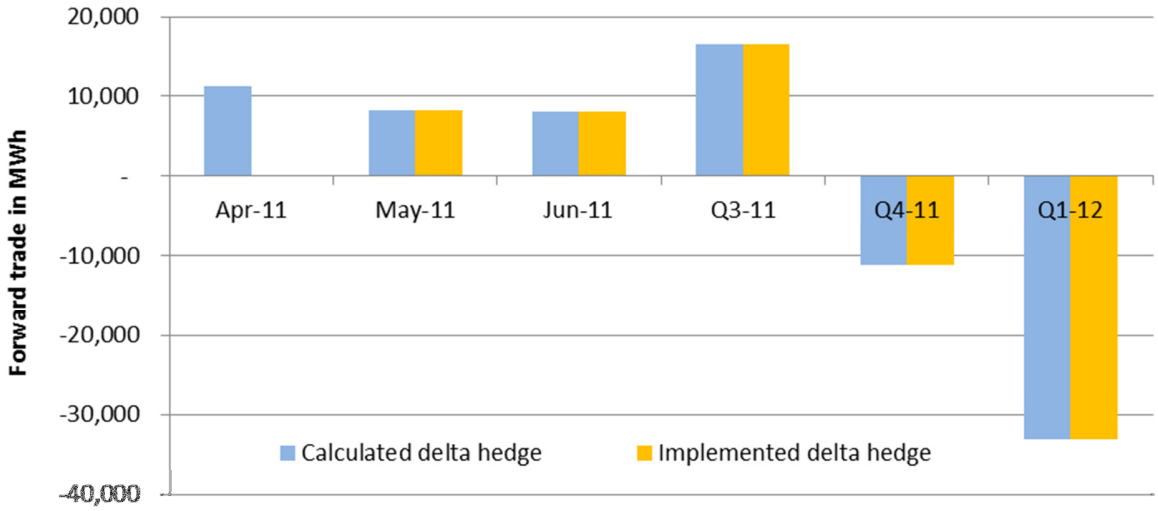

Figure 2: Calculated versus implemented delta hedge for Etzel on 1 April 2011

3.2 Step 2: trade in the spot market

Starting on 1 April, a trader will act in the spot market according to the spot signals of the storage model. For this purpose, the spot model is run on each day using the prevailing spot and forward prices. Following the trade signals, the trader will buy 400 MWh on 29 days in April, a total of 11,600 MWh (Figure 3). The average transaction price is 23.01 €/MWh. The only day that no gas is injected, the market price is 24 €/MWh, so a relatively expensive day. This is a good example of the 'cherry-picking' in the spot trading strategy, i.e. finding the best days to buy and the best days to sell.

