Instituto Superior de Economia e Gestão
UNIVERSIDADE TÉCNICA DE LISBOA
DESDE 1911

MASTER

FINANCE

MASTER´S FINAL WORK

INTERNSHIP REPORT

RISK HEDGING OF PRODUCT IMPORT IN THE OIL INDUSTRY: THE CASE OF CURRENCY RISK

RAQUEL DE SOUSA PEREIRA PINHO FIGUEIRA

DECEMBER – 2012

Instituto Superior de Economia e Gestão
UNIVERSIDADE TÉCNICA DE LISBOA
DESDE 1911

MASTER

FINANCE

MASTER´S FINAL WORK

INTERNSHIP REPORT

RISK HEDGING OF PRODUCT IMPORT IN THE OIL INDUSTRY: THE CASE OF CURRENCY RISK

RAQUEL DE SOUSA PEREIRA PINHO FIGUEIRA

SUPERVISION:

PROFESSOR RAQUEL M. GASPAR
LUÍS MEDEIROS

DECEMBER – 2012

Abstract

In this report we focus on an hedging case and on a particular contract used by OZ Energia for Diesel import, through the identification of hedging solutions using different financial instruments.

A case-study approach is used as method, given that the report is the result of an event within a real business context, with an extensive presentation of market, interest rate, credit and currency risks.

The analysis is based on the investment of 2011. The choice of time period is justified by the Diesel import made by OZ Energia over the course of that year, which was not fully hedged. Thus, this work seeks to provide answers and solutions to a perfect hedge on the firm's position.

Different strategies are studied and scenarios are simulated based on data for the period between Dec-08 and Jun-12 under two different angles – cost and revenue. The definition of the best strategy is done by comparing them for both perspectives. Stress tests are also performed in order to assess the results.

Keywords: Diesel Import, Risk Hedging, Market Risk, Interest Rate Risk, Credit Risk, Currency Risk, Asian Option, Swap.

Resumo

Este relatório foca um caso de cobertura de risco e um contrato específico da OZ Energia para importação de Diesel, com a exposição de propostas de cobertura desses riscos através de instrumentos financeiros.

Como metodologia é utilizada uma abordagem de case-study, com o enfoque na análise de um evento de negócio real, com uma extensa apresentação dos riscos de mercado, de taxa de juro, de crédito e cambial.

A análise é baseada no investimento realizado em 2011. A escolha do período de tempo é justificada pela importação de combustível por parte da empresa nesse ano, o qual não foi totalmente coberto. Assim, este trabalho procura dar respostas e soluções para um hedge perfeito da posição da empresa.

Diferentes estratégias são estudadas e cenários simulados com base em dados do período entre Dez-08 e Jun-12 sob dois diferentes ângulos – custo e receita. A definição da melhor estratégia é feita através da comparação para ambas as perspectivas. São ainda realizados *stress tests* por forma a avaliar os resultados.

Palavras-Chave: Importação de Diesel, Cobertura de Risco, Risco de Mercado, Risco de Taxa de Juro, Risco de Crédito, Risco Cambial, Opção Asiática, *Swap*.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

This Internship Report presents the results of one particular study developed during an internship at OZ Energia.

OZ Energia was created in 2009 when Gestmin SGPS (a familiar holding) acquired the Esso's LPG and Jet former businesses from Galp Energia. Gestmin SGPS board is composed by Mr. Manuel Champalimaud, among other shareholders.

Apart from OZ Energia, the Group holds *Gestmin Serviços, Oni Communications, Silos de Leixões, São Barão, SoGestão, SoGolfe, DaPraia*, having a direct participation in REN (PSI-20).

For 2012, OZ Energia expects a total revenue of 140 million Euros. The firm has its headquarters in the center of Lisbon, where the office is shared with *Gestmin Serviços,* and operates in three different areas – LGP, Fuels and Jet. In the client portfolio we can find large resellers, whereas on the supplier list large companies both national and international can be highlighted.

OZ Energia Gas' core business is LPG commercialization. This includes the bottle and bulk businesses, both propane and butane. In the LPG business, the company operates in the filling, storage and distribution lines, covering two segments – bottles (butane and propane) and bulk. It also supplies gas to urbanizations, housing and collective buildings.

OZ Energia Fuels commercializes several products, such as liquid fuels (gasoline, diesel and heating oil) to supply gas stations, industries, agriculture and services.

OZ Energia Jet provides aviation fuel at the Lisbon, Oporto and Faro airports.

The internship took place between November 16, 2011 and May 15, 2012 and despite the study here presented, it involved several other tasks, such as having direct contact with the operations and accounting and starting the credit policy of OZ Energia Fuels. The company wanted to create a mechanism to protect the possible failures in clients' receivables, thus several restrictions were implemented to set a minimal exposure to the credit risk.

Throughout the internship different assignments were carried, as the estimation of receivables, necessary funding and payments of OZ Energia and Gestmin Serviços for the following week; construction of financial statements relating to budget and cash flow analysis, economic viability analysis of projects and estimation of interests and insurance premiums.

In this report we focus on an hedging case and on a particular contract used by OZ Energia for Diesel import. We study alternative hedging strategies to create a more accurate model, capable of offsetting potential losses of the investment and generate more certainty about the firm's future cash flow.

The study explores several views on risk hedging using different financial instruments, more specifically derivatives traded in the capital market, while learning about hedging positions and their effectiveness as well.

Some of the risks involved can be identified from the start, such as market, interest rate, credit and currency risks. After an extensive review of these risks, an analysis on the potential hedging positions is conducted, along with the financial instruments that can support these strategies for a sample period of from Dec 08 to Jun 12.

The definition of the best hedging strategy is presented from two different angles – cost and revenue perspectives. First, the strategies outcomes are compared through their overall costs, including the specific financial costs of each operation, depending on the instrument applied.

After that, the margin results are analyzed through the simulation of the previous strategies, with the purpose to determine whether the exchange rate variations affect the margin of the investment, by conducting stress tests.

This report is organized as follows. Chapter 2 presents a business analysis, where a market overview, the contract specifications and the investment impact on the firm's cash-flow are highlighted. Chapter 3 describes the data set. We run statistical and performance analysis, focusing on Diesel and EUR-USD exchange rate. In Chapter 4 the study of hedging strategies takes place for the risks of the investment. However, the currency risk is our main target. From subsections 4.4.1 to 4.4.4, each strategy is described in detail. In subsection 4.4.5 strategies are compared based on overall costs, while subsection 4.4.7 considers an analysis based on revenue. In subsection 4.4.6 stress tests are considered, to give an assessment of the results. Chapter 5 concludes the report and discusses future research.

2. BUSINESS ANALYSIS

2.1. Market Overview

According to the paper "Oil & Gas Security - Emergency Response of IEA Countries Portugal 2011" published by the International Energy Agency (IEA) on August 8, 2011, oil represented 50% of Portugal's total primary energy supply (TPES) in 2009. With no confirmed reserves and no internal production of oil, Portugal is totally dependent on imports, strongly relying on foreign supply (Table A), such as OPEC and OECD members.

As stated in that publication, Portugal imported two-thirds of crude from eight OPEC countries in 2009. 70% of refined products were supplied by OECD European members.

Oil has been the dominant primary energy source in Portugal over the past 4 decades, though its share in the TPES has decreased from 74% in 1973 to 50% in 2009 (Figure A).

According to that report, the Portuguese Administration predicts a gradual oil decline to 46% by 2020, which suggests the decrease of its influence, though it is expected that its importance will persist, remaining as the country's major energy source.

The oil market has 4 big players operating in Portugal, namely Galp, BP, Repsol and Cepsa/Total. Galp is the only relevant national firm operating in this market.

Supermarkets have recently entered in this business, selling gasoline and diesel at lower prices, which is a real advantage comparing to other competitors, owning about 20% of the market share in 2010 (Table B).

Thus, this market is structured in the following way: Galp is the company with the highest market share (between 30% and 35% in the first half of 2010), followed by BP and Repsol (both with 15%-20%), Cepsa and Total together have between 5% and 10%, according to *Competition Authority*. OZ Energia still holds a very small market share, not appearing on the reports produced by that Institution.

As mentioned in the first document of the informative series "The price of fuel - the truth of the numbers" published by APETRO[1] on March 18, 2011, three parties formed the sale price

[1] Portuguese Association of Oil Companies.

of Gasoline 95 in 2011: the cost of Storage, Distribution and Commercialization (9%), Quote (35%) and Taxes (56%), (Figure B).

The quote is based on the average price in the market during the previous week, constituting the cost of the product in refinery, plus costs of freight and insurance. It should be noted that this price is not directly related to the price of an oil barrel, but with the price of refined products in the international markets.

There were three parties that formed the sale price of Diesel in 2011: the cost of Storage, Distribution and Commercialization (10%), Biodiesel Incorporation (3%), Quote (42%), and Taxes (45%), according to the second document of the informative series "The price of fuel - the truth of the numbers" published by APETRO on April 1, 2011.

The Diesel traded in Portugal incorporated 7% biofuels by volume. The biodiesel incorporation relates to the extra cost of biodiesel, which failed to qualify for partial exception by the ISP[2] since January 1, 2011, as expressed on *Ordinance 41/2011.*

The major difference between the gasoline 95 and diesel prices is the fiscal component, ISP being lower in the second case (37% versus 26% - Figure C).

The different prices found in Portugal and Spain in 2011 can be explained by the fiscal component. Those asymmetries were more accentuated since early 2011 due to an increase of the VAT to 23% in Portugal, whereas in Spain remained 18%; and also due to the end of the exception of ISP in Portugal, from which biodiesel benefited, according to the third document of the informative series "The price of fuel - the truth of the numbers" produced by APETRO on April 4, 2011. As shown on Figures D and E, the tax burden in Portugal is 44,6% for diesel and 56,4% for gasoline, while in Spain taxes represent 42,1% of the diesel price and 48,5% for gasoline.

There are a few components considered in the process of oil product price formation. According to the fifth document of the informative series "The price of fuel - the truth of the numbers" published by APETRO on April 28, 2011, the first element is the variation in the cost of refined products[3] before taxes, both in its rise and its decline. This is clearly visible on Figures F and G, where we can see a parallelism between both lines.

[2] Tax on Oil Products ("Imposto sobre Produtos Petrolíferos" – ISP).
[3] CIF NWE Gasoil 95, CIF NWE Diesel and MID Brent.

The smoothing effect on the lines representing the average price before taxes is explained by the fact that refinery prices in Portugal are adjusted only once a week, while CIF NWE average prices reflect daily changes.

A lag of about one to two weeks can be seen, both rise and decline, between changes in quotes and the average price before taxes as a consequence of the fact that Portuguese refineries reflect the average prices of the previous week.

There are other components that should be considered when analyzing the oil products prices, such as the exchange factor, given that the oil is priced in USD. However, the final product is sold in Euros, making an accurate conversion essential. Lag periods should be taking into account as well.

An analysis where these factors are missing is under the serious risk of being irrelevant and certainly contributes in making the process of price formation less precise.

2.2 Contract Specifications

This report is based on the analysis of an operation generated by the agreement reached between REPSOL YPF TRADING Y TTRANSPORTE S.A. (the seller) and OZ ENERGIA GAS S.A. (the buyer) for the sale of *Diesel 10 PPM*, quoted on Platts platform.

Following the similar product import held in 2011, a synthesis of the contract specifications is presented below:

Table I - SPECIFICATIONS OF PRODUCT IMPORT CONTRACT

Duration	1st May - 1st Sept, (or earlier if the 20.000 metric tons are consumed before) To be renewed by mutually agreement after that date
Buyer	OZ ENERGIA GAS S.A.
Seller	REPSOL YPF TRADING AND TRANSPORT S.A.
Commodity	Diesel 10 PPM
Quality	Diesel 10 PPM Portuguese specs as per attachment density 0.842 max, biofree
Quantity	Min 3.500 MT (%): -10 / +10 seller's option per month up to 20.000 metric tons
Q&Q determination	In tank
Inspection	50/50 in tank after discharge of vessel. Further analysis for buyer's account
Delivery terms	FCA[(a)] LISBON
Transfer of property	1st day of every month, in any case, at the time money is received in seller's account
Nomination	On the 20th of M-1 buyer nominates quantity to be lifted on month M
Price	Platts 10ppm ULSD HCIFNWE + 5,5 ($/MT) basis CIF Lisbon; Decimal Places: 2
Prepayment	Formula[(b)] = Quantity * [Price day 20 + Premium] * Density
Escalation	SPECIFIC GRAVITY Base Gravity: 0,845; Actual Measured at: tank; Temperature: 15º C; In: VAC
Adjustment	Formula[(c)] = [Average Price + Premium] * Density * Quantity +/– Payment
Credit Terms	Prepayment: money to be in seller's account by the 1st day of the month
Provisional Payment	1st of every month; first payment 1st May

(a) Free Carrier - Transportation costs and risk of loss is transferred to the buyer after delivery to the carrier.

(b) Quantity: tons per month; Price day 20: Platts quote of Diesel 10 PPM ULSDHCIF NWE on the 20th of every month; Premium: an amount of $5,5 per ton; Density: value dividing the metric tons vac by the cubic meters at 15 degrees Celsius.

