ISCTE Business School
Instituto Universitário de Lisboa

AN ANALYSIS OF US CLEAN ENERGY INDEXES RISK FACTORS

Pedro Manuel Duarte Antunes Luís

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Supervisor:

Professor Sofia Brito Ramos, Assistant Professor, ISCTE Business School, Finance Department

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Abstract

Environmental concerns coupled with the increasingly importance of the alternative energies in the world economy are moving the energy consumption from oil, towards more environmental friendly sources. Whereas it is commonly known that, an increase oil price has a good financial impact on alternative energy stock prices, the works that analyzes the alternative energy risk factors are scarce.

This thesis analyzes the risk factors of investing in alternative energies, using for this purpose, a four variable regression where the factors are oil prices, technology stock prices, S&P 500 and interest rates. Due to their growing importance in markets, it is of interest of investors, managers and policy makers to know the risks of this kind of investments. The correlation matrix show that clean energy companies are more influenced by technology companies returns than with oil prices movements. The regression analysis show that oil prices, technology stock prices, risk free rate and the S&P 500 have some relative strength in explaining clean energy stock price movements. In addition, it also demonstrates that technology stock price movements are more important to explain alternative energy stock price movements than oil price movements because investors may see alternative energy companies similar to technology companies.

JEL Classification: Q42, Q43.

Key Words: Clean Energy, Stock Prices, Oil prices, Risk Factors.

Resumo

Preocupações ambientais juntamente com a crescente importância das energias alternativas na economia mundial estão a mudar os hábitos de consumo energéticos do petróleo, em direção a fontes mais ecológicas. Enquanto é conhecido que, um aumento no preço do petróleo tem um impacto financeiro positivo no preço das ações das energias alternativas, os trabalhos que analisam os fatores de risco das energias alternativas são escassos.

Esta tese analisa os fatores de risco de investir em energias alternativas, usando para este propósito, uma regressão com quatro variáveis onde os fatores de risco são preços do petróleo, preços de ações de empresas tecnológicas, S&P 500 e taxas de juro. Devido à sua crescente importância nos mercados, é portanto do interesse dos investidores, empresários e políticos saber quais os riscos deste tipo de investimentos. A matriz de correlação indica que as empresas de energias alternativas são mais influenciadas pelo retorno de empresas tecnológicas do que pelas alterações dos preços do petróleo. A análise da regressão estatística demonstra que os preços do petróleo, as cotações das ações das empresas de tecnologia, as taxas de juro e o S&P 500 tem algum poder relativo na explicação das alterações das cotações das ações das empresas de energia alternativa. A regressão mostra ainda que, as alterações do preço das ações das empresas tecnológicas têm maior importância na explicação dos movimentos dos preços das ações das empresas de energia alternativa do que as oscilações do preço do petróleo, devido à forma como os investidores poderão ver as empresas de energia alternativa semelhantes às empresas tecnológicas.

Classificação JEL: Q42, Q43.

Palavras-Chave: Energia Alternativa, Preço das Ações, Preço do Petróleo, Fatores de Risco.

List of Abbreviations

Abbreviation	Meaning	Page
US	United States	1
Mb/d	Million barrels per day	2
OECD	Organization for Economic Co-operation and Development	2
OPEC	Organization of the Petroleum Exporting Countries	2
Mtoe	Millions tons of oil equivalent	3
Mb	Million barrels	3
IPCC	Intergovernmental Panel on Climate Change	4
Y2K	Year 2000	6
NYSE	New York Stock Exchange	7
S&P	Standard and Poor	7
Fed	Federal Reserve System	9
CDO	Collateralized Debt Obligations	9
MBS	Mortgage-Backed Securities	9
TARP	TARP	14
GDP	Gross Domestic Product	14
IMF	International Monetary Fund	16
EIA	US Energy Information Administration	19
IEA	International Energy Agency	23
REN21	Renewable Energy Policy Network for the 21st Century	23
GW	Gigawatts	23
PV	Photovoltaic	23
EU	European Union	24
RE	Renewable Energy	24
VRE	Variable Renewable Energy	24
USD	United States Dollar	25
ADF	Aumegted Dickey-Fuller	29

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1. Introduction

"The Administration is committed to a comprehensive energy strategy that supports economic and job growth, bolsters energy security, positions the US to lead the world in clean energy, and addresses the global challenge of climate change" Economic Report of the President (2013).

The importance of alternative energies is expected to continue to increase in the coming years, due mainly to environmental concerns and energy security issues. Therefore, the importance of this sector in the global economy is expected to grow and more firms have been appearing along the years. Thus it is of interest of investors to know the risks of investing in alternative energy firms.

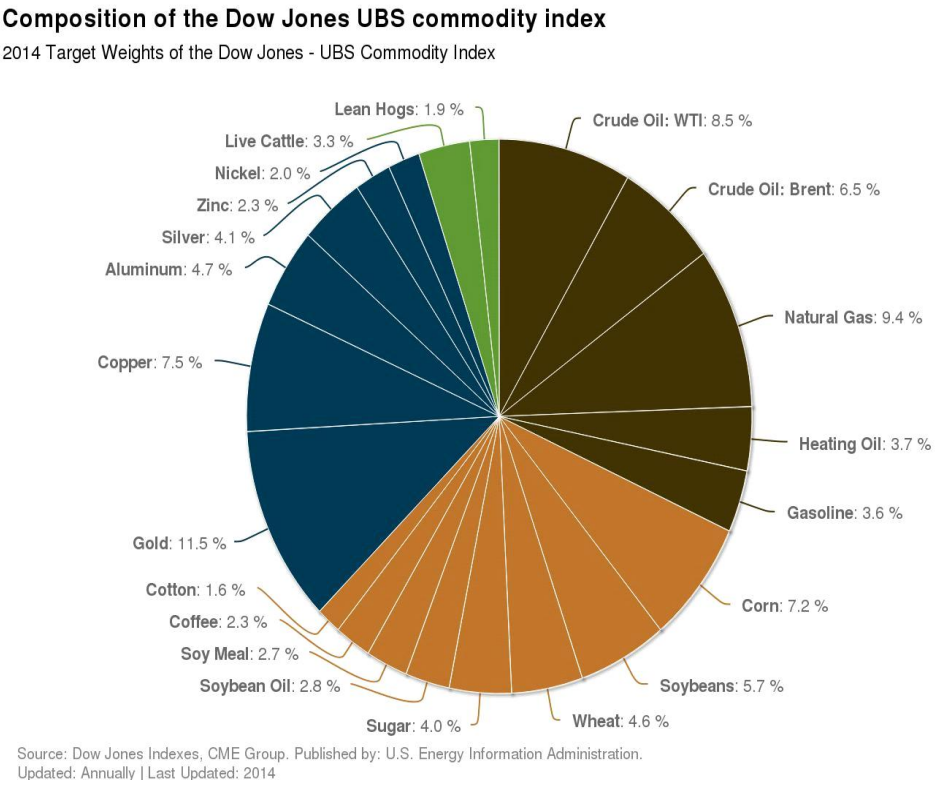
The aim of this thesis is to analyze the risk factors of alternative energy stocks, being oil prices, technology stock prices and interest rates the major risk factors. Oil price movements help to explain alternative energy stock movements because it is, first of all, an important substitute where rising oil prices increase alternative energy demand (Henriques and Sadorski, 2008). Furthermore, the same paper suggest that stock prices of alternative energy companies are more influenced by shocks in technology stock prices than by oil prices movements. Kumar et al. (2012) extend Henriques and Sadorsky (2008), and state that investors see clean energy firms as technology firms, although Managi (2013) results, contradict it. He shows that after structural breaks, there is a positive relationship between oil prices and clean energy prices, which reveal a different view, whereas Henriques and Sadorsky (2008) and Kumar et al. (2012) show that alternative energy companies are more influenced by shocks in technology stock prices than oil price movements and that alternative energy firms are seen by investors as technology firms, Managi (2013) states that before structural breaks the results are consistent with them, however, after structural breaks there is a positive relationship between oil prices and clean energy prices.

The purpose of this paper is, thus, to shed some light on this issue in order to know the risks of this kind of investments.

To better understand the aforementioned relations, it is fundamental to begin this study by analyzing the energy consumption worldwide.

Oil is the major driver of the world economy, it affects all industries thus every activity relies on it and it is as well, the most traded commodity, as it can be seen in Figure 1. Crude oil alone accounts for 15%, which represents the commodity with the greatest importance, followed by Gold (11.5%), Natural Gas (9.4%) and Copper (7.5%). In the other hand, Nickel (2.0%), Lean Hogs (1.9%) and Cotton (1.6%) are the ones with the smallest relevance when comparing with the other commodities. The US is the biggest crude oil importer according to Key World Energy Statistics (2013).