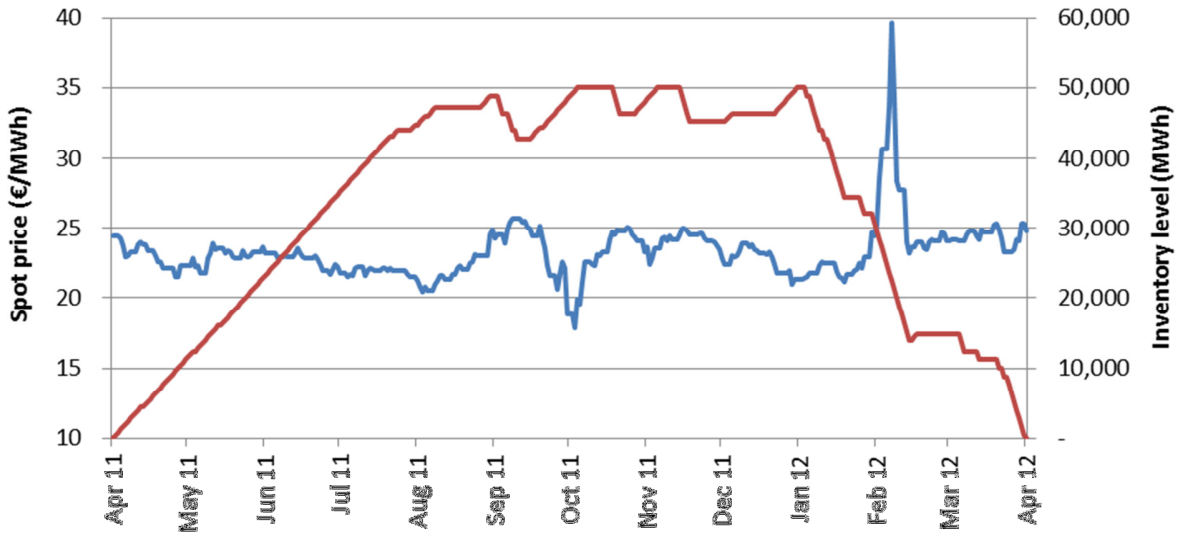

Figure 3: Inventory level development for Etzel, together with NCG spot prices

3.3 Step 3: rebalance forward positions at the beginning of a new month

On 1 May, a new valuation is performed, using 11,600 MWh as the start volume. The valuation leads to new delta hedges. For example, the forward position in the June-2012 contract was 8,169 MWh, while the delta has now gone up to 9,529 MWh. Therefore, the trader will buy 1,360 MWh extra in the market. The reason for buying more from the June contract, is that it has become relatively inexpensive compared to the July – December prices: the spread was 1.41 and increased to 2.42 €/MWh. Likewise, the trader buys and sells the other forward contracts. More precisely, he sells July-December and buys back some of the Q1-2012 forward, which has gone down in relative terms. Overall, the delta hedge lets the trader buy (extra) of contracts that have gone down, and sell of contracts that have gone up.

In our strategy, the trader also completely sells off the May position. This gives the trader an open position for May, such that he can trade in the spot market without having double positions (Figure 4).

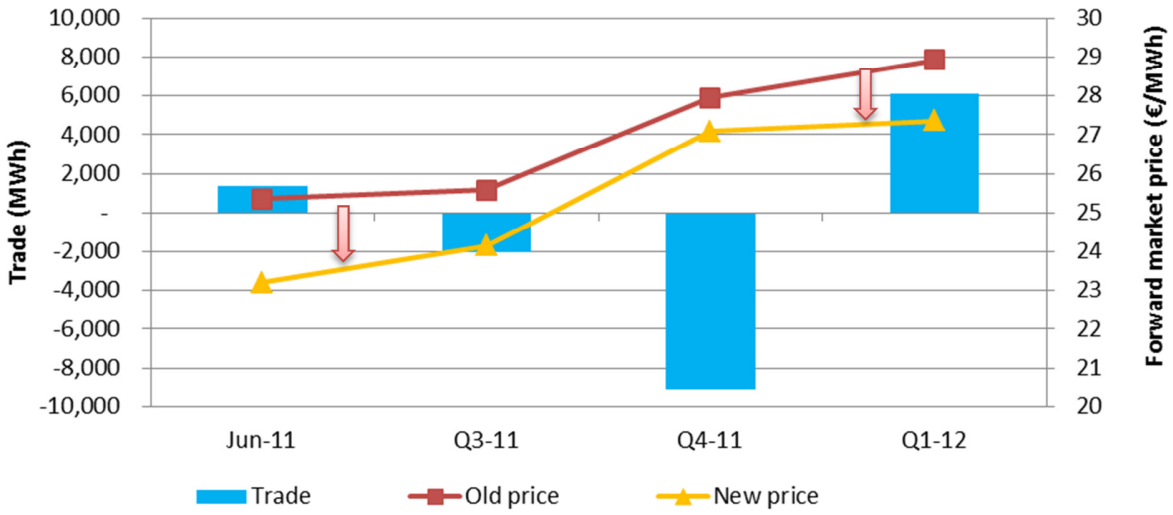

Figure 4: Forward trades on 1 May 2011 for Etzel in response to a changing forward curve

This process (step 1-3) is repeated at the beginning of each new month.