(c) Price: daily arithmetic average of the quotations for Diesel 10 PPM ULSDHCIF NWE; Premium: an amount of $5,5 per ton; Density: value dividing the metric tons vac by the cubic meters at 15 degrees Celsius; Quantity: tons per month; Payment: the initial amount paid to the seller on the 1st day of the month.

***Source**:* Internal data of OZ Energia.

OZ Energia Gas buys the product from Repsol and sells it to OZ Energia Fuels. OZ Energia Gas assumes the role of the buyer in this process instead of OZ Energia Fuels due to internal decision. This raises some immediate cash-flow issues, but in light of a bigger picture, optimizes the process.

The buyer shall indicate the quantity to be lifted on the following month by no later than the 20th of month M-1. The quantity is set at the initial period for 3.500 tons per month. If the buyer wishes to make any adjustment to the quantity, they should inform the seller beforehand, which occurred in August, reducing the quantity to 3.000 tons, forcing the extension of the period.

The 20th of every month has its importance, seeing as the prepayment is based on it. This was something arranged by both firms. It was agreed that the quote of the 20th would be used to determine the prepayment amount, in order to ease the account process, ensuring that OZ Energia would not close the month with outstanding values.

During the operation, the total product is placed in Trafaria, where it remains in a buyer's tank for legal purposes and passes from seller to buyer on the date that the payments are received into the seller's account.

Despite the fact that the product is stored with the buyer, it only belongs to the buyer once the transaction period is completed, by which time the 20.000 metric tons has been paid for; until then, part of the product belongs to the buyer as the payments are made.

Due to the variation of diesel prices, an adjustment may be needed at the end of each month. This guarantees that the commodity price evolution is reflected in the transaction, without any further costs for either party. This analysis is explored further on.

The investment is repeated semiannually. The firm has started another product import investment during the present year. It is expected to be completed by the submission of this report. The details of this new investment are used as assumptions on the historical analysis.

2.3 Cash-Flow

This kind of investment requires a level of liquidity above normal. The transaction represents a cash-out of approximately 20 million USD[4]. It allows a margin of nearly half million Euros[5], that represents a relevant impulse on the firm's operational margin. Hence, it is interesting to analyze these values in detail.

As shown in the following table, this investment requires 7 payments throughout the period. It is possible to verify the cost of every quantity order, in USD and Euros, and its margin as well.

Table II - CASH-FLOW OF PRODUCT IMPORT (2011)

	Quantity (MT)	Out-Flow ($)	Out-Flow (€)	Unit Margin (€)
May	3.569	-3.416.560	-2.403.644	44.713
June	3.523	-3.458.175	-2.412.268	109.037
July	3.446	-3.541.300	-2.485.445	63.081
August	3.053	-2.916.870	-2.034.487	81.433
September	2.979	-2.933.910	-2.130.691	83.107
October	2.959	-2.987.580	-2.184.056	51.919
November	2.213	-2.253.159	-1.659.432	62.387
	21.742	**-21.507.554**	**-15.310.023**	**495.679**

Source: Internal Data of OZ Energia; own calculations.

During this operation the quantity exceeds 21.000 metric tons, having a total cost of approximately 22M USD or 15M Euros, while margin reaches almost 500k Euros. The investment prevents OZ Energia to buy product to its direct competitors at higher prices, allowing a better margin through this operation. Last year's Diesel import represents 27,46%[6] of the annual volume of OZ Energia Fuels.

To meet the payments, daily USD purchases are made using daily forwards maturing at the end of the month. This strategy has its costs, which are automatically embedded in the exchange rate applied by the banking institution that charges 8 pips for each forward, reaching 8.718€ (as shows on Table C).

[4] This investment is evaluated for 21,5 million USD, approximately 15,3 million Euros.
[5] More precisely 495.678,65 €, through this investment which had an impact on the margin for 7 months.
[6] The total volume of OZ Energia Fuels reached 79.172 metric tons in 2011.

Despite the costs, this strategy continues to outperform the scenario where no hedging is executed. After creating a scenario of USD purchases at spot price on the payment day, rather than daily USD purchases using forward contracts, it was possible to achieve the following results[7]:

Table III - SPOT RATE PURCHASES VS FORWARD RATE PURCHASES (2011)

	Out-Flow ($)	Payment (forward) (€)	Payment (spot) (€)	Balance (€)
May	-3.416.560	-2.403.644	-2.371.294	32.351
June	-3.458.175	-2.412.268	-2.386.924	25.344
July	-3.541.300	-2.485.445	-2.456.677	28.768
August	-2.916.870	-2.034.487	-2.041.911	-7.424
September	-2.933.910	-2.130.691	-2.201.478	-70.787
October	-2.987.580	-2.184.056	-2.192.397	-8.342
November	-2.253.159	-1.659.432	-1.679.206	-19.774
	-21.507.554	**-15.310.023**	**-15.329.887**	**-19.864**

Source: Internal Data of OZ Energia; own calculations.

The strategy with forwards achieves a better result than the no risk hedging strategy (buying USD at the spot market), leading to a 20k€ save, with financial costs considered. In this case, the evolution of the EUR-USD is more favorable to the daily USD purchases throughout the month, than to purchases on the first day of the month.

This scenario shows that the firm is benefited, despite the fact that a good hedging strategy does not allow losses or gains. Strong fluctuations in the exchange rate and diesel prices make building on a risk management safer. The amounts and the substantial margin achieved from the investment, lead the firm to rethink its risk hedging.

[7] This value differs from the one presented below since these are actual figures, while the other amount result from a simulation based on different assumptions.

3. DATA

3.1 Platts: Diesel Price Evolution

The Platts platform is the world's foremost source of price assessments in the physical energy markets. It ensures the access to the daily quotes of some of the most traded commodities, such as Diesel 10ppm NWE.

It is possible to analyze the daily returns of Diesel between January 2009 and June 2012 through the following figure, based on the logarithmic prices. According to Hutson (1983) by plotting the logarithm of price, instead of price itself, the trader can compare percentage change in prices, rather than the dollar change.

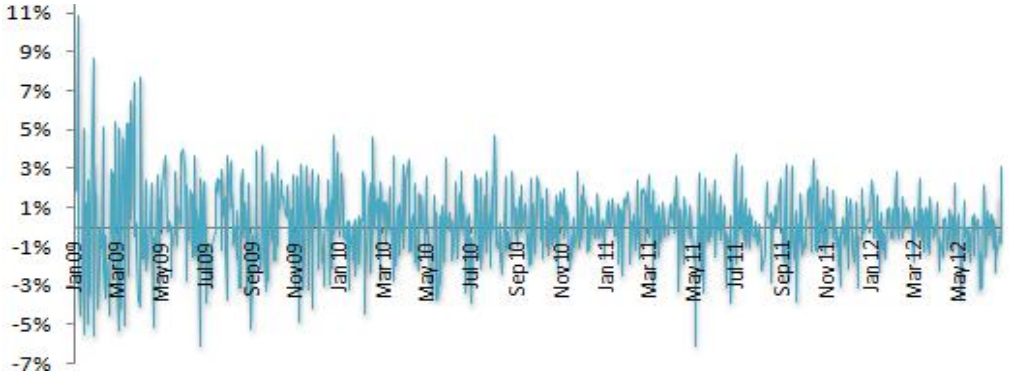

Figure I - Evolution of Diesel Daily Returns, from Jan-09 to Jun-12.
(*Source:* Platts Data; own calculations).

3.2 Exchange Rate: EUR-USD Price Evolution

The EUR-USD exchange rate can be described as a volatile rate. Since in most financial markets currencies are expressed in terms of Euros and/or USD, this rate has a relevant role in businesses, being one of the most important exchange rates worldwide.

It is interesting to analyze the rentability variation of EUR-USD exchange rate between January 2009 and June 2012, based on the logarithmic prices.

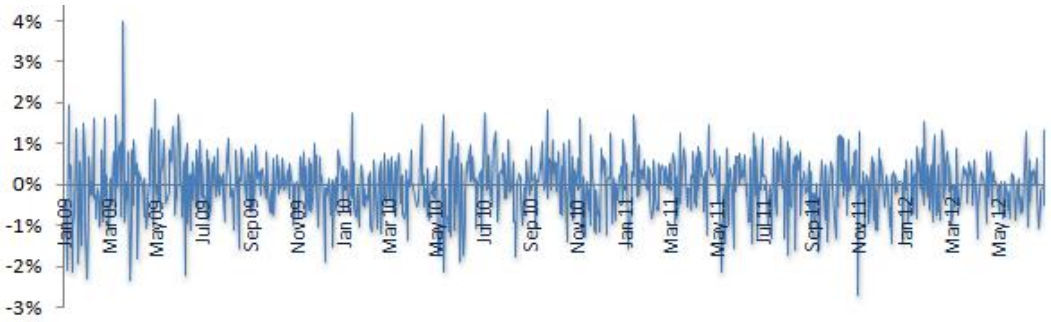

Figure II - Evolution of EUR-USD Daily Returns, between Jan-09 and Jun-12.
(*Source:* Platts Data; own calculations).

The daily volatility during the analyzed period reveals some differences between diesel and the exchange rate; there is a clear distinction between them:

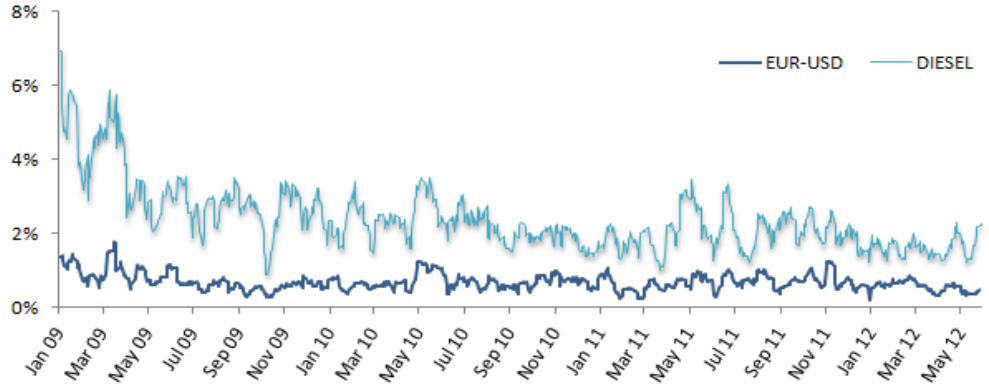

Figure III - Evolution of EUR-USD and Diesel Daily Volatility, from Jan-09 until Jun-12.
(*Source:* Platts Data; own calculations).

3.3 Performance Analysis

To a better understanding of the sample under study, a performance analysis of the two variables - Diesel and EUR-USD exchange rate – is shown. The analysis focuses on rentability, volatility and Value at Risk, comprising the period from January 1, 2009 to June 30, 2012.

- *Rentability*

In terms of return, Diesel had a great performance in 2009, 2010 and 2011 as well, but with a significant decrease on the average annual return. The trend has been downward, registering negative value in the current year.

The EUR-USD exchange rate had performed poorly over the last 4 years, achieving positive return only in 2009. The highest monthly return being 6,41% in 2009 and 2010; contrasting with Diesel that reached 18,11% in 2009. The monthly return amplitudes of both variables got thinner, suggesting a decline in volatility.

Table IV - RENTABILITY INDICATORS DURING 2011 INVESTMENT PERIOD

Diesel		EUR-USD Exchange Rate	
Period Average Return	-5,66%	Period Average Return	-10,05%
Monthly Average Return	-0,34%	Monthly Average Return	-0,91%
Daily Average Return	-0,05%	Daily Average Return	-0,07%

Source: Historical Data; own calculations.

During the investment period (May11-Nov11) Diesel return registered -5,7%, while the exchange rate reached -10,1%. This reveals the deterioration of the rentability indicators, leading to a rougher investment scenario.

Table V - DIESEL AND EUR-USD EXCHANGE RATE RENTABILITY INDICATORS

	2009	2010	2011	1S 2012
Diesel				
Average Annual Return	35,97%	16,53%	16,86%	-10,64%
Average Monthly Return	3,08%	0,55%	1,76%	-1,88%
Average Daily Return	0,15%	0,08%	0,07%	-0,07%
Median Annual Return	35,97%	16,53%	16,86%	-10,64%
Median Monthly Return	1,39%	3,32%	1,64%	0,26%
Median Daily Return	0,06%	0,11%	0,17%	-0,05%
Lowest Monthly Return	-9,94%	-13,67%	-6,55%	-15,30%
Hightest Monthly Return	18,11%	6,99%	8,67%	4,76%
Amplitude	**28,05%**	**20,66%**	**15,22%**	**20,06%**
Lowest Daily Return	-6,11%	-4,47%	-6,06%	-3,63%
Hightest Daily Return	10,91%	4,72%	3,73%	3,10%
Amplitude	**17,02%**	**9,20%**	**9,79%**	**6,73%**
% Months (+)	66,67%	58,33%	50,00%	50,00%
% Months (-)	33,33%	41,67%	50,00%	50,00%
% Days (+)	50,99%	52,17%	55,78%	45,97%
% Days (-)	49,01%	47,83%	44,22%	54,03%
EUR-USD Exchange Rate				
Average Annual Return	3,82%	-7,40%	-3,11%	-2,70%
Average Monthly Return	0,33%	-0,56%	0,02%	-0,03%
Average Daily Return	0,01%	-0,03%	-0,01%	-0,04%
Median Annual Return	3,82%	-7,40%	-3,11%	-2,70%
Median Monthly Return	0,26%	-0,74%	0,28%	1,09%
Median Daily Return	0,01%	0,01%	0,06%	-0,03%
Lowest Monthly Return	-7,87%	-6,90%	-5,63%	-5,70%
Hightest Monthly Return	6,41%	6,41%	4,96%	2,15%
Amplitude	**14,28%**	**13,31%**	**10,59%**	**7,86%**
Lowest Daily Return	-2,32%	-2,11%	-2,71%	-1,31%
Hightest Daily Return	4,04%	1,84%	1,73%	1,56%
Amplitude	**6,36%**	**3,95%**	**4,43%**	**2,86%**
% Months (+)	58,33%	41,67%	58,33%	66,67%
% Months (-)	41,67%	58,33%	41,67%	33,33%
% Days (+)	50,20%	50,20%	52,14%	47,58%
% Days (-)	49,80%	49,80%	47,86%	52,42%

Source: Historical Data; own calculations.