Figure 1 – Dow Jones UBS commodity Index Composition

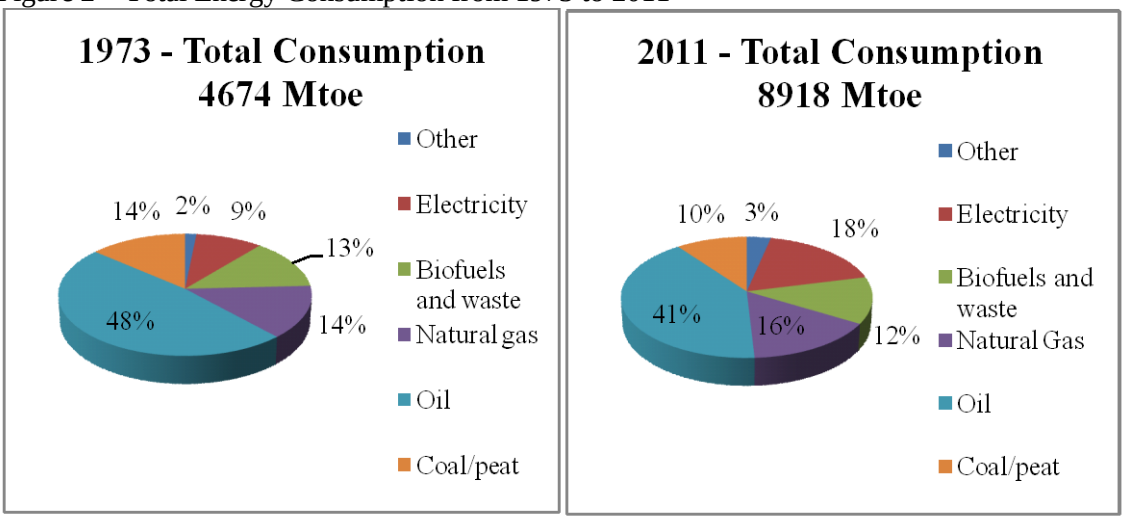


Source: http://www.eia.gov/finance/markets/financial_markets.cfm

The World oil demand in 2013 represents a growth of 1% or 0.82 mb/d compared to the previous year and forecasts for 2014 indicate that it is expected to increase by 1 mb/d or 1.2%. However, the OECD consumption is expected to continue to decline at rate of 0.2 mb/d (OPEC October 2013). On the other hand, compared to the global spectrum of the energy, as Figure 2 demonstrates, oil consumption has been

decreasing, which represents a change towards alternative energies. Analyzing the year of 1973 and 2011 in regard to the world consumption, we can see a positive evolution in the alternative energies it evolves from 1.6% in 1973 to 3.4% in 2011 and a decrease in oil from 48.1% to 40.8%, respectively, despite the fact that in global terms the energy consumption has increased from 4674 to 8918 Mtoe in 2011 (Key World Energy Statistics 2013).

Figure 2 – Total Energy Consumption from 1973 to 2011



Source : Key World Energy Statistics

Regarding the commercial stock movements, results for August 2013 show that OECD commercial oil stocks decreased by 10.4 mb, where it reached a 68 mb below the five-year average and presented a 53 mb less than the previous year. On the other hand, the results about the same period demonstrate that US commercial oil stocks increased by 4.5 mb and inventories stood at 2.4 mb or 0.2% above the year before and showed a gain of 33 mb or 3% over the five-year average (OPEC October 2013).

While energy consumption is increasing, as it can be seen in Figure 2, it is crucial that other sources of energy are used, namely clean or alternative energies such as solar, wind, geothermal, heat between others, in order to limit climate changes and so embrace the sustainable development. In the US, several policies and measures have been implemented such as market-based solution to climate change, which provide economic incentives to those who pollute less, so that the cost of polluting reflects the economic harm caused to others. Cap-and-trade system and Clean Energy Standard are

examples of market-based solutions presented in the Economic Report of the President (2013).

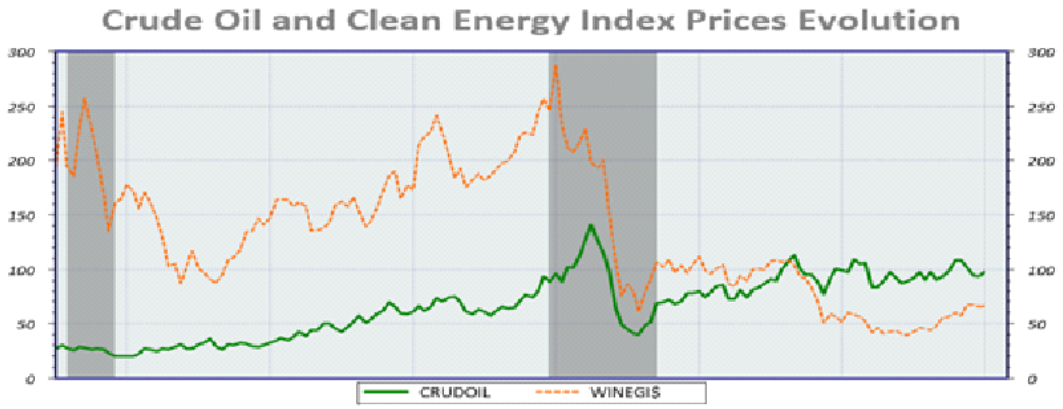
According to IPCC 2013, human influence on the climate is clear, raising greenhouse gas concentrations in the atmosphere, forcing positive radioactive and global warming. In addition, the report also states that in order to limit the climate changes it would be necessary to reduce the greenhouse gas emissions, because the continued emissions will cause further warming and changes to the climate system. So, it is fundamental not only, to further develop the alternative energies, but as well to reduce the human footprint on the environment, in order to build a greener society.

After motivating this topic and explaining what issues are expected to be covered it is time to do a brief overview over the sample period about what happened in the world economy but more precisely in the US, followed by market analysis, review literature, data and empirical analysis. The final chapter of the thesis presents the major conclusions.

2. Overview of the sample period- The new century

This chapter of the thesis intends to study some of the events of the sample period, from the year of 2001 until 2013, subdivided in three sub periods, which happened in the US, in order to examine the relationships among the variables under the scope of this paper.

Figure 3 – Crude Oil and Clean Energy Index Prices Evolution



Source: Thomson Reuters Datastream

Figure 3 provides a good picture regarding the way on these assets have developed since the beginning of 2001 until 2013. As the graphic illustrates, Crude Oil (West Texas Intermediate) is the green line and the Clean Energy Index is represented by WilderHill in orange. As it can be seen in 2001/2002 the Clean Energy Index suffered a great loss, whereas Crude Oil did not present a big variation, afterwards, both assets maintained a constant grow, prior to the global financial crisis, even reaching both assets peaking values, considering this sample period, suffering after it major hits. Following the losses caused by the crisis in 2007/2008 in the darker area, both assets kept constant values until the crude oil passes the clean energy index reverting the initial situation, until current days. In Figure 3 it seems that both assets follow a similar path, before the financial crisis and although the oil price had reached higher values after WilderHill, it appears that it suffered in the same way as clean energies. Contrasting with clean energies, which had decreased even more, the price of oil started to recover in 2009.

2.1 2001-2002 - The end of the recession and the terrorist attacks

The subperiod among 2001-2002 had two major events that caused a significant decline in financial markets, two distinct situations that combined aggravate even more the recession that was already in place. The so-called Dot-com bubble and the Terrorist attacks of 9/11.

In order to analyze this subperiod is necessary to go a couple of years back. In the year of 1999, there was an economic boom regarding technology companies, namely computer and software sales, induced by the Y2K fright, the bug of the millennium. In order to prevent this issue, many companies and individuals bought new software systems, which induced the stock prices of high technology companies to increase. As a result, a lot of investors invested in high technology companies, whether they are profitable or not.

In 2000, as companies and individuals had bought all the necessary computer equipment, computer orders had declined which led ultimately to a stock-market sell-off. As stock prices declined many high technology companies went bankrupt[1].As a consequence, the Nasdaq Composite, where most high technology company stocks are traded, lost 78% (percentage lost from peak to bottom) of its value as it fell from 5046.86 to 1114.11[2]. As it can be seen in the Figure 4, the Nasdaq suffered a great evolution, from less than 1000 points in 1995 to its highest value in 2000 of more than 4500 points. After it, the bubble burst and then, Nasdaq decreased to a little more than 1000 points in 2002. From 2002 until 2009, Nasdaq was having a constant growth when in 2008, with the global financial crisis as it is better explained afterwards, decreased again from 2500 to 1500 points.