4 Design of the backtest

4.1 Projected value

At the beginning of the storage period, 1 April 2011, the model calculates the expected value of the storage for the upcoming year. This value is determined with KyStore, based on the NCG forward curve at that time, and volatility information for the coming year. We distinguish between 2 main values:

- ***Intrinsic value.*** This is the maximum value that can be secured in the forward market on the current date.
- ***Spot value.*** This is the value that you expect to realize when trading in the spot market. A storage owner can benefit from the day to day movements of prices in the spot market: sell gas from storage when prices are temporarily high, and inject gas back into the storage when prices are relatively low. The optimal strategy across a range of price scenarios can be calculated using the least-squares Monte Carlo approach (see e.g. Boogert and De Jong, Journal of Derivatives, 2008; Boogert and De Jong, Journal of Energy Markets, 2012). This method is implemented in KyStore and will always give a higher value than the intrinsic, due to the volatility and mean-reversion in spot prices. The difference with the intrinsic value is called the extrinsic value.

4.2 Realized value

During the 1-year period, the owner has to decide day by day what is optimal to do: inject, withdraw or do nothing. For this purpose, KyStore recalculates every day the optimal action based on the prevailing forward and spot prices. On average, one would expect that the realized value equals the projected value of the spot strategy. However, when only trading in the spot market, a trader can be either very lucky or unlucky. For example, when the storage is full at the beginning of the winter, and then all prices go down (due to warm weather, oil market movements, etc), he may actually face a loss. To reduce the price exposure and show a more stable trading performance, it is common practice, and strongly advisable, to hedge the exposure in the forward market.

In the backtest the trader is assumed to delta hedge. At the beginning of the year, the model calculates the delta sensitivities and the trader implements the corresponding hedges. Then, at the beginning of each month, the hedge is recalculated and positions are adjusted. However, we assume the front-month is always unhedged in order to avoid double positions in forward and spot. Trading costs of 0.10 €/MWh are assumed for any spot or forward transactions. This corresponds with a 0.20 €/MWh bid-ask spread. Furthermore, we assume any trade size can be executed in the market.

4.3 Market dynamics

Gas market prices vary over time. Part of the movements are somewhat predictable seasonal patterns, while other movements are harder to predict. Within the storage valuation model KyStore we employ a 3-

factor stochastic model for simulating the gas prices, which contains four parameters to be estimated from historical data:

- Volatility of the spot prices (spot vol)
- Mean-reversion rate of spot to month-ahead forward prices (MR)
- Forward price volatility derived from 1-year-ahead forward contracts (LT vol)
- Volatility in the winter-summer forward spread (WS vol).

Generally speaking, high levels of mean-reversion and spot volatility lead to higher storage values, especially for fast-churn storage assets. The long-term has almost no impact on storage value, because it does not create differences *between* prices on the forward curve (which is the primary value for a storage). The seasonal forward volatility has a small impact because the gas storage facilities primarily benefit from short-term (spot movements) rather than long-term variations in winter-summer spreads. Parameters have been estimated on NCG gas data using the period 1 April 2011 to 1 April 2012. Figure 5 contains the spot and front-month forward prices on which the estimation is based. Over this period, the spot volatility equals 43% and the mean-reversion rate of spot prices to the front-month prices 9%.