- *Volatility*

In 2009, Diesel recorded an annual volatility of 43%, dropping to more adequate levels in the following years. The EUR-USD exchange rate was more stable, rounding an annual volatility of 12% throughout the period.

Over the investment period, Diesel volatility reached 19%, exchange rate volatility being 10%. It became even clearer the need to conduct a risk hedging strategy.

Table VI - VOLATILITY INDICATORS DURING 2011 INVESTMENT PERIOD

Diesel		EUR-USD Exchange Rate	
Period Volatility	18,70%	Period Volatility	9,53%
Monthly Volatility	6,83%	Monthly Volatility	3,44%
Daily Volatility	1,53%	Daily Volatility	0,77%
May-November	150	May-November	153

Source: Historical Data; own calculations.

Both variables registered negative Sharpe Ratios[8] in 2012 due to the negative annual returns. This fact indicates that the risk free asset performed better than the other assets. Strategies with negative ratios should be 'held short' (Sharpe, 1994).

Table VII - DIESEL AND EUR-USD EXCHANGE RATE VOLATILITY INDICATORS

	2009	2010	2011	1S 2012
Diesel				
Annual Variance	18,44%	6,44%	5,07%	1,72%
Monthly Variance	1,46%	0,51%	0,40%	0,28%
Daily Variance	0,07%	0,03%	0,02%	0,01%
Annual Volatility	42,94%	25,37%	22,51%	13,10%
Monthly Volatility	12,07%	7,13%	6,35%	5,26%
Daily Volatility	2,70%	1,60%	1,42%	1,18%
Days	253	253	251	124
Sharpe Ratio				
Annual	79,99%	59,84%	66,02%	-92,50%
Rf	**1,618%**	**1,348%**	**1,997%**	**1,476%**
EUR-USD Exchange Rate				
Annual Variance	1,68%	1,31%	1,29%	0,42%
Monthly Variance	0,13%	0,10%	0,10%	0,07%
Daily Variance	0,01%	0,01%	0,01%	0,00%
Annual Volatility	12,97%	11,44%	11,35%	6,49%
Monthly Volatility	3,63%	3,20%	3,17%	2,60%
Daily Volatility	0,81%	0,72%	0,71%	0,58%
Days	255	255	257	124
Sharpe Ratio				
Annual	16,98%	-76,49%	-45,01%	-64,44%
Rf	**1,618%**	**1,348%**	**1,997%**	**1,476%**

Source: Historical Data; own calculations.

[8] The Sharpe ratio is calculated by the excess of the asset return over the free-risk asset return, dividing by the standard deviation of the excess of the asset return (Sharpe, 1994).

- *Value at Risk*

Value at Risk (VaR) is a single, summary, statistical measure of possible portfolio losses. It aggregates all of the risks in a portfolio into a single number, describing the magnitude of the likely losses on the portfolio (Linsmeier & Pearson, 1996).

The estimation of VaR was based on the Delta Normal Method, using the daily standard deviation of the portfolio during the period under analysis, multiplied by the market value of the portfolio, times the square root of the number of days, times the inverse of the normal distribution with 95% of confidence.

Table VIII - VAR INDICATORS DURING 2011 INVESTMENT PERIOD

Diesel		EUR-USD Exchange Rate	
Period VaR (95%)	-36,43%	Period VaR (95%)	-25,72%
Monthly VaR (95%)	-11,57%	Monthly VaR (95%)	-6,57%
Daily VaR (95%)	-2,56%	Daily VaR (95%)	-1,33%

Source: Historical Data; own calculations.

The VaR of Diesel reached 36,43% during the investment period and the exchange rate 25,72%, giving 95% confidence level. With 95% confidence, the maximum potential loss on the exchange rate can exceed 5,5 million USD (the investment represented over 21M USD).

Once again this demonstrates the great risk exposure that the investment was on.

Table IX - DIESEL AND EUR-USD EXCHANGE RATE VAR INDICATORS

	2009	2010	2011	1S 2012
Diesel				
Annual VaR (95%)	-34,67%	-25,20%	-20,17%	-32,20%
Monthly VaR (95%)	-16,78%	-11,19%	-8,69%	-10,54%
Daily VaR (95%)	-4,29%	-2,55%	-2,27%	-2,00%
Inv Normal 5%	**-1,645**	**-1,645**	**-1,645**	**-1,645**
EUR-USD Exchange Rate				
Annual VaR (95%)	-17,51%	-26,23%	-21,78%	-13,37%
Monthly VaR (95%)	-5,64%	-5,83%	-5,19%	-4,31%
Daily VaR (95%)	-1,32%	-1,21%	-1,18%	-1,00%
Inv Normal 5%	**-1,645**	**-1,645**	**-1,645**	**-1,645**

Source: Historical Data; own calculations.

4. RISK HEDGING

Several risks can be found in the contract under analysis and be subject of multiple readings. Some of those risks are hedged, whereas others are not, because the hedging is already promoted by the firm.

4.1 Market Risk

Every asset is exposed to market risk, meaning there is a possibility of value decline due to a change in the value of one or more market variables, including interest rates, foreign exchange rates, equity prices, and commodity prices (Bychuk & Haughey, 2011). Here, the commodity prices variation is the focus of analysis.

The payment amount is estimated on the 20th of month M-1, while the payment is set for the 1st day of month M. As payment is based on a single quote (of day 20), it is important that prices of every trading day would be taken into account, using an arithmetic average. Thus, the variations in Diesel prices are covered by this adjustment mechanism practiced by the firms, presented below:

Adjustment = [Average Monthly Price + Premium] * Density * Quantity +/– Initial Payment

Throughout the month, Diesel quotes can suffer great variation, putting both sides in a position of receiving/paying less/more than the exact amount, which could lead the buyer to a need for liquidity.

This adjustment may be paid by the buyer or the seller, depending on the evolution of diesel prices and the amount initially paid. In the event that this is paid by the buyer, that is offset on the sale prices, which replicates the Diesel variations on the market with one week lag. If the seller pays the adjustment, the buyer does not retain the gains, since these are reflected directly on the market with a price reduction.

Although Diesel variations cause a need for an adjustment, OZ Energia's margin remains unchanged, due to the market mechanisms.

For example, if on day 1 the payment is set as 1M USD and on the last trading day and using the average price, that amount turns out to be less, the buyer is harmed. The adjustment makes sure that difference is compensated by one party at the end of each month. In this case, the seller returns money to the buyer.

As such, the monthly adjustment is made to compensate that discrepancy. The initial advance would represent a market risk situation if it weren't for the adjustment, which minimises potential losses.

Taking 2011 as example and looking at the balance of the paid and received adjustments below[9], it is clear that it has no substantial impact on the firms.

Table X - PAID AND RECEIVED ADJUSTMENTS FROM DEC-08 TO JUNE-2012

OZ PAYS			OZ RECEIVES			TOTAL		
max	7,72%	78.408 USD	max	-5,18%	- 60.523 USD	pays	824.425 USD	58,64%
min	0,05%	1.176 USD	min	-0,08%	- 1.641 USD	receives	581.420 USD	41,36%
avg	2,01%	33.690 USD	avg	1,98%	- 34.201 USD		***net***	***- 243.005 USD***

Source: Internal Data of OZ Energia; own calculations.

Over 43 analyzed cases, OZ Energia paid 61%, an additional cost of about 893k USD. OZ Energia paid it more often and had a higher amount than Repsol, with the monthly price of Diesel being greater than the price of day 20, on average. Here, the maximum OZ Energia had to pay was 7,72%, having received 5,18% (both amounts as the weight of the adjustment over the monthly payment).

The agreement recognises market risk hedging by adding a mechanism that reflects the variation of Diesel prices, making sure that the existing position risk is minimised, although it demands a risk premium. Without initial payments, the premium wouldn't be considered; however this would require the creation of a method to offset the Platts risk. The market risk is considered to be negligible since the adjustment cancels it.

[9] Assumptions – **time period**: monthly basis [Dec2008-Jun2012]; **quantity:** 2.500 tons per month; **premium**: 6,75 USD/ton; **density**: 1,0097 [0,845/0,8369].

4.2 Interest Rate Risk

Interest rate risk is derived from the risk of an adverse change in market interest rates and the resulting possibility negative impact on the firm's profitability or asset value (Wolke, 2008).

The hedging of this risk is not currently considered. With the strategy used by the firm, this risk is present in the nature of the forward itself: $\mathbf{F_0 = S_0\, e^{(r-rf)T}}$

The second component of this formula[10] is analyzed in the figure below, showing the evolution of the domestic interest rate (EONIA – Euro Overnight Index Average[11]) and foreign interest rate (FED FUNDS – Federal Reserve Funds Rate[12]) from January 2, 2008 to June 29, 2012.

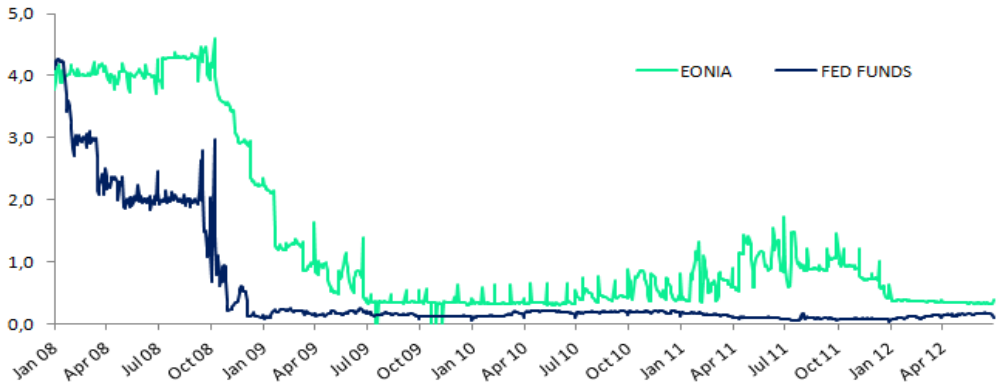

Figure IV - Evolution of EONIA and Fed Funds Rates between Jan-08 and Jun-12.
Source: European Central Bank and Federal Reserve; own calculations.

Since the EONIA and the Federal Reserve Funds rates are so close to one another, the firm prefers taking the risk of not hedging this risk, than support the costs associated therewith.

The costs of the hedging are estimated to be higher than the potential losses. This would also require a greater liquidity to meet the hedging mechanism, which would be another restriction over the firm's liquidity.

The operational impact is null and, although it is assumed that this risk affects the financial component of the company, it is ignored.

[10] Hull, J. (2002*). Fundamentals of Futures and Options Markets*, 4th Edition. Prentice Hall.
[11] EONIA is a measure of the effective interest rate prevailing in the euro interbank overnight market. It is calculated as a weighted average of the interest rates on unsecured overnight lending transactions denominated in euro. (**Source**: European Central Bank).
[12] The daily effective FED FUNDS RATE is a volume-weighted average of rates on trades arranged by major brokers. (**Source**: Federal Reserve Bank of New York).

4.3 Credit Risk

Credit Risk can be defined as the possibility that a contractual counterparty does not meet its obligations stated in the contract, causing the creditor a financial loss (Ammann, 2001).

The most popular credit derivative is *Credit Default Swaps*, contracts that provide insurance against the risk of a default by particular company (Hull, 2009). But this does not suit the firm's purpose. The market seems unable to give an accurate solution to this specific risk, related to corporate credit risk of OZ Energia's clients.

Here we have two different sides. On one hand, there is the risk of payment failure by OZ Energia towards Repsol. The risk would be that OZ wouldn't pay the total value of the product, worth around 20 million dollars. Product being at OZ Energia terminal, the credit risk would be even greater since the product would already be in the possession of the buyer.

Initially, OZ Energia offered a *Standby Letter of Credit* (SBLC) issued by a reputable banking institution in Portugal, but Repsol rejected. Repsol preferred to split the delivery of its product monthly, when they would get paid in advance at the beginning of each month.

On the other hand, there is the risk of payment failure by the retail firms to whom OZ Energia sells the product. When OZ Energia customers order product, they have about 1 month to pay for it, which makes the credit risk positive during that period[13].