[1] http://useconomy.about.com/od/grossdomesticproduct/a/cause_recession.htm
[2] http://www.investopedia.com/features/crashes/crashes8.asp

Figure 4 – Nasdaq Evolution between 1995 and 2010

Source: http://news.bbc.co.uk/2/hi/business/8558257.stm

Regarding the terrorist attacks, which happened on 11th of September of 2001, they had several implications, both short and long-term economic impacts, which led the Dow Jones to decrease more than 600 points, the 2001 recession to aggravate and had initiated the War on Terrorism. As stated before, the terrorist attacks worsened the 2001 recession, the economy had contracted in the first quarter and however the second quarter had described an economy growth, the attacks had extended the recession with a new economy contraction[3].

Furthermore, one of the measures undertaken was to kept NYSE and the Nasdaq closed until the 17th of September to try to avoid panic selling and a huge loss in the markets, it was the longest shutdown since 1933. On the first trading day of NYSE after 9/11, it set a record for the great loss in one day in exchange history, the market fell 684 points, which represented a 7.1% loss. By the end of that week, with the biggest losses in NYSE history, the Dow Jones had felt for almost of 1370 points, which translates in a loss over 14%. Regarding the other US index, the S&P lost 11.6%, a $1.4 trillion in value in a week. The most affected sectors were the airlines and insurance companies where American Airlines and United Airlines suffered the hardest hit, the first one dropped from a $29.70 per share on September 11th to $18.00 per share September 17th,

[3] http://useconomy.about.com/od/Financial-Crisis/f/911-Attacks-Economic-Impact.htm

a 39% decline, whereas the latter dropped from $30.82 to $17.50 representing a 42% decrease. Considering the financial services, Merrill Lynch and Morgan Stanley suffered the greatest losses, 11.5% and 13%, respectively.

In the other hand, there were some sectors which increased value, for instance, some technology, defense, weaponry, communications and pharmaceutical companies saw share prices grow due to an increase in government business as the country prepared for war[4].

According to Kliesen, the 2001 recession and its recovery was unique in some aspects. Firstly, it had a relatively short duration, when compared to other recessions. Secondly, in a usual recession, the spending on durable goods and real estate decrease, but this was not the situation, it kept increasing during the recession.

After covered the period among 2001-2002 it is time to study what happened between the following subsample period, 2003-2007.

[4] http://www.investopedia.com/financial-edge/0911/how-september-11-affected-the-u.s.-stock-market.aspx

2.2 2003-2007 – Sub-prime crisis and the housing market bubble

Following the technology bubble and the events happened on 11th September of 2001, the Fed, in the US, cut the interest rates to an extremely low level, in order to stimulate the economy. This measure was the beginning, ironically, to a new crisis. People who usually could not afford loans, because of the poor credit rating, were able to access it through the sub-prime lending, when non-traditional mortgages were created, interest-only loans and mortgages with extended amortization periods, for example. Interest rates ended up climbed back up and many borrowers defaulted when their mortgages were reset to much higher monthly payments. This left mortgage lenders with property that was worth less than the loan value due to a weakening housing market. Defaults increased; the problem snowballed, and several lenders went bankrupt[5].

The consequences regarding the financial markets were originated mostly due to a fundamental change in the way mortgages markets work. Normally, banks financed their mortgage lending with deposits received from customers, which had limited the amount of lending they could do. However, the change made to the traditional model allowed banks to fund additional borrowing in a much easier way: they sold the mortgages to the bond markets which led to abuses as banks no longer have the incentive to check carefully the mortgages they issue[6]. In other words, lenders sold mortgages they originated into the secondary market, where they were sold together as CDOs and other MBSs.

In the year of 2005, sub-prime lending had spread across America. By then, one of five mortgages were sub-prime, they were particularly popular among recent immigrants, or in other terms, families that did not qualify for ordinary home loans who were looking for a home for the first time in the US and because of the high prices it was difficult to buy one without moving to the suburbs. The evolution between the 2003 and 2006 of below-investment MBSs is shown in the Table 1 and as it can be seen, the subprime lending was the one with the bigger increase, from 37.4 (34%) in 2003 to

[5] http://www.investopedia.com/terms/s/subprime-meltdown.asp
[6] http://news.bbc.co.uk/2/hi/business/7073131.stm

114.3 Million Dollars (44%). The main problem with the sub-prime mortgages was the payments, which were fixed for two years and then become dependent on the level of Fed interest rates, which many of them increased in the next two years, leading to a much higher rate of repossession by the banks than other mortgages. Furthermore, the many repossessions made by banks had one major impact, the reverse evolution of houses prices, which force the property owners to lower the prices, in order to try to sell the remain properties, or in other terms, the repossessions caused the first house prices decline since the decade of 30s[7].

Table 1 – Mortgage Evolution between 2003 and 2006

Growing apace

Issuances of below-investment-grade mortgage-backed securities ballooned beween 2003 and 2006.

(billion dollars; percent of total)

Type	2003	Jan.–June 2006
Prime	57.6 (52)	67.2 (26)
Subprime	37.4 (34)	114.3 (44)
Alt-A	15.8 (14)	76.5 (30)
Total	**110.8**	**258.0**

Source: *Inside Mortgage Finance.*

Source : http://www.imf.org/external/pubs/ft/fandd/2007/12/dodd.htm

As a conclusion of this sub-sample period, during the sharp growth of the sub-prime market among 2001 and 2006, the quality of loans had become worse and the underwriting criteria wider; the fact that house prices had appreciated between 2003 and 2005 disguised the real risk of sub-prime mortgages which was underestimated by rating agencies and finally the unsustainable growth of the sub-prime market led to its collapse (Demyanyk and Van Hemert 2009).

The sub-prime crisis, as well as the housing prices crash or downturn, had several implications on the global financial crisis as it is explained hereafter.

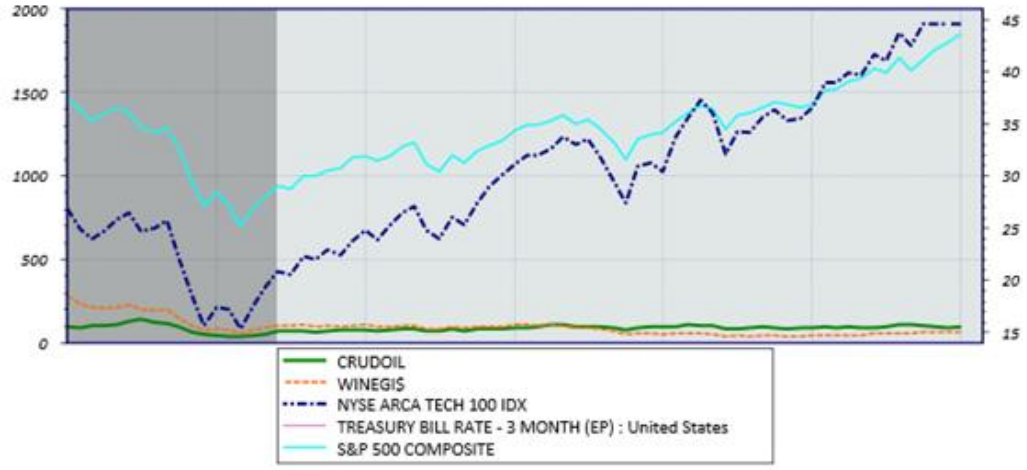
[7] http://news.bbc.co.uk/2/hi/business/7073131.stm

2.3 2008-2013 – Global Financial Crisis up to today

The time period from 2008 to 2013, represents a global financial crisis that is so far, the worst crisis since the great depression of 1930s. This crisis had several consequences such as, the deterioration of most financial markets around the world, contributed to a potential collapse of major financial institutions worldwide and it involved national governments in bailing out too-big-to-fail banks (SIFIs). During this time period more was affected besides financial markets and its institutions, in particular, the house market and real estate prices at a global level, the unemployment and the long-term unemployment rates increased, the consumer wealth and its expenditures decreased over this period and ultimately, this crisis contributed to the European sovereign-debt crisis (*Causes and Consequences of the 2008 Global Financial Crisis* by Vodenska, Boston University).