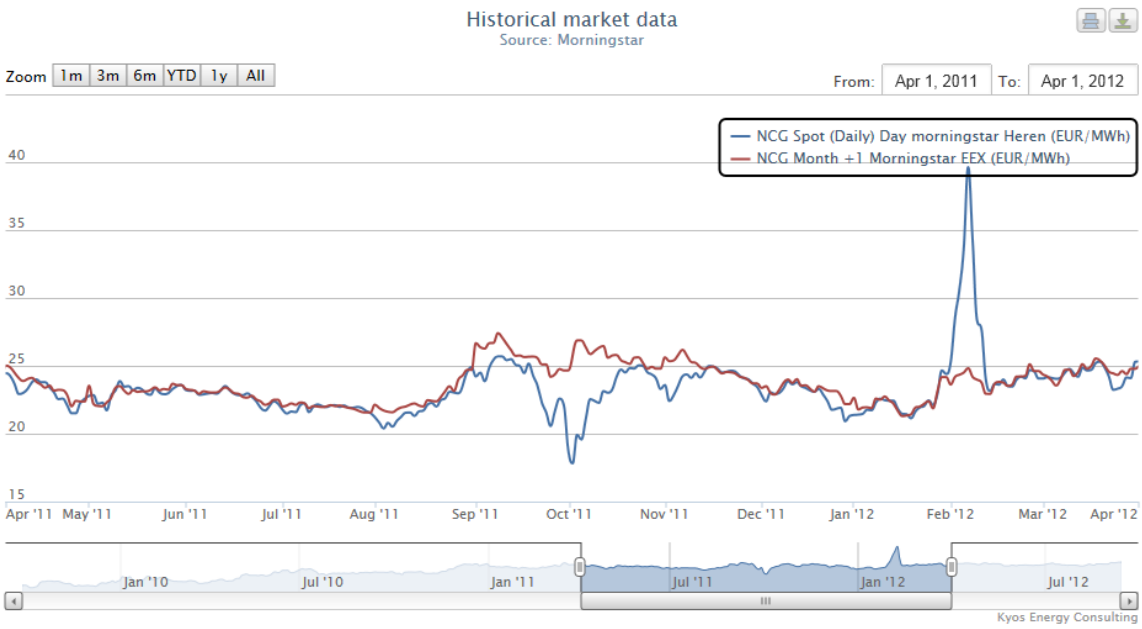

Figure 5: Price development in the NCG market. Source: Morningstar data in KYOS Analytical Platform.

5 Appendix – Detailed transaction overview of the delta hedge of Etzel

Forward prices

		Trade date											
Begin date	**End date**	**01 Apr 11**	**30 Apr 11**	**31 May 11**	**30 Jun 11**	**31 Jul 11**	**31 Aug 11**	**30 Sep 11**	**31 Oct 11**	**30 Nov 11**	**31 Dec 11**	**31 Jan 12**	**29 Feb 12**
01/04/2011	30/04/2011	23.83											
01/05/2011	31/05/2011	25.02	22.37										
01/06/2011	30/06/2011	25.35	23.20	23.58									
01/07/2011	31/07/2011	25.40	23.84	23.74	22.50								
01/08/2011	31/08/2011	25.66	24.31	24.33	22.43	21.56							
01/09/2011	30/09/2011	25.66	24.31	24.35	23.15	22.42	24.70						
01/10/2011	31/10/2011	27.95	27.08	27.70	26.54	24.50	27.28	24.66					
01/11/2011	30/11/2011	27.95	27.08	27.70	26.54	26.78	29.14	26.75	24.79				
01/12/2011	31/12/2011	27.95	27.08	27.70	26.54	26.78	28.56	27.70	25.76	23.70			
01/01/2012	31/01/2012	28.92	27.36	28.26	26.64	28.05	29.20	27.90	26.28	23.84	22.18		
01/02/2012	29/02/2012	28.92	27.36	28.26	26.64	28.05	29.20	27.90	26.14	23.92	22.65	24.17	
01/03/2012	31/03/2012	28.92	27.36	28.26	26.64	28.05	29.20	27.90	26.14	23.83	22.55	23.28	24.62