This risk is controlled by OZ Energia that uses an internal credit policy, with several restrictions. A great effort has been made during the last few months to achieve a fully coverage of those positions. Different hedging instruments have been requested to their customers, such as Bank Guarantees, Credit Insurances and other guarantees.

[13] The ratio of days sales outstanding of OZ Energia Fuels in 2011 attained 37 days.

4.4 Currency Risk

The currency risk is defined as the variance component in the firm's overall cash-flow due to exchange rate volatility (Jacque, 1996). To neutralize the risk of a loss, the buyer can hedge its foreign currency exchange exposure to a predetermined level, using forward contracts.

Since the payments are made in USD, there is an uncertainty about the exact amount in foreign currency that is actually transferred to the seller.

If the payment was made in Euros, then the exchange rate risk would not take place. But that would imply passing it to the seller that is not willing to do so, leading to the cancelling of the operation.

As previously presented, the advance payment is already an issue since the correct value is only known on day 20. Besides that, the amount has to be converted from Euros (buyer currency) to USD (seller currency) and since the investment takes 7 months, there is also an uncertainty about the amount to pay.

Here there is the possibility of currency depreciation, leading to a potential loss due to a change in the exchange rate that affects negatively the value of the investment. An exchange rate risk can either result in an exchange gain or in a loss.

To neutralize the risk of a loss and to make sure that OZ Energia has enough foreign currency to meet the payments, some strategies are proposed to find effective alternatives.

During the following analysis several assumptions are made and some are common to all scenarios, like the data time period (between December 1, 2008 and June 30, 2012), the simulation of the quantity purchased (2.500 tons per month), premium (6,75 USD per ton) and density (1.0097).

4.4.1 Scenario 0 - No risk hedging

Scenario 0 describes the strategy of not hedging the currency risk. Then the payments are made at the exchange spot rate, which may be completely different from the exchange spot rate of the previous day.

In this strategy there are no costs involved, because the costs are usually associated with the hedging position.

Another positive aspect of this scenario is that any estimation of the amount to pay on day 1 is not necessary. In other strategies that operation is done. There is, however, always an uncertainty about the amount to pay in Euros before the actual payment day.

Although the period under consideration includes volatile moments of Diesel and exchange rate, stress tests to assess the robustness of this strategy are also performed below.

4.4.2 Scenario 1 - Current Hedging

To meet the payments, daily USD purchases are made, taking into account settlement date (T+3). To make these payments, daily forwards maturing at the end of the month are prepared (having a cash-out at that moment), so that the money is available at the beginning of the month.

That amount may vary on a daily basis, since its calculation is based on an estimate of the value to advance, with daily product purchases being simulated for the following month. The process is repeated every month in order to estimate the next payment.

For the months in which there is product import, a monthly average exchange rate is assumed, since in this strategy the daily forward average rates are very close to the monthly average rate. The financial costs are included in these rates (8 pips for each operation). For the remaining months (May11-Nov2011 and Mar12-Jun12) the effectively accounted rate is considered.

There is another aspect of this strategy that is not measurable in this analysis. In addition to the daily forwards, a long-term forward is prepared to sell USD upon payment of the first advance, so as to simulate the payment to the seller and close the cycle.

It is contracted at the start of the investment. Its gain or loss results from the difference between the last month forward rate and the long-term forward rate. It ensures that at the end of the period, the initial payment is refunded. With this forward the last sales period is simulated (when there are no longer amounts to be paid to Repsol) allowing it to be only necessary to manage the monthly payments.

Table XI - 2011 LONG-TERM FORWARD

	Rate	Amount ($)	Amount (€)	Result (€)
Spot 6/May	1,4501	3.668.875	2.530.084	17.746
Spot 1/Jun	1,4408	3.668.875	2.546.415	1.415
Spot 1/Jul	1,4488	3.668.875	2.532.354	15.475
Spot 1/Aug	1,4415	3.668.875	2.545.179	2.651
Spot 1/Sep	1,4285	3.668.875	2.568.341	-20.511
Spot 3/Out	1,3327	3.668.875	2.752.964	-205.134
Spot 1/Nov	1,3627	3.668.875	2.692.357	-144.527
Fwd 6/May - 1/Nov	1,4400	3.668.875	2.547.830	

Source: Internal Data of OZ Energia; own calculations.

Beyond the economic utility of this forward, in 2011 it allowed 145k€ save. This was due to the fact that the exchange rate is contracted at the start (May 6) instead of the end of period (November 1). The different rates lead to negative differences in the first four months, but later becoming positive.

Table XII - 2012 LONG-TERM FORWARD

	Rate	Amount ($)	Amount (€)	Result (€)
Spot 1/Mar	1,3312	2.617.500	1.966.271	-9.371
Spot 2/Apr	1,3319	2.617.500	1.965.238	-8.338
Spot 2/May	1,3131	2.617.500	1.993.374	-36.475
Spot 1/Jun	1,2322	2.617.500	2.124.249	-167.350
Fwd 1/Mar - 1/Oct	1,3376	2.617.500	1.956.900	

Source: Internal Data of OZ Energia; own calculations.

It is possible to verify partial savings over the first months of the new investment.

This may continue until the end of the period unless the spot rate finish above the forward rate, a scenario that now seems unlikely.

4.4.3 Scenario 2 – Asian Put Option

Asian Options are exotic options (Rubinstein & Reiner, 1992) where the payoff depends on the average of the underlying asset during at least some part of the life of the option (Hull, 2009). The payoff from an average price put is max (0, K – $S_{average}$). One of its advantages is the reduction of the risk of price manipulation of the underlying asset at the maturity date (Kemna & Vorst, 1990).

This strategy simulates monthly purchases of put option by setting up a rolling strategy.

On day 1 of month M-1, the payable amount on day 1 of month M is estimated. This value is calculated using the formula with the value of Platts of that day, as hypothesis.

The estimated USD have to be in the account at the end of the month and two things may happen: either a higher value was estimated to pay (Diesel price on day 1 is higher than on day 20) and the surplus is sold on the market at the spot rate; or the estimated value was lower than the payment amount (Diesel price on day 1 is lower than on day 20) and the remaining is purchased on the market at the spot rate.

The results obtained with these purchases/sales at the spot rate are considered. These amounts arise from estimation errors and can lead to gains or losses, depending on the difference between the value of spot and the average rates[14].

The purchase of Asian Put Options is simulated in this strategy. This option gives the buyer the right to sell Euros for USD at a monthly average price of the EUR-USD exchange rate. The contract has the following specifications:

Underlying Asset: EUR-USD exchange rate Notional: USD 2.206.148 (taking June 2012 as example) Maturity: 1 Month Strike: EUR-USD average price at maturity

This rate is less exposed to price fluctuations, since it is an average of all prices recorded over the month, so it is more consistent with an accurate currency risk management.

[14] The estimation errors record positive balance, providing a gain of 32.798,66 €, based on historical data.

The option may be exercised or not. OZ Energia exercises the right to sell Euros for USD if the average rate is higher than the spot rate, not exercising it in the opposite case (the firm buys the USD in the spot market).

The option premium is a financial cost that the firm always has to bear, regardless if the option is exercised or not (Table D).

It is not possible (or very hard) to find a closed-form solution for the valuation of options on an arithmetic average (Haug, 1997). The main reason for this is that when the asset is assumed to be lognormally distributed the arithmetic average does not itself have a lognormally distribution.

Arithmetic average-rate options can be priced by analytical approximations, such as the Turnbull & Wakeman (1991) approximation, used to calculate the put option premium. The approximation adjusts the mean and variance so that they are consistent with the exact moments of the arithmetic average.

The adjusted mean and variance are then used as input in the generalized Black & Scholes (1973) formula:

$$d_1 = \frac{\ln(S/X) + (b_A + \sigma_A^2/2)T_2}{\sigma_A\sqrt{T_2}}$$

$$d_2 = d_1 - \sigma_A\sqrt{T_2}$$

$$p \approx Xe^{-rT_2}N(d_2) - Se^{(b_A - r)T_2}N(d_1)$$

Where: S = Spot Price of the asset;

X = Strike Price of the asset;

b_A = Cost-of-Carry;

σ_A = Volatility of natural logarithms of return of the underlying asset;

T_2 = Remaining Time to Maturity;

r = Risk-Free Interest Rate.

Being:

- Strike price equal to the spot price;

- The adjusted mean or arithmetic average of the asset price is considered in the asset spot price calculation;

- Cost of Carry is the opportunity cost of investing in an option rather than investing the money on a risk-free application. Since commodities contracts are not being considered, there are no storage costs, although there are financial costs involved. The difference between the domestic interest rate and the foreign interest rate was found;

- Total volatility is expressed by the historical volatility plus the spread volatility (difference between implied volatility and historical volatility), on an annual basis.
  An average spread of 1,17% was considered, based on the Euro-Dollar Continuous Put traded on the Chicago Mercantile Exchange from December 2008 to June 2012;

Figure V - Implied Volatility 1 Month Constant Maturity, from Jan-05 to June-12. **(*Source:*** Reuters).

- Risk-Free Interest Rate as 1-Month Euribor annualized rate, since this is an average rate that a prime bank is willing to lend funds in Euro to another prime bank[15].

[15] Source: European Central Bank.

4.4.4 Scenario 3 – SWAP

A Swap is conceptually the exchange of one asset for another (Baz & Pascutti, 1996).

Two counterparties agree to a periodic exchange of cash flows for a set length of time based on a specified amount of principal. In a currency swap, the cash flows are expressed in different monetary units (Brown & Smith, 1996).

In this strategy, payments are made through a short-term treasury instrument denominated in USD that allows OZ Energia to get the USD required to meet the payment at the 1st day of each month.

Financial costs are fixed and lower than with put option. The exchange rates are the same, but in this case, the preference for the spot exchange rate if higher than the average rate cannot be exercised.

At the end of the month OZ Energia receives enough USD in its account, through this:

Start date: 1st day of the month
End date: Last day of the month
OZ receives in USD:
*[(Monthly Average of Platts Diesel 10ppm CIF NWE + Premium) * 2.500 tons] * Density*
OZ pays in Euros:
*[(Monthly Average of Platts Diesel 10ppm CIF NWE + Premium) * 2.500 tons * Density / (Monthly Average of ECB EURUSD fixings for the relevant days – 15 pips)]*

In this currency swap an exchange of principal and interest payments are held in one currency for principal and interest payments in another.

The operation set-up costs reach 15 pips per month, which are paid every month during the risk hedging period, having a direct impact on the firm's treasury operations.

As in strategy 2, the exact amount to advance is not possible to predict. The firm may have to go to the spot market to buy USD to complete the payment.

4.4.5 Comparing Strategies

Using Diesel historical prices quoted on Platts, it is possible to draw an analysis of the payment amounts for the four strategies listed above.

The value of each strategy in Euros is presented for each amount payable in USD on day 1, so there might be four different amounts, since each one has its exchange rate and its own costs. This analysis aims at evaluating the best strategy for each scenario.

The best strategy turns out to be the strategy where **no hedging positions** are set and therefore no costs involved. In most cases, the spot rate on day 1 exceeds the average rate of the month, which was clearly pure luck.

Obviously, the firm wouldn't risk letting its position uncovered in an investment of this magnitude; as such, this strategy is not an option.

S**trategy 1** supports the lowest financial costs, about 36k€ throughout the analyzed period, with an average of 845€ per month, that represents 0,06% of the investment.

Despite the fact that this strategy has been applied with good hedging results, OZ Energia wants the hedging mechanism to be more automatic and gain autonomy in the process. The firm does not want to depend on the availability of one employee, who fulfills the daily USD purchases and is the only one to have access to the platform. There is also human error risk that may jeopardize the entire investment. In addition to this, the fact that this strategy is time-consuming makes the firm unwilling to waste time executing it.

Strategy 2 has the highest costs. This is due to the financial costs involved, reaching up to almost 929k€ and 1,5% of the investment, since the put premium has to be always paid, whether or not the option is exercised.

This strategy allows the firm to choose the most favorable rate (the higher EUR-USD exchange rate), since the exercise of the put option only dependents on it.

The strategy with the best outcome is **Strategy 3**. The exchange rate results from a monthly average, beating strategy 1. Here, the estimation error helps gaining about 33k€, which is another distinction between both strategies (estimations errors gains exceeded the difference between the costs of strategies 1 and 3). Despite higher costs, strategy 3 surpasses strategy 1, proving to be a viable alternative to the product import, based on historical data.