In Figure 5 are represented the evolution of five variables, Crude Oil, WilderHill, Arca Tech 100, 3 month Treasury Bill Interest Rate, S&P 500 from 2008 to 2013. In this Figure it can be seen when the global financial crisis took place (the darker grey in the Figure), all variables suffered a loss, being the S&P 500 and the Arca Tech 100 the ones that suffered the major losses. After it in the following years, the S&P 500 and the Arca Tech 100 had a great recovery ended in the 2013 with superior values than the ones when the crisis hit, whilst the Crude Oil, the WilderHill and the 3 month Treasury Bill Interest Rate kept constant values after the crisis, being the 3 month interest rate the one with the lowest values during the entire subperiod. According to some papers, namely Managi (2013),he shows that after structural breaks, the financial crisis, there is a positive relationship between oil prices and clean energy prices, which is what can be seen in Figure 5, where both have approximately the same values.

Figure 5 – Crude Oil, WilderHill, Arca Tech 100, 3 month Treas Bill Int Rate and S&P 500 Evolution from 2008 to 2013



Source: Thomson Reuters Datastream

The financial crisis of 2008 can be defined as the worst recession since the great depression of 1929, where house prices fell 31.8% and unemployment continue to be above the rate of 9% two years after the recession[8].

The first evidence that was something wrong with the economy appeared in 2006, when the house prices started to downturn, as mentioned before. In addition, there was a chain of reactions, after the house market downturn, in the financial system. Furthermore, the financial instruments supposedly without risk turn out to be worthless, namely MBSs and CDOs even with the approval of the rating agencies[9].

According to *Causes and Consequences of the 2008 Global Financial Crisis* by Vodenska, Boston University, the number of failed banks in the US between 2000 and 2013 was 497, 27 from the year of 2000 to 2007 and 470 from 2008 until 2013, which can reveal what happened to the financial system during the last years. In addition, Vodenska also states several reasons for Lehman Brothers bankruptcy, namely, the high level of leverage, which increased from 2003 to 2008, the heavy investments made in the real estate market and the large positions taken in the sub-prime market as well as

[8] http://useconomy.about.com/od/criticalssues/f/What-Is-the-Global-Financial-Crisis-of-2008.htm
[9] http://www.economist.com/news/schoolsbrief/21584534-effects-financial-crisis-are-still-being-felt-five-years-article

other lower-rated mortgages, which ended up with Lehman Brothers declaring bankruptcy on September 2013.

According to the article *The origins of the financial crisis* by The Economist, one of the most dramatic errors made during the crisis was to let Lehman Brothers to go bankrupt, which had multiplied the panic in the markets leading to a real problem in the economy, where non-financial companies were unable to borrow money from banks, thus making the companies powerless to fulfill its payment obligations, namely to suppliers or even workers.

In 2008 the Dow Jones Industrial Average in the US lost 33.8% of its value and by the end of the year, since the economic systems had become more globally interconnected, the recession had spread to most of the World[10]. The situation deteriorated during the summer of 2008, where the Treasury Department was allowed to spent up to $150 billion to subsidize and eventually take over Fannie Mae and Freddie Mac, the two most important mortgage companies, and regarding the AIG (American International Group), an insurance company that faced its most delicate financial situation in 2008, due to the sold credit protection that ultimately had decrease in value, the Fed used $150 billion to bail it out.

On September, because of the lack of trust on other financial instruments, businesses moved record $140 billion into even safer Treasury bonds. Meanwhile, the Treasury Secretary Henry Paulson along with Fed Chairman Ben Bernanke, proposed a proposed a $700 billion bailout package, although only $350 billion was used in 2008 to buy bank and automotive company stocks, in order to try to stimulate these industries. One of the measures done by the Treasury Secretary in order to establish and manage of a treasury fund, TARP, that was created in October 2008, which objectives were to bought stocks in eight banks: Bank of New York Mellon, Goldman Sachs, J.P. Morgan, Morgan Stanley, Bank of America/Merrill Lynch, Citigroup, Wells Fargo, and State Street. Moreover, TARP funds were used to buy other company stocks namely: AIG ($40 billion), Community banks ($92 billion), Big 3 auto companies ($24.8 billion), Citigroup and Bank of America ($45 billion)[11]. In the year of 2010, banks had already

[10] http://www.britannica.com/EBchecked/topic/1484264/The-Financial-Crisis-of-2008-Year-In-Review-2008
[11] http://useconomy.about.com/od/glossary/g/TARP.htm

paid back $194 of the TARP fund. The remaining money, reserved for the President Obama was never used, in other way he created the economic stimulus package ($787 billion), which was approved by the congress in 2009[12].

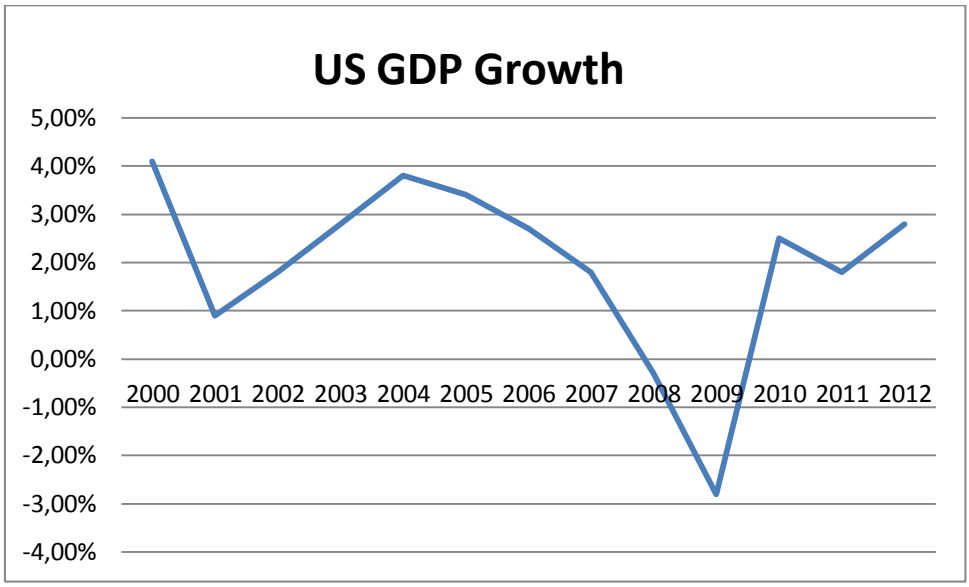
The main objective of the economic stimulus package was to quickly begin the economic growth, save between 900,000 to 2.3 million jobs, to ensure the needed confidence to restore the economic growth and it has as an objective to restore the trust in the financial industry. The stimulus package was a success, in March 2009, before it was launched, the GDP in the first quarter (Q1) was -5.4% and the Dow had decreased to 6,594.44 on March 5, 2009. By the last quarter of 2009, the GDP was up to 3.9% and the Dow had risen to 10,428. However, not all success can be assigned to the stimulus package, since there were other important issues such as the expansive monetary policy and the emerging markets which both had contributed to stimulate the economy, although the last two were already set in the beginning of 2009, so one can conclude that at least the President Obama's stimulus package gave the investors and markets the confidence needed to turn the economy round[13].

In order to show what happened regarding the US GDP during the sample analysis (2001-2013), is shown in Figure 6 the evolution since the beginning of the 21st century. As one can see, in 2000 the GDP was a little bit above the 4% where it suffered a great decrease reaching the value of 1%, which can be explained by the technology bubble as well as the 9/11 terrorist attacks. Following the before mention events, the Fed, cut the interest rates to an extremely low level, in order to stimulate the economy, which can explain the positive variation in the GDP, between 2001 and 2004, where it reached almost 4%. Furthermore, this period roughly coincides with the sharp growth of the sub-prime market among 2001 and 2006, where the quality of loans had become worse and the underwriting criteria wider and the fact that house prices had appreciated between 2003 and 2005 disguised the real risk of sub-prime mortgages which was underestimated by rating agencies and finally the unsustainable growth of the sub-prime market led to its collapse in 2008 where the GDP almost reached -3%. The time period between 2008 and 2013, represent a global financial crisis that is so far, the worst crisis since the great depression of 1930s. According to the World Bank, the US GDP in 2012

[12] http://useconomy.about.com/od/criticalssues/f/What-Is-the-Global-Financial-Crisis-of-2008.htm
[13] http://useconomy.about.com/od/candidatesandtheeconomy/a/Obama_Stimulus.htm

was 2.8%, which demonstrates a sharp increase since 2009, revealing that the measures undertaken were successful.

Figure 6 – US GDP Growth



Source : World Bank

Following the explanation about the events happened and their consequences on the US economy as in the World economy as well, since the beginning of the new century, it is presented afterwards, a brief forecast on the years to come.