Dynamic delta hedges

		Trade date											
Begin date	End date	**31/03/2011**	**30/04/2011**	**31/05/2011**	**30/06/2011**	**31/07/2011**	**31/08/2011**	**30/09/2011**	**31/10/2011**	**30/11/2011**	**31/12/2011**	**31/01/2012**	**29/02/2012**
01/04/2011	30/04/2011	-	-	-	-	-	-	-	-	-	-	-	-
01/05/2011	31/05/2011	8,233	- 8,233	-	-	-	-	-	-	-	-	-	-
01/06/2011	30/06/2011	8,169	1,360	- 9,529	-	-	-	-	-	-	-	-	-
01/07/2011	31/07/2011	5,567	1,562	1,271	- 8,400	-	-	-	-	-	-	-	-
01/08/2011	31/08/2011	5,567	- 1,832	- 353	3,076	- 6,457	-	-	-	-	-	-	-
01/09/2011	30/09/2011	5,387	- 1,773	2,031	- 2,133	- 2,000	- 1,513	-	-	-	-	-	-
01/10/2011	31/10/2011	- 3,754	- 3,088	460	- 1,704	7,993	- 2,550	2,643	-	-	-	-	-
01/11/2011	30/11/2011	- 3,633	- 2,988	445	- 1,649	3,368	- 7,959	7,469	4,947	-	-	-	-
01/12/2011	31/12/2011	- 3,754	- 3,088	460	- 1,704	3,480	2,717	- 7,056	1,375	7,569	-	-	-
01/01/2012	31/01/2012	- 11,256	2,085	- 1,043	1,455	- 5,000	2,585	- 879	- 1,097	3,367	9,783	-	-
01/02/2012	29/02/2012	- 10,530	1,950	- 976	1,361	- 4,677	2,418	- 822	- 817	790	- 7,426	18,729	-
01/03/2012	31/03/2012	- 11,256	2,085	- 1,043	1,455	- 5,000	2,585	- 879	- 874	- 1,857	- 3,945	10,786	7,942

Cash flow delta

		Trade date											
Begin date	**End date**	**01/04/2011**	**30/04/2011**	**31/05/2011**	**30/06/2011**	**31/07/2011**	**31/08/2011**	**30/09/2011**	**31/10/2011**	**30/11/2011**	**31/12/2011**	**31/01/2012**	**29/02/2012**
01/04/2011	30/04/2011	-	-	-	-	-	-	-	-	-	-	-	-
01/05/2011	31/05/2011	- 206,808	183,344	-	-	-	-	-	-	-	-	-	-
01/06/2011	30/06/2011	- 207,891	- 31,688	223,732	-	-	-	-	-	-	-	-	-
01/07/2011	31/07/2011	- 141,948	- 37,399	- 30,310	188,164	-	-	-	-	-	-	-	-
01/08/2011	31/08/2011	- 143,395	44,349	8,561	- 69,298	138,572	-	-	-	-	-	-	-
01/09/2011	30/09/2011	- 138,770	42,919	- 49,666	49,161	44,644	37,210	-	-	-	-	-	-
01/10/2011	31/10/2011	104,550	83,311	- 12,792	45,057	- 196,635	69,314	- 65,436	-	-	-	-	-
01/11/2011	30/11/2011	101,177	80,623	- 12,379	43,604	- 90,533	231,135	- 200,548	- 123,131	-	-	-	-
01/12/2011	31/12/2011	104,550	83,311	- 12,792	45,057	- 93,550	- 77,863	194,746	- 35,568	- 180,152	-	-	-
01/01/2012	31/01/2012	324,390	- 57,251	29,379	- 38,909	139,744	- 75,744	24,428	28,730	- 80,596	- 217,970	-	-
01/02/2012	29/02/2012	303,462	- 53,558	27,484	- 36,399	130,728	- 70,858	22,852	21,285	- 18,967	167,461	- 454,548	-
01/03/2012	31/03/2012	324,390	- 57,251	29,379	- 38,909	139,744	- 75,744	24,428	22,753	44,058	88,570	- 252,181	- 196,321