Table XIII - COMPARISON OF STRATEGIES' TOTAL AND FINANCIAL COSTS

		scenario 0		scenario 1		scenario 2		scenario 3	
month	prepayment	total	cost	total	cost	total	cost	total	cost
Dec-08	1.215.401 USD	876.533 €	- €	904.220 €	538 €	891.020 €	14.487 €	908.046 €	1.009 €
Jan-09	1.199.624 USD	940.144 €	- €	906.700 €	548 €	922.492 €	15.089 €	908.432 €	1.028 €
Feb-09	1.015.989 USD	806.597 €	- €	795.189 €	498 €	809.818 €	17.019 €	793.732 €	933 €
Mar-09	1.168.072 USD	881.830 €	- €	895.636 €	549 €	896.371 €	14.541 €	892.593 €	1.030 €
Apr-09	1.166.810 USD	882.409 €	- €	885.134 €	537 €	899.610 €	17.200 €	885.542 €	1.007 €
May-09	1.269.671 USD	892.877 €	- €	930.677 €	545 €	909.978 €	17.101 €	924.970 €	1.023 €
Jun-09	1.529.663 USD	1.085.175 €	- €	1.091.957 €	623 €	1.106.048 €	20.873 €	1.091.731 €	1.169 €
Jul-09	1.417.967 USD	991.378 €	- €	1.007.101 €	572 €	1.012.978 €	21.601 €	1.008.188 €	1.073 €
Aug-09	1.581.409 USD	1.104.799 €	- €	1.108.983 €	622 €	1.127.323 €	22.524 €	1.109.408 €	1.166 €
Sep-09	1.513.256 USD	1.040.825 €	- €	1.039.778 €	571 €	1.060.200 €	20.930 €	1.040.341 €	1.072 €
Oct-09	1.667.232 USD	1.128.643 €	- €	1.125.872 €	608 €	1.146.025 €	20.098 €	1.127.067 €	1.140 €
Nov-09	1.599.709 USD	1.061.238 €	- €	1.073.164 €	576 €	1.082.055 €	20.818 €	1.074.000 €	1.080 €
Dec-09	1.549.857 USD	1.077.112 €	- €	1.060.418 €	580 €	1.079.428 €	20.905 €	1.059.611 €	1.088 €
Jan-10	1.613.593 USD	1.159.773 €	- €	1.131.226 €	634 €	1.148.121 €	19.571 €	1.129.739 €	1.190 €
Feb-10	1.669.756 USD	1.234.570 €	- €	1.220.787 €	714 €	1.238.941 €	17.104 €	1.223.176 €	1.339 €
Mar-10	1.730.337 USD	1.284.776 €	- €	1.276.010 €	752 €	1.293.831 €	18.101 €	1.277.142 €	1.411 €
Apr-10	1.852.760 USD	1.415.509 €	- €	1.382.894 €	825 €	1.400.417 €	18.097 €	1.383.868 €	1.548 €
May-10	1.603.496 USD	1.319.207 €	- €	1.279.161 €	816 €	1.289.516 €	19.066 €	1.271.980 €	1.531 €
Jun-10	1.790.286 USD	1.452.211 €	- €	1.467.388 €	962 €	1.470.631 €	18.420 €	1.466.527 €	1.804 €
Jul-10	1.693.105 USD	1.295.116 €	- €	1.326.677 €	831 €	1.311.707 €	16.591 €	1.324.702 €	1.559 €
Aug-10	1.673.542 USD	1.307.455 €	- €	1.297.779 €	805 €	1.314.817 €	18.601 €	1.297.726 €	1.509 €
Sep-10	1.784.607 USD	1.300.165 €	- €	1.366.572 €	837 €	1.317.799 €	17.634 €	1.362.946 €	1.570 €
Oct-10	1.884.313 USD	1.353.090 €	- €	1.356.615 €	781 €	1.371.469 €	18.379 €	1.357.307 €	1.465 €
Nov-10	1.873.585 USD	1.428.582 €	- €	1.372.293 €	804 €	1.390.207 €	19.199 €	1.372.516 €	1.508 €
Dec-10	2.016.202 USD	1.510.490 €	- €	1.526.023 €	923 €	1.531.675 €	21.185 €	1.525.835 €	1.732 €
Jan-11	2.144.305 USD	1.558.928 €	- €	1.606.020 €	962 €	1.580.884 €	21.957 €	1.602.709 €	1.804 €
Feb-11	2.263.573 USD	1.637.304 €	- €	1.659.396 €	973 €	1.661.143 €	23.839 €	1.659.930 €	1.825 €
Mar-11	2.533.662 USD	1.791.714 €	- €	1.810.900 €	1.035 €	1.817.104 €	25.390 €	1.811.002 €	1.941 €
Apr-11	2.647.882 USD	1.784.648 €	- €	1.834.502 €	1.016 €	1.810.183 €	25.535 €	1.833.693 €	1.906 €
May-11	2.403.035 USD	1.667.848 €	- €	1.690.602 €	944 €	1.694.239 €	26.391 €	1.677.224 €	1.753 €
Jun-11	2.464.247 USD	1.700.888 €	- €	1.728.651 €	958 €	1.724.936 €	24.048 €	1.714.744 €	1.787 €
Jul-11	2.579.729 USD	1.789.614 €	- €	1.810.571 €	1.021 €	1.812.664 €	23.050 €	1.807.957 €	1.904 €
Aug-11	2.398.618 USD	1.679.116 €	- €	1.673.012 €	933 €	1.696.150 €	24.265 €	1.673.636 €	1.751 €
Sep-11	2.472.450 USD	1.855.219 €	- €	1.792.910 €	1.045 €	1.819.381 €	25.340 €	1.795.999 €	1.958 €
Oct-11	2.534.924 USD	1.860.222 €	- €	1.852.614 €	1.108 €	1.874.907 €	24.000 €	1.852.934 €	2.026 €
Nov-11	2.556.380 USD	1.916.902 €	- €	1.882.531 €	1.075 €	1.912.480 €	26.457 €	1.888.113 €	2.089 €
Dec-11	2.360.124 USD	1.824.603 €	- €	1.791.903 €	1.100 €	1.816.225 €	26.783 €	1.791.482 €	2.041 €
Jan-12	2.415.656 USD	1.833.515 €	- €	1.873.057 €	1.168 €	1.860.998 €	27.483 €	1.875.087 €	2.178 €
Feb-12	2.642.834 USD	1.985.302 €	- €	1.999.708 €	1.211 €	2.011.933 €	26.631 €	1.999.218 €	2.269 €
Mar-12	2.700.890 USD	2.027.848 €	- €	2.049.344 €	1.237 €	2.056.699 €	28.852 €	2.047.412 €	2.327 €
Apr-12	2.621.378 USD	1.983.788 €	- €	1.992.987 €	1.211 €	2.021.050 €	29.528 €	1.993.794 €	2.272 €
May-12	2.367.065 USD	1.921.007 €	- €	1.840.810 €	1.145 €	1.873.769 €	29.405 €	1.846.541 €	2.177 €
Jun-12	2.207.410 USD	1.753.304 €	- €	1.761.757 €	1.124 €	1.778.200 €	24.896 €	1.762.943 €	2.109 €
		61.402.273 €	- €	61.479.529 €	36.316 €	61.845.421 €	928.984 €	61.451.538 €	68.104 €
			0,000%		0,059%		1,502%		0,111%

Source: Historical Data; own calculations.

If we could ignore financial costs, strategy 2 would be the best one, followed by strategies 3, 0 and 1. Taking 2011 investment period as example, strategy 1 costs 1,43% of the unit margin, while strategy 2 represents about 35% and strategy 3 2,68%. It is clear that financial costs in strategy 2 (174k€ for 495k€ unit margin from May to November) make the business unviable, given the existence of more suitable alternatives.

4.4.6 Stress Test

Stress testing is a procedure that attempt to gauge the vulnerability of the portfolio to hypothetical events (Dowd, 2002). It is now often used, due to the fact that good stress testing might have helped firms to prevent some of the recent year's losses.

A negative variation in the EUR-USD exchange spot rate at 1% and 2% is set. The test forces the depreciation of Euro against USD on the first day of each month.

Table XIV - STRESS TESTS RESULTS

	scenario 0		scenario 1		scenario 2		scenario 3	
	total	cost	total	cost	total	cost	total	cost
baseline	61.402.273 €	- €	61.479.529 €	36.316 €	61.845.421 €	928.984 €	61.451.538 €	68.104 €
1,00%	61.995.066 €	- €	61.494.788 €	36.338 €	62.134.932 €	929.503 €	61.491.623 €	68.168 €
	0,97%	0,00%	0,02%	0,06%	0,47%	0,06%	0,07%	0,09%
2,00%	62.609.778 €	- €	61.523.964 €	36.372 €	62.282.907 €	930.008 €	61.531.957 €	68.231 €
	1,97%	0,00%	0,07%	0,15%	0,71%	0,11%	0,13%	0,19%

Source: Historical Data; own calculations.

The effects of 1% and 2% decline on the EUR-USD exchange rate:

- Strategy 0: spot rate at a lower value. The purchase of USD at a lower spot rate forces the firm to spend more Euros to buy the same amount of USD, given its depreciation against USD. This has a negative impact of 593k€ comparing to the baseline scenario, with an average increase of 14k€ per month. With 2% change it becomes the most expensive one (1.09M€ more than strategy 1, 1,08M€ more than strategy 3 and 327k€ more than strategy 2).

- Strategy 1: spot rate at a lower value. It has a negative impact on the monthly average rate. The costs remain practically unchanged. The increase of the amount results from a decrease in the average rate, causing an increase of 15k€. With 2% variation it has the lowest amount, due to the decline of the estimation errors growth rate.

- Strategy 2: The overall difference of 290k€ results from the change on the monthly average rate. In 27 out of 43 observations, it became more beneficial to exercise the option. *Strategy 2* works so well because it chooses the most favorable rate. With 2% change, the option is exercised in 35 situations instead of 27, since the average rate does not record a decline as steep as the spot rate, due to the dilution effect thought the remaining trading days.

- Strategy 3: with a lower spot rate, the impact on the average rate is negative. Financial costs remain practically unchanged. The variation on the spot rate causes an increase of 40k€ on the amount. With 2% variation it is only 0,013% worse than strategy 1.

4.4.7 Pricing Analysis

OZ Energia Gas buys the product from Repsol and sells it to OZ Energia Fuels, generating an internal transferred price. Given a purchasing and a selling price of Diesel, different unit margins are generated depending on the EUR-USD exchange rate, the only variable capable of changing the margin, since variations on Platts do not affect it.

The margin results are analyzed through the simulation of the previous strategies. Since the selling price is equal to all strategies, the purchasing price is the differentiating element, which depends entirely on the exchange rate used.

A weekly analysis is conducted from December 2008 to June 2012, where Diesel selling price on Monday is the Diesel average quotes on Platts of the previous week. Assuming the purchasing price as Diesel quotes on Platts plus 6,75 USD and the selling price as Diesel quotes on Platts plus 19,5 USD, these are the strategy formulas:

Purchasing Price:

Strategy 0: [Monthly Average Platts + 6,75 USD] * Day 1 Spot Exchange Rate

Strategy 1: [Daily Platts + 6,75 USD] * [Monthly Average Exchange Rate – 8pips]

Strategy 2: [(Monthly Average Platts + 6,75 USD) * Max (Monthly Average Exchange Rate; Day 1 Spot Exchange Rate)] * (1 + Put Premium/Payment)

Strategy 3: [Monthly Average Platts + 6,75 USD] * [Monthly Average Exchange Rate – 15pips]

Selling Price:

All strategies: [Daily Platts + 19,5 USD] * Daily Spot Exchange Rate

Following a simulation on each unit margin for 43 month long, we obtain four scenarios. *Strategy 0* reaches the best total margin, coming ahead of *Strategy 1* (exceeded by 16%), Strategy 3 (exceeded by 18%) and Strategy 2 (exceeded by 92%).

Financial costs have an important role in this analysis, where the strategy with no financial costs and no hedging positions set beats the others.

However, after conducting another stress test on the results, we got a different outcome:

Table XV - UNIT MARGIN ANALYSIS USING DIFFERENT STRATEGIES

	BASELINE SCENARIO				STRESS TEST (Δ = 1%)				STRESS TEST (Δ = 2%)			
	Strategy 0	Strategy 1	Strategy 2	Strategy 3	Strategy 0	Strategy 1	Strategy 2	Strategy 3	Strategy 0	Strategy 1	Strategy 2	Strategy 3
Dec-08	- 279,00 €	223,76 €	338,44 €	219,79 €	Dec-08	- 356,46 €	224,79 €	267,21 €	220,83 €	Dec-08	- 435,51 €	225,92 €	194,53 €	221,95 €
	- 279,00 €	**223,76 €**	**338,44 €**	**219,79 €**		**- 356,46 €**	**224,79 €**	**267,21 €**	**220,83 €**		**- 435,51 €**	**225,92 €**	**194,53 €**	**221,95 €**
Jan-09	549,80 €	196,93 €	73,43 €	192,85 €	Jan-09	479,06 €	196,58 €	73,01 €	192,50 €	Jan-09	406,89 €	196,29 €	72,67 €	192,21 €
Feb-09	184,39 €	193,27 €	52,27 €	189,55 €	Feb-09	119,54 €	193,68 €	52,60 €	189,95 €	Feb-09	53,37 €	194,15 €	53,01 €	190,43 €
Mar-09	- 61,78 €	200,19 €	195,90 €	196,21 €	Mar-09	- 135,87 €	200,26 €	124,41 €	196,28 €	Mar-09	- 211,47 €	200,39 €	84,67 €	196,41 €
Apr-09	222,87 €	188,66 €	72,67 €	184,88 €	Apr-09	154,94 €	188,66 €	54,68 €	184,88 €	Apr-09	85,62 €	188,72 €	54,69 €	184,94 €
May-09	- 12,52 €	180,81 €	341,30 €	177,23 €	May-09	- 12,52 €	177,43 €	272,37 €	173,84 €	May-09	- 12,52 €	174,04 €	202,03 €	170,45 €
Jun-09	333,74 €	196,33 €	78,13 €	191,71 €	Jun-09	245,95 €	196,19 €	24,82 €	191,56 €	Jun-09	156,37 €	196,13 €	24,68 €	191,50 €
Jul-09	211,08 €	200,60 €	150,65 €	196,09 €	Jul-09	123,94 €	200,93 €	62,91 €	196,42 €	Jul-09	35,03 €	201,34 €	12,01 €	196,82 €
Aug-09	200,00 €	173,81 €	30,32 €	169,53 €	Aug-09	116,72 €	174,09 €	1,97 €	169,81 €	Aug-09	31,73 €	174,45 €	2,26 €	170,17 €
Sep-09	41,86 €	188,47 €	17,00 €	184,25 €	Sep-09	- 43,84 €	188,79 €	17,25 €	184,57 €	Sep-09	- 131,29 €	189,20 €	17,58 €	184,97 €
Oct-09	6,98 €	181,34 €	18,42 €	176,89 €	Oct-09	- 85,61 €	181,37 €	18,38 €	176,91 €	Oct-09	- 180,10 €	181,48 €	18,42 €	177,02 €
Nov-09	92,57 €	175,33 €	101,87 €	171,05 €	Nov-09	4,45 €	175,58 €	13,85 €	171,31 €	Nov-09	- 85,46 €	175,92 €	4,30 €	171,65 €
Dec-09	457,10 €	179,95 €	5,29 €	175,58 €	Dec-09	372,37 €	179,99 €	5,25 €	175,61 €	Dec-09	285,91 €	180,11 €	5,29 €	175,73 €
	2.226,08 €	**2.255,69 €**	**1.137,25 €**	**2.205,85 €**		**1.339,13 €**	**2.253,53 €**	**721,50 €**	**2.203,64 €**		**434,09 €**	**2.252,23 €**	**551,59 €**	**2.202,29 €**
Jan-10	251,10 €	171,47 €	17,89 €	166,96 €	Jan-10	164,13 €	171,73 €	18,07 €	167,22 €	Jan-10	75,38 €	172,09 €	18,35 €	167,57 €
Feb-10	340,48 €	182,92 €	57,84 €	178,15 €	Feb-10	252,57 €	182,78 €	57,64 €	178,01 €	Feb-10	162,87 €	182,73 €	57,53 €	177,95 €
Mar-10	151,24 €	197,80 €	28,31 €	174,89 €	Mar-10	42,83 €	198,04 €	28,47 €	175,11 €	Mar-10	- 67,79 €	198,37 €	28,73 €	175,43 €
Apr-10	242,80 €	184,88 €	46,30 €	179,08 €	Apr-10	136,89 €	184,88 €	46,23 €	179,08 €	Apr-10	28,81 €	184,99 €	46,27 €	179,18 €
May-10	784,54 €	180,65 €	33,47 €	174,88 €	May-10	790,48 €	180,92 €	33,67 €	175,15 €	May-10	796,55 €	181,31 €	33,98 €	175,54 €
Jun-10	174,48 €	220,37 €	194,77 €	213,33 €	Jun-10	55,84 €	220,46 €	76,33 €	213,42 €	Jun-10	- 65,22 €	220,67 €	74,70 €	213,62 €
Jul-10	- 190,86 €	212,91 €	345,65 €	206,62 €	Jul-10	- 305,44 €	213,23 €	236,50 €	206,93 €	Jul-10	- 422,35 €	213,66 €	125,12 €	207,35 €
Aug-10	349,28 €	198,04 €	45,36 €	191,99 €	Aug-10	243,93 €	198,25 €	45,50 €	192,20 €	Aug-10	136,43 €	198,58 €	45,75 €	192,52 €
Sep-10	- 27,32 €	211,19 €	639,18 €	204,86 €	Sep-10	- 143,30 €	211,43 €	529,93 €	205,10 €	Sep-10	- 261,65 €	211,77 €	418,46 €	205,44 €
Oct-10	51,72 €	186,65 €	63,17 €	180,95 €	Oct-10	- 58,25 €	186,93 €	40,20 €	181,22 €	Oct-10	- 170,46 €	187,32 €	40,52 €	181,61 €
Nov-10	444,58 €	203,89 €	39,34 €	197,60 €	Nov-10	328,54 €	203,72 €	39,09 €	197,42 €	Nov-10	210,12 €	203,66 €	38,95 €	197,35 €
Dec-10	95,98 €	190,61 €	144,99 €	183,84 €	Dec-10	- 28,02 €	191,14 €	21,49 €	184,36 €	Dec-10	- 154,54 €	191,78 €	21,97 €	184,99 €
	2.668,01 €	**2.341,38 €**	**1.656,24 €**	**2.253,16 €**		**1.480,21 €**	**2.343,51 €**	**1.173,12 €**	**2.255,21 €**		**268,16 €**	**2.346,92 €**	**950,34 €**	**2.258,54 €**
Jan-11	53,96 €	185,46 €	389,46 €	178,79 €	Jan-11	53,49 €	179,40 €	263,09 €	172,73 €	Jan-11	- 96,17 €	173,34 €	134,13 €	166,66 €
Feb-11	289,56 €	178,34 €	166,67 €	171,46 €	Feb-11	161,83 €	178,21 €	37,70 €	171,31 €	Feb-11	31,49 €	178,20 €	- 6,81 €	171,30 €
Mar-11	0,76 €	200,32 €	145,78 €	192,01 €	Mar-11	- 161,70 €	200,45 €	- 15,21 €	192,13 €	Mar-11	- 327,47 €	200,72 €	- 22,76 €	192,40 €
Apr-11	- 97,43 €	173,92 €	352,52 €	167,57 €	Apr-11	- 225,10 €	174,62 €	229,40 €	168,25 €	Apr-11	- 355,37 €	175,46 €	103,76 €	169,08 €
May-11	591,62 €	68,59 €	40,07 €	182,52 €	May-11	591,62 €	182,76 €	- 23,02 €	176,15 €	May-11	591,62 €	176,39 €	- 29,49 €	169,76 €
Jun-11	214,13 €	53,43 €	87,47 €	178,03 €	Jun-11	69,68 €	185,60 €	- 17,09 €	178,27 €	Jun-11	- 77,72 €	186,00 €	- 16,79 €	178,66 €
Jul-11	419,72 €	174,20 €	159,03 €	175,38 €	Jul-11	279,14 €	182,23 €	15,82 €	174,95 €	Jul-11	135,70 €	181,94 €	1,28 €	174,64 €
Aug-11	276,42 €	196,24 €	- 12,70 €	187,02 €	Aug-11	134,48 €	194,93 €	- 12,12 €	187,67 €	Aug-11	- 10,36 €	195,73 €	- 11,40 €	188,47 €
Sep-11	764,54 €	227,02 €	- 14,99 €	187,37 €	Sep-11	620,42 €	195,13 €	- 15,24 €	187,21 €	Sep-11	473,36 €	195,12 €	- 15,34 €	187,19 €
Oct-11	- 240,75 €	165,24 €	- 5,75 €	174,54 €	Oct-11	- 391,19 €	182,46 €	- 5,67 €	174,69 €	Oct-11	- 544,71 €	182,75 €	- 5,46 €	174,98 €
Nov-11	291,88 €	234,64 €	- 24,82 €	187,66 €	Nov-11	134,17 €	196,16 €	- 24,92 €	187,65 €	Nov-11	- 26,76 €	196,30 €	- 24,88 €	187,78 €
Dec-11	523,56 €	178,57 €	- 29,39 €	170,86 €	Dec-11	387,94 €	178,87 €	- 29,19 €	171,15 €	Dec-11	249,54 €	179,32 €	- 28,84 €	171,59 €
	3.087,97 €	**2.035,99 €**	**1.253,37 €**	**2.153,19 €**		**1.654,78 €**	**2.230,83 €**	**403,55 €**	**2.142,16 €**		**43,16 €**	**2.221,26 €**	**77,41 €**	**2.132,51 €**
Jan-12	89,23 €	203,07 €	311,19 €	194,36 €	Jan-12	88,79 €	195,75 €	150,22 €	187,03 €	Jan-12	77,36 €	188,43 €	- 14,03 €	179,70 €
Feb-12	141,23 €	192,32 €	93,63 €	183,64 €	Feb-12	- 17,09 €	192,19 €	- 16,13 €	183,51 €	Feb-12	- 178,63 €	192,22 €	- 16,20 €	183,52 €
Mar-12	361,28 €	184,45 €	123,00 €	193,47 €	Mar-12	191,91 €	202,77 €	- 36,32 €	193,35 €	Mar-12	19,09 €	202,81 €	- 36,39 €	193,38 €
Apr-12	361,25 €	173,76 €	- 39,16 €	166,58 €	Apr-12	219,40 €	174,79 €	- 39,07 €	166,77 €	Apr-12	74,65 €	175,14 €	- 38,83 €	167,11 €
May-12	737,60 €	293,87 €	- 75,20 €	168,99 €	May-12	745,65 €	178,01 €	- 75,41 €	168,89 €	May-12	753,87 €	178,08 €	- 75,46 €	168,94 €
Jun-12	- 35,81 €	186,77 €	64,26 €	177,82 €	Jun-12	- 164,24 €	185,63 €	71,53 €	178,24 €	Jun-12	- 295,29 €	186,20 €	78,95 €	178,80 €
	1.654,79 €	**1.234,24 €**	**477,73 €**	**1.084,86 €**		**1.064,43 €**	**1.129,15 €**	**54,82 €**	**1.077,78 €**		**451,04 €**	**1.122,87 €**	**- 101,96 €**	**1.071,46 €**
	9.358 €	**8.091 €**	**4.863 €**	**7.917 €**		**5.182 €**	**8.182 €**	**2.620 €**	**7.900 €**		**761 €**	**8.169 €**	**1.672 €**	**7.887 €**
						-45%	*1%*	*-46%*	*0%*		*-92%*	*1%*	*-66%*	*0%*

Source: Internal Data of OZ Energia; own calculations.

With 1% change on the spot exchange rate of day 1, *Strategy 0* sees its margin reducing by 45% and with 2% change on the same rate, 92% decline of the margin is attained. This strategy is undesirable, since the firm cannot take the risk of losing almost 100% of the investment due to changes on the exchange rate.

Apart from that, strategies 1 and 3 remain solid in both cases and don't record any negative effect on their margins, while *Strategy 2* has a negative impact of 46% with 1% change and 66% with 2% change.

This is explained by several aspects. The decline in the exchange rate is felt intensely, since both spot and average rates register falls. Due to the fact that the option is not exercised many times, the decline of the spot rate of day 1 turns out to have a greater impact than, for instance, strategies 1 and 3 which have a much lower impact on the average rate.

Additionally, the financial costs of this strategy weigh heavily in its final result.

This analysis complements the previous one, where the best hedging strategy is studied taking into account the total costs of the operation. Here, the revenue side is considered to define the best strategy in terms of income immunization to changes in the exchange rate.

The firm needs to focus on the business and the investment cannot be subject of external variables that may have such an impact making it impracticable. Thus, strategies 1 and 3 are the best choices and, since the firm wants to replace the current one, due to human risks (among other factors presented), then *Strategy 3* is once again the best strategy.

5. CONCLUSIONS

This section reports the results for the best hedging strategy of a particular investment at OZ Energia. Among the risks initially identified, only currency risk has led to an extensive analysis, since the other risks are already hedged (the case of market and credit risks) or can be ignored (the case of the interest rate risk).

Focusing on the currency risk hedging, four different scenarios are presented: no risk hedging strategy, the current strategy using forwards, an asian option and a swap strategy.

From the cost analysis comparison, where the financial costs to support the hedging are considered, it is possible to see that strategy 3 has a better performance than the others, based on monthly historical data. Furthermore, in stress test scenarios simulating a negative variation in the EUR-USD exchange spot rate at 1% and 2%, strategy 3 still remains as the more consistent one.

Through the pricing analysis we study the investment revenue of the firm for the strategies previously applied, which then translates into the study of the firm's net margin.

Strategy 1 has an outcome only 2 percentage points above strategy 3 (the second best) based on weekly historical data, but as is known, the firm wants to replace the current strategy for one that would suit better its circumstances.

After simulating two stress tests with the same variations as previously used, strategy 3 remains unchanged in both situations, which proves to be a good strategy, since is not possible to obtain neither gain nor loss from it.

Giving the circumstances, strategy 3 is the best one, since it has a simple execution and allows the firm to obtain an average exchange rate, leaving it less exposed to volatility. Therefore, that is considered the best strategy in risk hedging of this particular product import.

Firms in this industry that are oil product sellers rather than producers, have the same sort of issue faced by OZ Energia. As future research we think that it would be interesting to extend this analysis to such firms, to understand how their different features in terms of dimension or exposure would affect the resolution of those risks and the choice of the hedging instruments.

6. REFERENCES

Ammann, M. (2001). *Credit Risk Valuation: Methods, Models, and Applications,* 2nd Edition. Springer.

APETRO (2011). The Price of Fuel - The Truth of the Numbers. Informative Series Volumes I-V.

Bank of Portugal – 1-Month Euribor (Dec 08 – Jun 12).

Bank of Portugal – EUR-USD Exchange Rates (Dec 07 – Jun 12).