2.4 Brief Forecast on Following Years

Following the explanation about what happen in the world during the thesis's sample period, it is time to make a relatively short forecast on the years to come about, mostly, the economy growth.

In accordance with CNBC, the Japanese investment bank Nomura have stated that the global financial crisis have ended in 2013 and 2014 is the recovery year. As evidence for this, the bank's equity research team led by Michael Kurtz identified some economic indicators that have been improving such as the US real estate market and the Europe's economic expansion, among others[14].

In agreement with Nomura is IMF, that stated that during the second part of 2013, after a slow start in the beginning of the year, the global activity have been strengthened and it is expected to continue to increase even further in 2014 and 2015, mostly due to the recovery in the advanced economies. The growth at a global level is expected to be higher in 2014, with 3.7%, increasing to 3.9% in the next year[15].

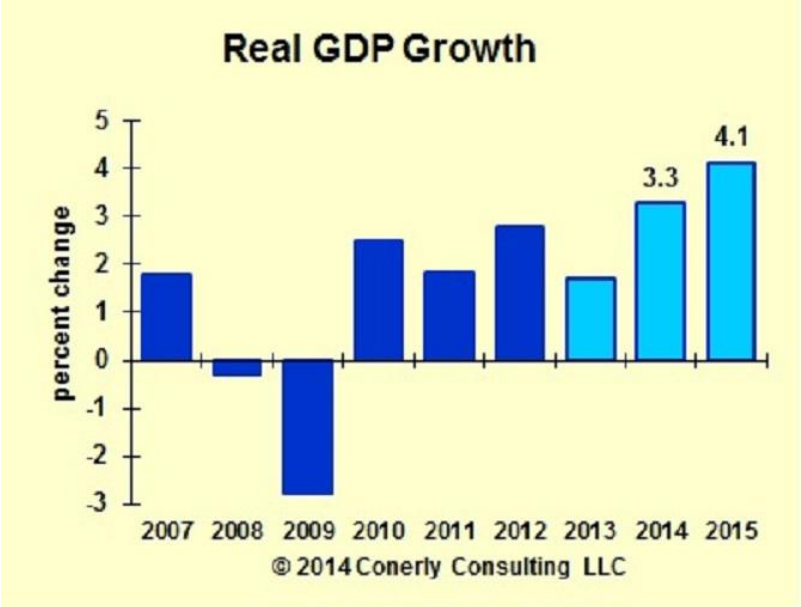
Similarly, the White House is in line with the last two points of view. According to Reuters, under its projection, US economy is going to surpass in 2014 the last year's growth of 1.7% with 3.1%, while the forecast for 2015 is similar, it is going to overcome 2014's with 3.4%. Moreover, the White House gave some reasons for the aforementioned growth: the decline of budget deficit, the improving house market and US energy production, decrease in health costs and advances in technology were some of the economic drivers pointed out by the White House[16].

In accordance with Bloomberg, S&P 500 Index rose 30% last year for the highest increase since 1997, whereas house prices increased in October, comparing with the homologous year, for the biggest increment for more than seven years[17].

[14] http://www.cnbc.com/id/101231654
[15] http://www.imf.org/external/pubs/ft/weo/2014/update/01/
[16] http://www.reuters.com/article/2014/03/11/us-usa-obama-economy-idUSBREA2A00Z20140311
[17] http://www.bloomberg.com/news/2014-01-04/feldstein-joins-summers-predicting-stronger-u-s-growth-in-2014.html

As it has been shown, the outlook for 2014 and 2015 is better than before, which means that the economic indicators are still going to increase and improve. Bill Conerly is in line with that thought, he states that in the demand side, consumer spending is going to increase and housing construction is going to grow. One of the most important facts is the growth of oil and gas production, petroleum accounted for 77% of 2012 imports, which is declining due to the increasing energy production. The Real GDP Growth is presented in the Figure 7. As it can be seen, in 2013 the GDP growth was inferior to 2012, however in 2014 the 3.3% change as well as the 4.1% in 2015 reveals that the crisis ended in 2013 and 2014 is the recovery year, suggesting that the global financial crisis has finally ended[18].

Figure 7 – Real GDP Growth Forecast



Source: http://www.forbes.com/sites/billconerly/2014/01/22/economic-forecast-2014-2015-looking-better-with-help-from-oil-and-gas/

Have ended the analysis on the sample period, as done a brief forecast on the following years as well as given some reasons/drivers for the economic growth projections, it is presented afterwards a market analysis about the alternative energies and the oil prices, so it could be better understood some of their different characteristics.

[18] http://www.forbes.com/sites/billconerly/2014/01/22/economic-forecast-2014-2015-looking-better-with-help-from-oil-and-gas/

3. Market Analysis

In order to study the relationships among the alternative energies and the oil prices it is better to understand firstly some of their different characteristics, some aspects that could affect prices, evolution taking in consideration the last decade and even some forecasts in what respects their consumption.

3.1 Oil

Brief Introduction

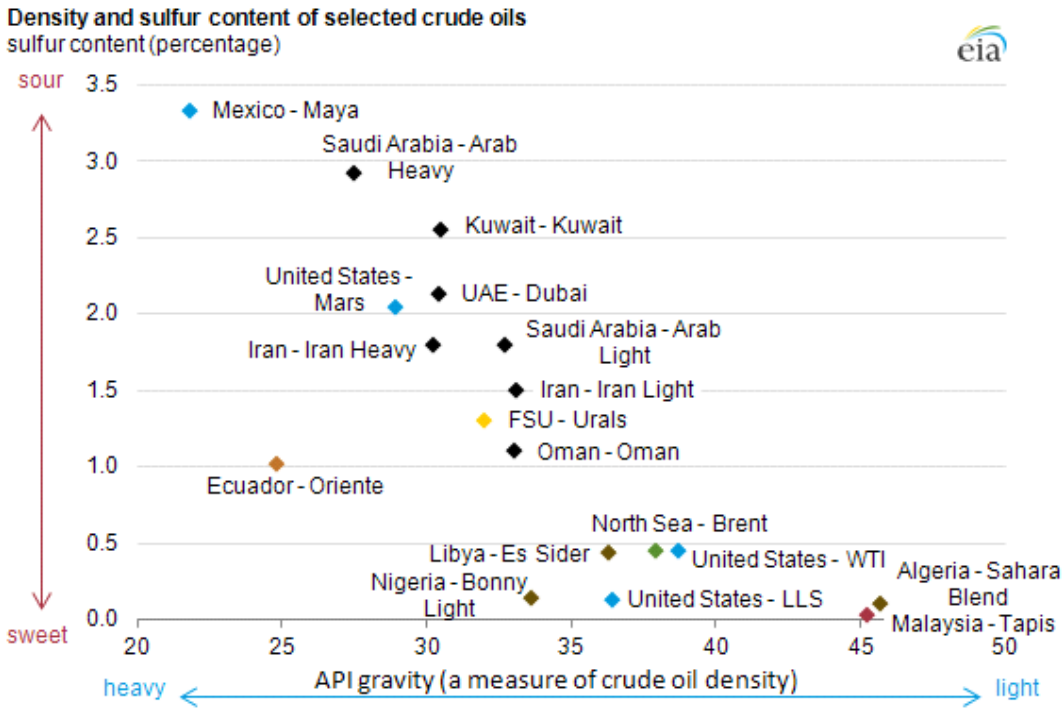
The oil is the major driver of the world economy as well as the most traded commodity, it affects every industry and so every activity relies on it. Nowadays the US is the biggest crude oil importer according to Key World Energy Statistics (2013).

According to US Environmental Protection Agency, in the US, crude oil is mainly used for transportation and heating purposes, however a small percentage is used as fuel for electricity generating plants[19].

One of its characteristics is that crude oil come in many varieties as well as qualities, that is, its features, namely the specific gravity and sulfur content, depends on the place where it was extracted from as it is priced[20]. This is represented in the Figure 8. The crude oil market value depends especially on these two features and so, the density ranges from light to heavy while sulfur content is whether sweet or sour. A sweet crude oil is characterized by its sulfur content which is less than 0.5%, while oil with more than 0.5% is defined as sour.

[19] http://www.epa.gov/cleanenergy/energy-and-you/affect/oil.html
[20] http://news.bbc.co.uk/2/hi/904748.stm

Figure 8 – Different crude oil characteristic



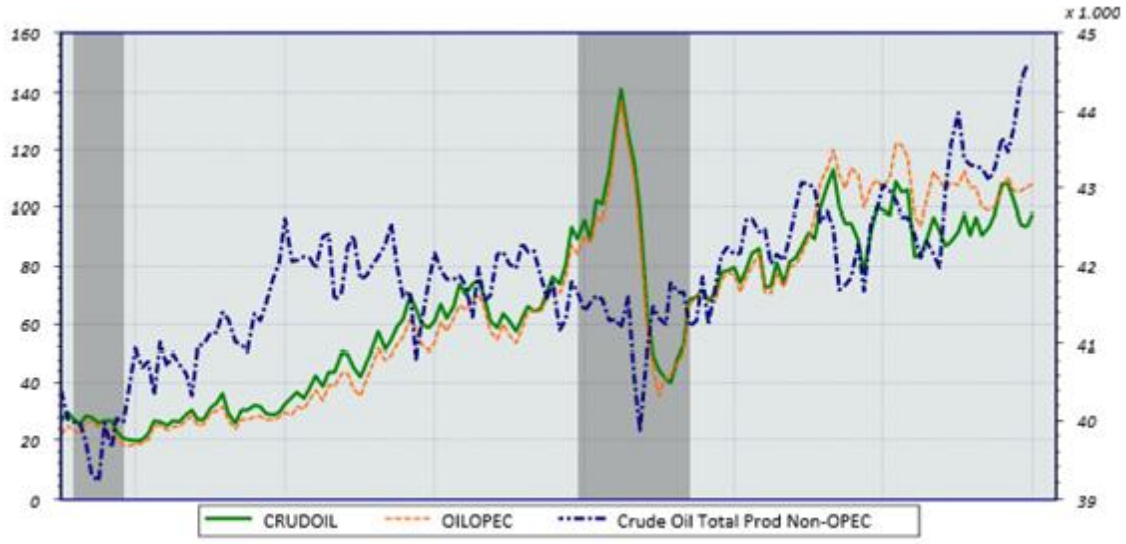
Source : U S Energy Information Administration

The figure 8 represents, the different crude oil characteristics regarding the place where it was extracted from, for instance the Mexico-Maya is the one with the highest sour percentage and the one with the highest density, and so it is the one with the higher heavy and sour results. In contrast, Algeria-Sahara Blend and Malaysia-Tapis are the ones with higher sweet and light values and this is the reason why the Algeria-Sahara Blend, as well as Malaysia-Tapis are priced higher than the Mexico-Maya crude oil, as it is explained below.

According to EIA, crude oils are priced differently considering its characteristics, namely, the crude oils with "light (higher degrees of API gravity, or lower density)" and sweet, with low sulfur content are normally priced higher than heavy, sour crude oil. This is mainly due to the fact that gasoline and diesel fuel are sold at a premium, rather than residual fuel and others that are usually more easily and cheaply produced using light, sweet crude oil. Basically, the ones that can be got with more rudimentary processes as well as with less energy-consuming refineries are the desirable ones, thus the light sweet grades are the most desirable crude oils[21].

[21] http://www.eia.gov/todayinenergy/detail.cfm?id=7110#

Figure 9 – Crude Oil, OPEC Oil Basket and Non-OPEC Crude Oil Total Prod Evolution from 2001 to 2013



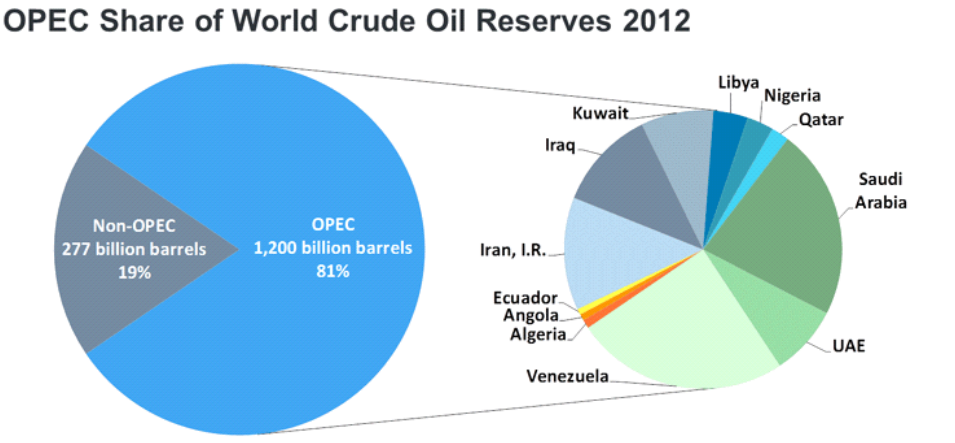
Source: Thomson Reuters Datastream

The Figure 9 illustrates Crude Oil (West Texas Intermediate) and OPEC Oil Basket prices as well as Non-OPEC Crude Oil Total Production from 2001 to 2013. In the beginning of this period, coinciding with the recession, all variables suffered a loss, being the Non-OPEC oil production the one that suffered the most. After it and until the global financial crisis, the Non-OPEC oil production had a sharp growth, while the other variables kept a constant growth with similar values. However, when the crisis took place, all variables had a big loss in their values, where Crude Oil and OPEC Oil Basket suffered the major hit. Following this period, all variables recovered and the Crude Oil and OPEC Oil had different growths, where the OPEC Oil registered, occasionally, higher values than Crude Oil.

The need to price crude oil in terms of a benchmark comes from the fact that there are many different qualities of crude oil, so, buyers and sellers found it easier to have benchmarks, thus other varieties are priced at a discount or premium according to their quality. There are some benchmarks worldwide, such as, Brent, Dubai, OPEC and West Texas Intermediate. Regarding the Brent benchmark, it is usually accepted as the world benchmark and according to EIA it prices two thirds of the world's traded crude oil. In what respects the Dubai benchmark, it is used to price sales of other regional crudes into Asia, simply because it is one of the few Gulf crudes available in single, on the spot,

sales as opposed to long term supply contracts. In what regards the US benchmark, the crude oil is priced in relation to West Texas Intermediate. Regarding the OPEC basket, this organization is currently constituted by 12 countries namely, Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates and Venezuela[22]. The OPEC benchmark price is determined by the average of all of its 12 countries and one of its objectives is to control the amount of oil they supply to the market in order to keep the price between a predetermined range prices[23]. In addition, 81% of the world's oil reserves belong to OPEC which is represented in figure 4[24], which give a great amount of diplomatic leverage in worldwide businesses, due to its importance. The countries with highest crude oil reserves, as it can be seen in Figure 10, are Venezuela with 24.8%, Saudi Arabia with 22.1% and Iran with 13.1% of total reserves and in the other hand the OPEC countries with fewer crude oil reserves are Algeria 1%, Angola 0.8% and Ecuador with 0.7% of total reserves. Moreover, one issue coupled with OPEC is that most of its countries are located in geopolitical stressed regions of the world, which create a security matter for large consumption nations (Henriques and Sadorski 2008).

Figure 10 –OPEC's oil reserves



OPEC proven crude oil reserves, end 2012
(billion barrels, OPEC Share)

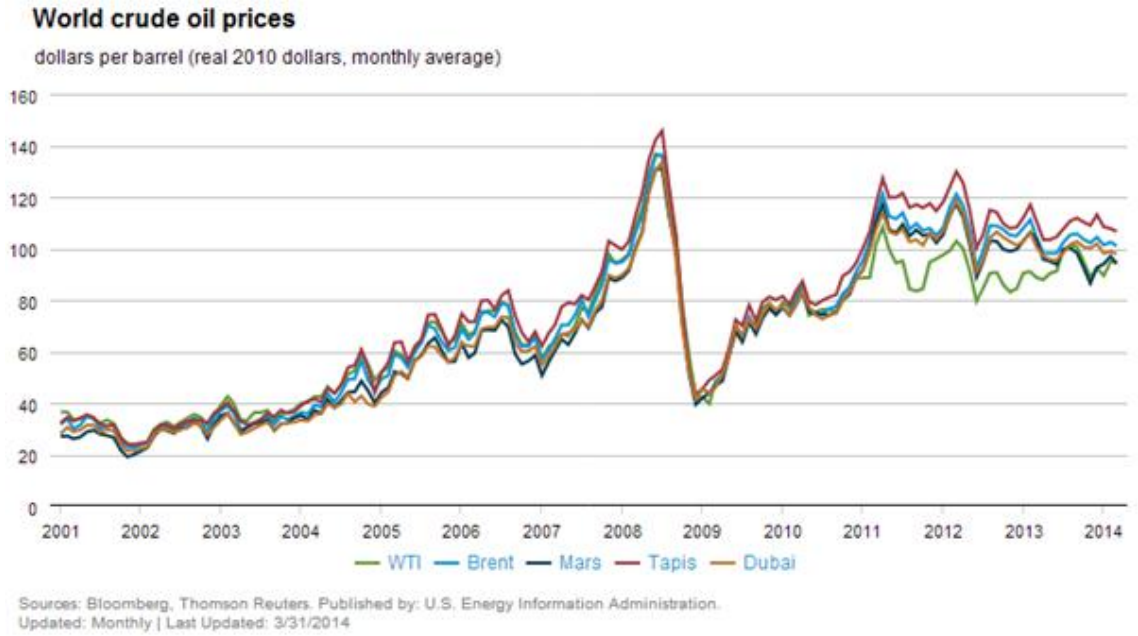
Venezuela	297.7	24.8%	Iraq	140.3	11.7%	Libya	48.5	4.0%	Algeria	12.2	1.0%
Saudi Arabia	265.9	22.1%	Kuwait	101.5	8.5%	Nigeria	37.1	3.1%	Angola	9.1	0.8%
Iran, I.R.	157.3	13.1%	United Arab Emirates	97.8	8.1%	Qatar	25.2	2.1%	Ecuador	8.2	0.7%