Baz. J. and Pascutti, M. (1996). Alternative Swap Contracts Analysis and Pricing. *Journal of Derivatives* (Winter 1996), 7-21.

Black, F and Scholes, M. (1973). The Pricing of Options and Corporate Liabilities. *The Journal of Political Economy* 81 (3), 637-654.

Brown, K. and Smith, D. (1996). Interest Rate and Currency Swaps: A Tutorial. Association for Investment Management and Research.

Bychuk, O. and Haughey, B. (2011). *Hedging Market Exposures: Identifying and Managing Market Risks,* 1st Edition. Wiley.

Dowd, K. (2002). *Measuring Market Risk*, 1st Edition. Wiley.

European Central Bank - EONIA Rate (Jan 08 – Jun 12).

Federal Reserve Bank of New York - Federal Reserve Funds Rate (Jan 08 – Jun 12).

Haug, E. G. (1997). *The Complete Guide to Option Pricing Formulas*, 1st Edition. McGraw-Hill.

Hull, J. (2002*). Fundamentals of Futures and Options Markets*, 4th Edition. Prentice Hall.

Hull, J. (2009). *Options, Futures, and Other Derivatives*, 7th Edition. Prentice Hall.

Hutson, J. (1982-83). The Logarithmic Scale. *Technical Analysis of Stocks & Commodities* 1 (5), (123-123).

International Energy Agency (2011). Oil & Gas Security - Emergency Response.

Jacque, L (1996). *Management and Control of Foreign Exchange Risk*. 1st Edition. Springer.

Kemna, A. and Vorst, T. (1990). A Pricing Method for Options Based on Average Asset Values. *Journal of Banking & Finance* 14, 113–129.

Linsmeier, T. and Pearson, N. (1996). Risk Measurement: An Introduction to Value at Risk. *Paper*. University of Illinois.

Marrison, C. (2002). *The Fundamentals of Risk Measurement*, 1st Edition. McGraw-Hill.

Ordinance 41/2011 (January 9, 2011).

Platts Platform – Diesel 10ppm NWE daily quotes (Dec 08 – Jun 12).

Rubinstein, M. and Reiner, E. (1992). Exotic Options. *Working Paper*. University of California.

Sharpe, W. (1994). The Sharpe Ratio. *The Journal of Portfolio Management* 21, 49-58.

Turnbull, S. and Wakeman, L. (1991). A Quick Algorithm for Pricing European Average Options. *Journal of Financial and Quantitative Analysis* 26, 377–389.

Wolke, T. (2008). *Risiko-Management*, 2snd Edition. Oldenbourg.

7. APPENDIX

Table A - KEY OIL DATA IN PORTUGAL

	1985	1990	1995	2000	2005	2008	2009	2010
Production (kb/d)	-	-	-	-	-	0.8	0.8	0.3
Demand (kb/d)	179.9	251.0	290.3	332.7	336.9	288.9	270.6	271.7
Motor gasoline	*19.8*	*31.7*	*43.8*	*49.0*	*41.9*	*34.4*	*34.2*	*32.5*
Gas/diesel oil	*41.2*	*54.2*	*66.8*	*101.2*	*115.0*	*111.2*	*112.9*	*114.2*
Residual fuel oil	*63.8*	*79.1*	*82.3*	*68.9*	*63.7*	*40.7*	*31.7*	*26.9*
Others	*55.1*	*85.9*	*97.5*	*113.6*	*116.3*	*102.6*	*91.9*	*98.1*
Net imports (kb/d)	179.9	251.0	290.3	332.7	336.9	288.1	269.8	271.4
Import dependency	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*99.7%*	*99.7%*	*99.9%*
Refining capacity (kb/d)	290	313	304	304	304	304	304	310
Oil in TPES	75.7%	63.9%	65.6%	60.6%	58.6%	52.9%	49.5%	-

Source: International Energy Agency (IEA).

Table B - MARKET SHARE OF OIL INDUSTRY IN PORTUGAL

	2008	2009	1S 2010
GALP	[40%-50%]	[35%-40%]	[30%-35%]
BP	[10%-15%]	[15%-20%]	[15%-20%]
REPSOL	[15%-20%]	[15%-20%]	[15%-20%]
CEPSA / TOTAL	[5%-10%]	[5%-10%]	[5%-10%]
Independent	7%	9%	9%
Supermarkets	12%	16%	18%
	100%	**100%**	**100%**

Source: Competition Authority.

Table C - FINANCIALS COSTS RELATED TO FORWARDS CONTRACTED IN USD DAILY PURCHASES

	Out-Flow ($)	Payment (forward) (€)	Forward Costs (€)
May	-3.416.560	-2.403.644	1.352
June	-3.458.175	-2.412.268	1.345
July	-3.541.300	-2.485.445	1.395
August	-2.916.870	-2.034.487	1.135
September	-2.933.910	-2.130.691	1.237
October	-2.987.580	-2.184.056	1.277
November	-2.253.159	-1.659.432	977
	-21.507.554	**-15.310.023**	**8.718**

Source: Internal Data of OZ Energia; own calculations.

Table D - ASIAN PUT OPTION EXERCISE ANALYSIS

month	s = x	rf	volatility	put		premium		rate (put)	rate (spot)	strategy
Dec-08	1,2608	3,52%	13,23%	0,018	1,43%	19.485 USD	14.487 €	1,3449	1,3866	*not exercised*
Jan-09	1,3866	2,57%	15,34%	0,024	1,70%	19.975 USD	15.089 €	1,3239	1,2760	*exercised*
Feb-09	1,2760	1,74%	16,43%	0,024	1,85%	21.758 USD	17.019 €	1,2785	1,2596	*exercised*
Mar-09	1,2596	1,52%	16,60%	0,024	1,87%	18.975 USD	14.541 €	1,3050	1,3246	*not exercised*
Apr-09	1,3246	1,11%	17,39%	0,026	1,97%	22.688 USD	17.200 €	1,3190	1,3223	*not exercised*
May-09	1,3223	0,93%	17,63%	0,027	2,00%	23.343 USD	17.101 €	1,3650	1,4220	*not exercised*
Jun-09	1,4220	0,93%	17,91%	0,029	2,04%	29.256 USD	20.873 €	1,4016	1,4096	*not exercised*
Jul-09	1,4096	0,74%	18,02%	0,029	2,07%	30.431 USD	21.601 €	1,4088	1,4303	*not exercised*
Aug-09	1,4303	0,53%	18,02%	0,030	2,07%	32.137 USD	22.524 €	1,4268	1,4314	*not exercised*
Sep-09	1,4314	0,48%	17,92%	0,029	2,05%	30.478 USD	20.930 €	1,4562	1,4539	*exercised*
Oct-09	1,4539	0,44%	17,29%	0,029	1,98%	29.779 USD	20.098 €	1,4816	1,4772	*exercised*
Nov-09	1,4772	0,42%	16,46%	0,028	1,89%	31.049 USD	20.818 €	1,4914	1,5074	*not exercised*
Dec-09	1,5074	0,48%	16,01%	0,028	1,83%	30.571 USD	20.905 €	1,4624	1,4389	*exercised*
Jan-10	1,4389	0,45%	14,14%	0,023	1,62%	27.932 USD	19.571 €	1,4272	1,3913	*exercised*
Feb-10	1,3913	0,43%	13,04%	0,021	1,49%	23.408 USD	17.104 €	1,3686	1,3525	*exercised*
Mar-10	1,3525	0,42%	12,71%	0,020	1,46%	24.561 USD	18.101 €	1,3569	1,3468	*exercised*
Apr-10	1,3468	0,40%	11,47%	0,018	1,31%	24.260 USD	18.097 €	1,3406	1,3089	*exercised*
May-10	1,3089	0,41%	10,91%	0,016	1,25%	23.916 USD	19.066 €	1,2544	1,2155	*exercised*
Jun-10	1,2155	0,43%	11,67%	0,016	1,34%	22.488 USD	18.420 €	1,2209	1,2328	*not exercised*
Jul-10	1,2328	0,51%	11,48%	0,016	1,31%	21.187 USD	16.591 €	1,2770	1,3073	*not exercised*
Aug-10	1,3073	0,65%	11,70%	0,017	1,34%	24.001 USD	18.601 €	1,2903	1,2800	*exercised*
Sep-10	1,2800	0,62%	11,70%	0,017	1,34%	23.042 USD	17.634 €	1,3067	1,3726	*not exercised*
Oct-10	1,3726	0,70%	11,93%	0,019	1,35%	25.543 USD	18.379 €	1,3898	1,3926	*not exercised*
Nov-10	1,3926	0,85%	12,20%	0,019	1,39%	26.228 USD	19.199 €	1,3661	1,3115	*exercised*
Dec-10	1,3115	0,81%	12,61%	0,019	1,44%	28.007 USD	21.185 €	1,3220	1,3348	*not exercised*
Jan-11	1,3348	0,77%	12,62%	0,019	1,43%	29.334 USD	21.957 €	1,3360	1,3755	*not exercised*
Feb-11	1,3755	0,92%	12,79%	0,020	1,45%	32.538 USD	23.839 €	1,3649	1,3825	*not exercised*
Mar-11	1,3825	0,87%	12,65%	0,020	1,43%	35.544 USD	25.390 €	1,3999	1,4141	*not exercised*
Apr-11	1,4141	0,98%	12,63%	0,020	1,42%	36.877 USD	25.535 €	1,4442	1,4837	*not exercised*
May-11	1,4780	1,24%	12,73%	0,021	1,43%	37.868 USD	26.391 €	1,4349	1,4408	*not exercised*
Jun-11	1,4408	1,22%	12,27%	0,020	1,37%	34.602 USD	24.048 €	1,4388	1,4488	*not exercised*
Jul-11	1,4488	1,33%	12,19%	0,020	1,36%	32.879 USD	23.050 €	1,4264	1,4415	*not exercised*
Aug-11	1,4415	1,43%	12,18%	0,020	1,37%	34.803 USD	24.265 €	1,4343	1,4285	*exercised*
Sep-11	1,4285	1,35%	12,30%	0,020	1,38%	34.893 USD	25.340 €	1,3770	1,3327	*exercised*
Oct-11	1,3327	1,36%	12,41%	0,019	1,39%	32.895 USD	24.000 €	1,3706	1,3627	*exercised*
Nov-11	1,3627	1,36%	12,58%	0,019	1,42%	35.864 USD	26.457 €	1,3556	1,3492	*exercised*
Dec-11	1,3492	1,21%	12,69%	0,019	1,44%	35.297 USD	26.783 €	1,3179	1,2935	*exercised*
Jan-12	1,2935	1,01%	12,54%	0,019	1,43%	35.466 USD	27.483 €	1,2905	1,3175	*not exercised*
Feb-12	1,3175	0,70%	12,39%	0,019	1,42%	35.217 USD	26.631 €	1,3224	1,3312	*not exercised*
Mar-12	1,3312	0,55%	12,64%	0,019	1,45%	38.087 USD	28.852 €	1,3201	1,3319	*not exercised*
Apr-12	1,3319	0,42%	12,56%	0,019	1,44%	38.864 USD	29.528 €	1,3162	1,3131	*exercised*
May-12	1,3131	0,40%	12,38%	0,019	1,42%	37.572 USD	29.405 €	1,2777	1,2322	*exercised*
Jun-12	1,2322	0,38%	12,35%	0,017	1,41%	31.210 USD	24.896 €	1,2536	1,2590	*not exercised*

Source: Internal Data of OZ Energia; own calculations.

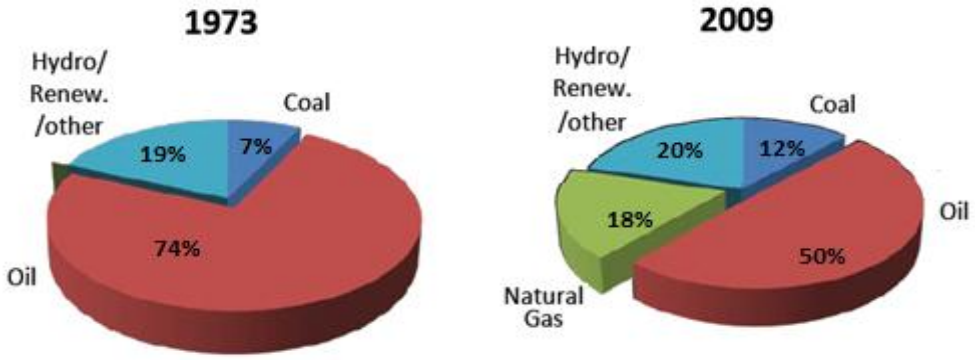

Figure A - Total Primary Energy Supply in Portugal.
Source: Energy Balances of OECD Countries, IEA.

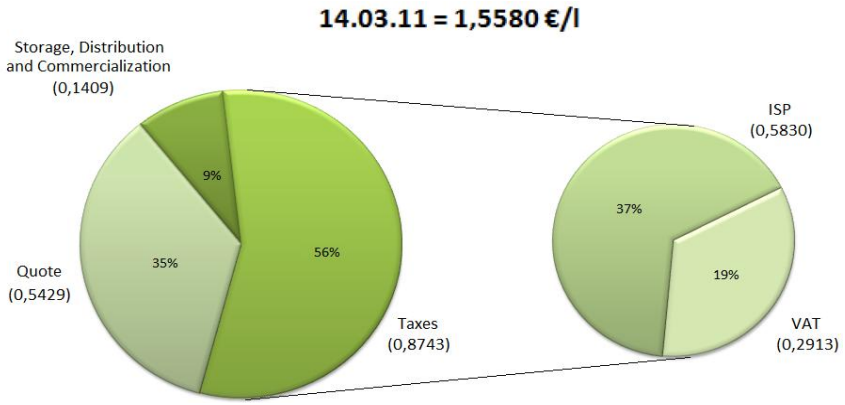

Figure B - Weekly Average Sale Price of Gasoline 95 in Portugal on March 14, 2011.
Source: APETRO.