Source: OPEC Annual Statistical Bulletin 2013

[22] http://www.opec.org/opec_web/en/about_us/25.htm
[23] http://news.bbc.co.uk/2/hi/904748.stm
[24] http://www.opec.org/opec_web/en/data_graphs/330.htm

Crude oil is priced according to its characteristics which make some crude oils more expensive than others, however as Figure 11 presents, they tend to move together.

Figure 11 – World Crude Oil Prices



Source : http://www.eia.gov/finance/markets/spot_prices.cfm

Figure 11 presents the crude oil spot prices from 2001 to 2014 and as it is shown, the different crude oils tend to move together, even when crude oils are significantly different between them: crude oil types, light-weight, low sulfur grades and heavier-sulfur crudes that have lower quality as it was explained before. From 2001 to 2008 all crude oils saw their price increase and after the 2008 financial crisis all of them suffered a big loss, which recovered after it. Although there are many types of crude oil around the world due to their characteristics, the prices are different as well, but because oil prices are globally integrated, they tend to move together.

Have exposed the main characteristics, benchmarks, places where crude oil is got from and different crude oil prices evolution during the sample period it is explained afterwards the characteristics of RE.

3.2 Renewable Energy

According to IEA, RE can be defined as energy that is derived from natural processes such as sunlight or wind and is restored faster that it is consumed, for instance, solar, wind, geothermal and hydro are usual sources of RE. In 2009, 13.1% of primary energy supply came from renewable sources. In addition, 19.5% of global energy generation, or in other terms, renewable energies are mostly used for generating electricity and 3% of global energy consumption for road transport belongs as well to RE.

In 2011 and 2012, in spite of the global financial crisis, policy uncertainty and decreasing support in some markets, the demand for renewable energies continued to increase (REN21).

Regarding the RE evolution since the year of 2000, Table 2 presents it considering Wind Power, Solar and Biofuel and presenting in the last column, the evolution between 2000 and 2010 in the case of Biofuel or 2011 considering Wind Power and Solar.

Table 2 – Renewable Energies evolution over the last decade

Renewable Energy	2000	2010/2011	Evolution
Wind Power	220 GW	238 GW	8.2%
Solar	1.5 GW	67 GW	4366.7%
Biofuel	16 Billion	100 Billion	525%

Source: IEA

Wind Power had grown 18 GW since 2000 to 2011 which represents an evolution of 8.2%, with an average growth rate over 25% considering the past five years.

Solar energy can be directly converted into electricity using a PV cell. Analyzing the Table 2, it can be observed that there was an impressive growth, comparing the year of 2000 (1.5 GW) with 2011 (67 GW), which represents a 4366.7% growth, furthermore, over the past five years Solar PV had an average growth rate over 50%.

Biofuel energy reached a value of more than 100 Billion liters in 2010, comparing with 16 Billion liters registered in 2000 represents an increase of 525%. In addition, Biofuel supplies 3% of the world's fuel for transport, for instance, in Brazil it represents 23% of all transport fuel, while in the US it registers 4% and 3% in the EU[25].

In regard of the VRE, or in other terms, taking in consideration the renewable energies that are variable, which includes wind, solar and other renewable energies that fluctuate during the day or season, or which are connected to the variability of wind speed or solar radiation which changes during the day or year season. Coupled with this flexibility is the market value and price of VRE, which is affected by the amount of energy received by the generators, or in other words, during windy and sunny times, the additional amount of electricity received decreases the prices, thus because of the higher energy reception, the market value of VRE falls with higher penetration rate (Hirth 2013). However, there are measures that can be considered in order to reduce this variability, such as more flexible generating capacities as gas and hydro power plants, interconnections or storage so that it can be combined to provide the required flexibility[26].

According to World Energy Outlook, renewable energies increase their importance in all long-term scenarios regarding the expectation until the year of 2035, renewable electricity generation triples from 2009 to 2035, moreover, when considering the limitation of the global warming, renewable energies grow even more, it almost quadruples.

As it is addressed in this thesis, the energy security is one of the major concerns in regard of the energy supply due to the reduction in oil supplies coupled with the increase of global demand as well as political insecurity in oil rich countries (Henriques and Sadorski, 2008). Taking this in account, it is easy to understand that energy security has great relevance for policy driver for RE. Furthermore, the use of RE can reduce fuel importation and detach the economy from fossil fuel price rises and variations, which would improve energy security.

[25] http://www.iea.org/aboutus/faqs/renewableenergy/
[26] http://www.iea.org/aboutus/faqs/renewableenergy/

As it was covered before, the RE sector is increasing its competitiveness, wind and solar PV are growing at a fast pace, portfolios of RE technologies are becoming cost-competitive, moreover, technologies such as hydro and geothermal are frequently fully competitive. Although, some economic barriers still remain and there is a need for costs to be reduced in order to achieve competitiveness[27].

According to IEA, there is a need for further subsidies to the RE sector, because it is believed that further growth is essential for a secure and sustainable energy system, in order to stimulate costs reduction throughout technology deployment, as improvements in manufacturing, technology performances and economies of scale. This issue has a special importance because in several countries, the policies in place are not the better, which led to higher than anticipated costs and excessive policy costs[28].

In terms of investment in RE, the global investment decreased 11% in 2013, according to BNEF (Bloomberg New Energy Finance), which was the second time it declined since 2011. Moreover, financing must double by 2020 and double again to $1 trillion by 2030, so that environmental targets could be achieved namely, the global warming of more than 2 degrees could be avoided[29].

According to REN21, the Global investment in renewable power and fuels was in 2012, 244 billion USD, which represent a 12% decline, comparing with the year before. However, if the investments in hydropower projects larger than 50 megawatts (MW) and in solar power were included, in 2011 the total new investment would have reached a value of 285 billion USD. Furthermore, the decrease in investment, after several years of growth, came from uncertainty about support policies in major economies, such as Europe and the US, with the first decreasing 36% and the latter 35%. Although, disregarding replacement plants and so considering only net additions to electric capacity, in 2012 for the third year in a row, the global investment in renewable power was ahead of fossil fuels. These values regarding the evolution in investment in new renewable capacity and renewable power capacity (with and without hydro) between 2010 and 2012 can be seen in the Table 3.

[27] http://www.iea.org/aboutus/faqs/renewableenergy/
[28] http://www.iea.org/aboutus/faqs/renewableenergy/
[29] http://www.bloomberg.com/news/2014-01-16/renewable-energy-at-254-billion-let-s-make-it-a-clean-trillion.html

Table 3 – Investment in new renewable capacity and renewable power capacity from 2010 to 2012

		2010	2011	2012
Investment in new renewable capacity	Billion USD	227	279	244
Renewable power capacity (total, not including hydro)	GW	315	395	480
Renewable power capacity (total, including hydro)	GW	1250	1355	1470

Source: REN21

In addition, considering the year of 2012, it saw the most dramatic shift regarding the investment among developed and developing economies, whilst the investment in developing countries in 2011 arrived to 112 billion USD representing 46% of the world total, the investment in developed countries declined 29% to 132 billion USD, illustrating the lowest level since 2009. The major drivers regarding this reduction were the reductions in subsidies, the increase investor interest in emerging economies with attractive energy resources and decreasing costs in technology costs of wind and solar PV.