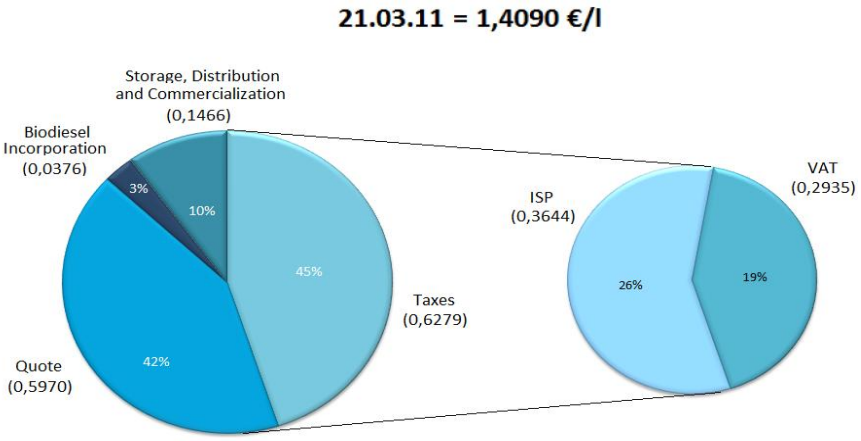

Figure C - Weekly Average Sale Price of Diesel in Portugal on March 21, 2011.
Source: APETRO.

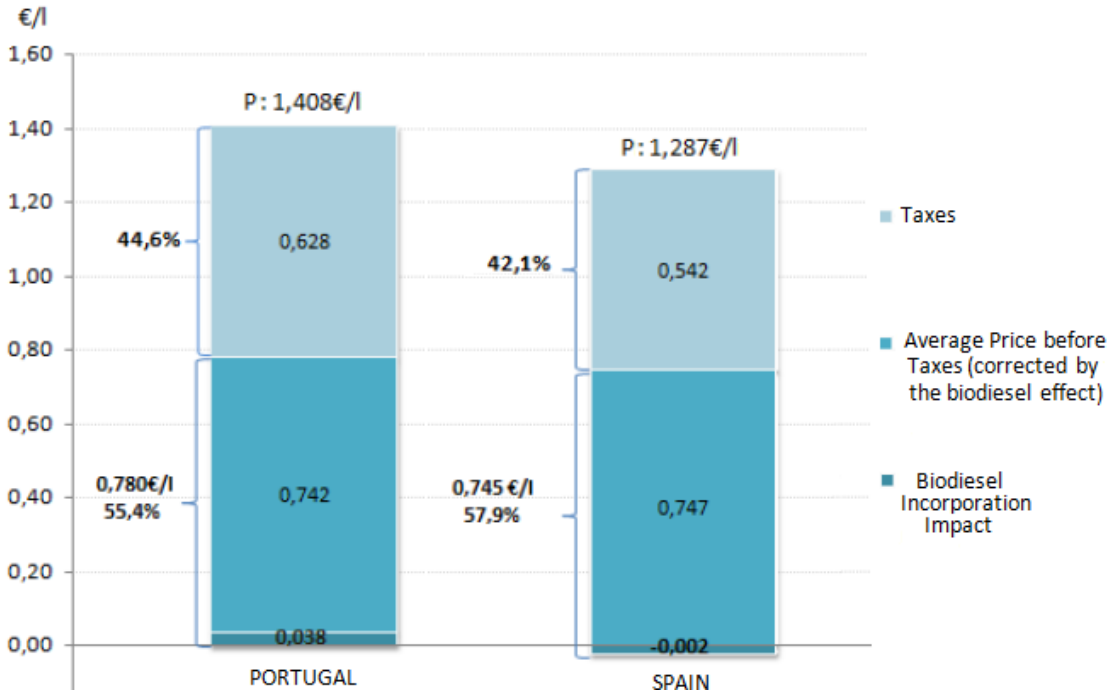

Figure D - Average Sale Price of Diesel in Portugal and Spain, on March 28, 2011.
Source: APETRO.

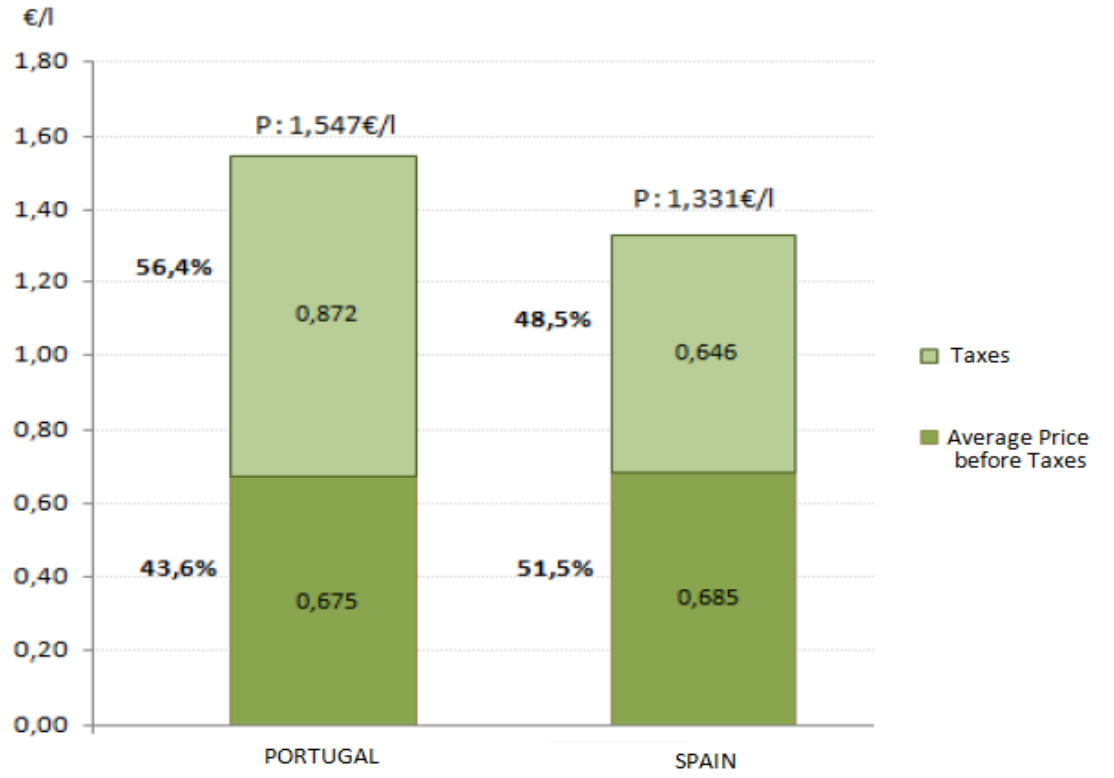

Figure E - Average Sale Price of Gasoil in Portugal and Spain, on March 28, 2011.
Source: APETRO.

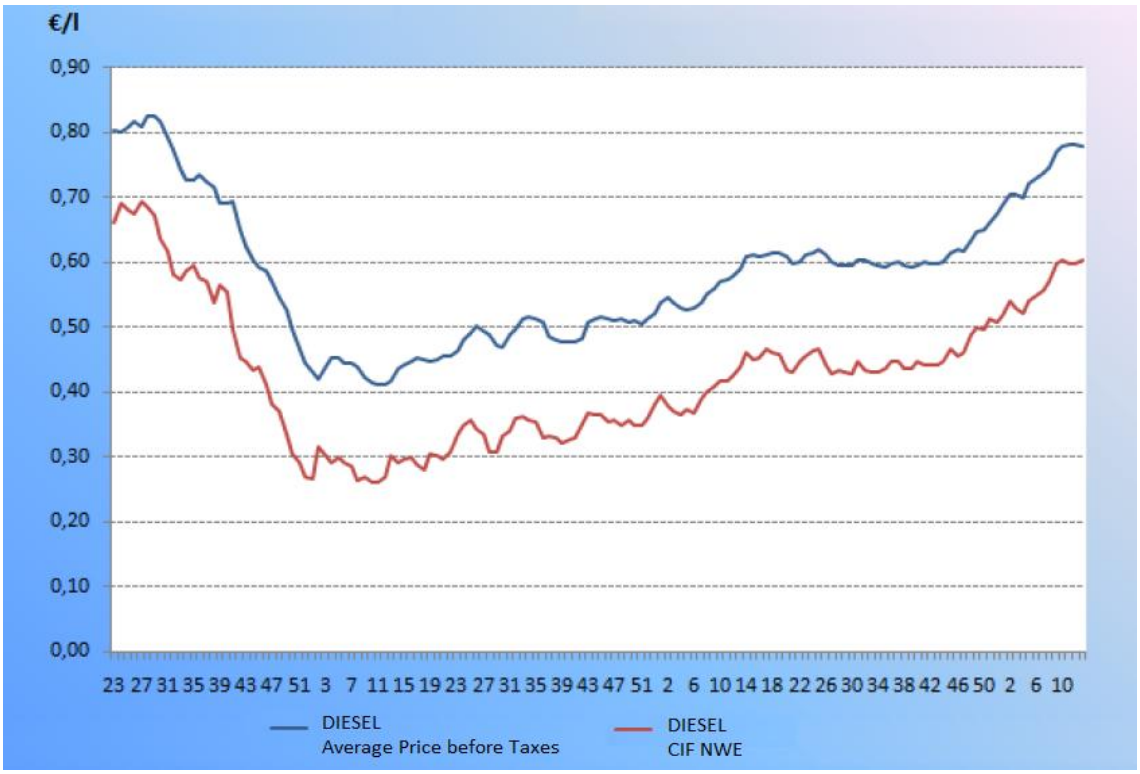

Figure F - Diesel Average Price before taxes and CIF NWE evolution, from Jun-08 to Apr-11.
Source: European Commission Oil Bulletin.

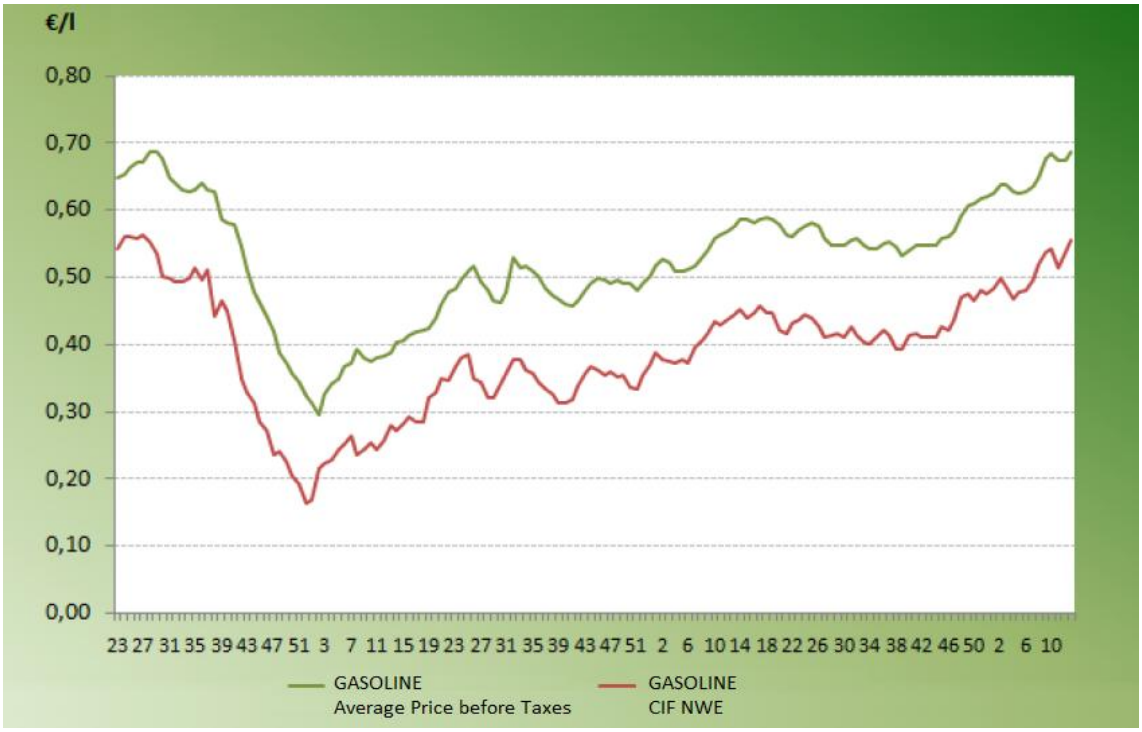

Figure G - Gasoil Average Price before taxes and CIF NWE evolution, from Jun-08 to Apr-11.
Source: European Commission Oil Bulletin.