Considering the top five countries regarding the annual investment in renewable energies, in 2012, divided by sources the US is in the top five except for Hydropower capacity and Solar water collector (heating) capacity, reaching the first positions in Wind power capacity, Biodiesel and Ethanol production as it can be seen in the Table 4. In addition, Europe and China combined a 60% value of global investment in 2012, with Solar power being the sector with more money applied, having received in 2012, 57% of the total new investment in RE, which accounted for 96% to solar PV.

Table 4 - Annual Investment/Additions/Production in 2012

	New capacity investment	**Hydropower capacity**	**Solar PV capacity**	**Wind power capacity**	**Solar water collector (heating) capacity**	**Biodiesel production**	**Ethanol production**
1	China	China	Germany	United States	China	United States	United States
2	United States	Turkey	Italy	China	Turkey	Argentina	Brazil
3	Germany	Brazil/Vietname	China	Germany	Germany	Germany/Brazil	China
4	Japan	Russia	United States	India	India	France	Canada
5	Italy	Canada	Japan	United Kingdom	Brazil	Indonesia	France

Source: REN21

Following presenting a brief introduction on some characteristics, what drives their prices, the growth since the year of 2000 and even some forecasts on future consumption of renewable energies as well as crude oil, it is exposed in the next chapter the literature review where all the main literature is discussed.

4. Literature Review

In this section, it is discussed the literature with greater relevance regarding the topic under the scope.

The literature on the relationship between the alternative energy stock prices and oil prices is scarce. Henriques and Sadorski (2008) study this topic using a vector autoregression model with four variables: alternative energy companies returns, technology stock returns, oil prices, and interest rates. Results show that the technology stock returns, oil prices, and interest rates are related with alternative energy companies returns and can explain movements on its stock price. Furthermore, they found that stock prices of alternative energy companies are more influenced by shocks in technology stock prices than by oil prices movements.

Sadorsky (2008) uses a study on a RE company systematic risk. This paper shows that increases in company sales reduce systematic risk whereas increases in oil price returns increase systematic risk. However, when oil price returns are positive and moderate, increases in company sales can offset the impact of oil prices and thus lower the systematic risk, although when they are higher it is in general not possible to offset the effects with sales growth. The Monte Carlo simulation reveals that oil prices have greater impact on beta than sales growth do. It also shows that market returns cause more effects on stock returns, followed by oil prices and then sales growth.

Kumar et al. (2012) extends Henriques and Sadorsky (2008) work by adding the carbon market data from April 22nd of 2005 to November 26th of 2008 using Markov-Switching VAR. This paper studied the relationship between clean energy companies, technology companies, oil prices, carbon prices and interest rates using for this purpose three indices of clean energy stocks. This paper demonstrates that the movements of all three indices of clean energy stocks are explained by oil prices, technology firms stock prices and interest rates movements. Moreover, it shows that investors see clean energy firms as technology firms and also that the carbon market does not influence the clean energy stock prices, which might be due to the fact that the carbon price have been lower than the oil price and so it has not created any incentive to switch to low-carbon technologies.

Managi (2013) analyzed the same issue but now considering structural breaks. For this purpose he uses a four variable Markov-switching vector autoregressive model (oil prices, clean energy, technology stock prices and interest rates). The results suggest that after structural breaks, there are positive relationship between oil prices and clean energy prices, which contradicts some papers previously made. These results are consistent with those found by Henriques and Sadorsky (2008) before the structural break in 2007, however after it they are contradictory. Managi (2013) found that oil prices and clean energy prices have a positive relationship after structural changes. The paper also states that when the economy recovers, it may turn back into a non-relationship again, among clean energy and oil prices.

Bohl et. Al. (2013) addresses the evolution of German RE stock returns from 2004 to 2011. To this end, they used the four factor Carhart model which is an expansion of the CAPM (Capital Asset Pricing Model) and Fama French models, that adds the momentum (factor which is the difference between the highest 30% and the lowest 30% stock returns). The German government undertook several measures and policies in order to change to alternative energies. This study found that the German stock analyzed from 2004 to 2007 was perceived as a winner, however between 2008 to 2011 the alternative energy sector suffered a great hit with the global crisis and so, these stocks turned into looser after all. The author considers that in the sub-period 2004-2007, there was a speculative bubble. To test this, Bohl (2013) used a supremum ADF test and the Markov regime-switching ADF test, which confirmed the existence of a price bubble.

The previous two studies seem to concur that there was a structural break, in both papers the period prior to 2007 is studied and after it some conclusions were made. In the German case were found that since 2004-2007 there was a speculative bubble and in the other case after structural breaks the relationships change. So, after speculative bubbles some relationships change and that was the case of the oil prices and clean energy stock prices, which after the 2008 break have created a positive one and so the connection can be made among the positive relationship with the underperform of German clean energy stock prices. Thus, the positive relationship between oil prices and clean energy stock prices, have badly influenced the German stocks which had underperformed.

Wen, Guo, Wei, Huang (2013) study the return and volatility spillover effect among two variables: the stock prices of Chinese new energy and fossil fuels companies. For this matter, the asymmetric BEKK model is used to investigate the volatility between the mentioned variables while considering that the volatility spillover effects might be asymmetric. The sample period used goes from August 30, 2006 to September 11, 2012; the performance of new energy and fossil fuel companies in China stock markets is taken from China's new energy index (NE index) and coal and oil index (CO index), respectively. Results suggest that the relationships among the previously referred variables are significant and asymmetric, that is, bad news have a greater impact than good ones in each of the variables thus, bad news about both variables leads to larger return changes in their assets. In addition, however good news about new energy stock returns leads fossil fuels returns to fall, good news on fossil fuel stocks returns cause a rise in new energy returns, although when comparing with bad news, these ones causes larger impacts than positive news do on both variables. Furthermore, in regard of volatility spillover, both variables spill over into each other assets variance, and also, volatility spillovers depend on the respective signs of the return shocks of each asset, for example the spillover is greater when the new energy and fossil fuel returns have different signs. The results demonstrate that new energy and fuel stocks are viewed as competitors, substitutes and so, the positive news about one variable could affect the attractiveness of the other, moreover, the results also show that new energy stock investment is more speculative and thus, riskier than investing in fossil fuel stock investment.

To deeply understand the relationship among oil prices and alternative energy stock prices is fundamental to perceive the government intervention and so the policies and measures implemented. Felix Groba and Barbara Breitschopf (2013) study the needs and motivations regarding the implementation of renewable specific policies. They show that policy intervention has been successful in change relative prices and thus foster innovation, or in other words, policy intervention can reduce technological costs and so lower the final cost, making this industry more attractive. This paper also explains the importance of policy mix, market-pull and technological-push policies. The main purpose of market-pull policy is to increase the technology usage by creating demand for RE technology in one hand by increasing incentives (reduce the investment costs, for example) or by rising costs (additional taxes or even technological standards),

which can be accomplished by setting a variety of measures, for instance, the introduction of carbon-tax, carbon trading scheme, feed-in-tariffs, renewable portfolio standards, fiscal incentives or even public finance. Regarding the technological-push policy, the main objective is to generate new technologies through Research and Development incentives. The paper demonstrates that there are different phases in the new energy technology deployment and each requires different types of policies, whereas the initial phases requires technology-push policies in order to develop new technologies and reduce the producing cost and the latter is more suitable for market-pull policy to commercialize it and put it available in the market to increment the market expansion.

Hirth (2013) considered one aspect that was not yet covered the effect of solar and wind power variability on their relative price. In his paper, it is studied the drivers of the market value of VRE. In regard of the variable renewable, it includes wind, solar and other renewable energies that fluctuate during the day or season. Coupled with this flexibility is the market value and price of VRE, which is affected by the amount of energy, received by the generators, or in other words, during windy and sunny times, the additional amount of electricity received decreases the prices. Thus the higher the energy reception and higher penetration rate, more the market value of VRE falls.

In his study, the author reinforces the fact that the electricity generation from renewable energies has been growing at a fast pace during the past years, which had been driven by technological progress, economies of scale as well as more subsidies. In addition, he also states that one of the best option to reduce greenhouse gas emissions is, in fact RE, thus it is expected to grow even more in the following decades. According to this paper, the objectives for RE share in EU has to come from 17% in 2008, to 35% in 2020 and finally to 60-80% in 2050, which ensure the growing importance, deployment and investment in the alternative energy sector in the coming years. Furthermore, most of the growth has to come from wind and solar power, due to the hydropower potential is already largely developed and biomass growth is limited by supply constraints. Regarding the supply, as it goes without saying, the supply of VRE is variable, thus the market value of the electricity depends on when it was produced, which is determined by weather conditions. Moreover, as the output is characterized by its uncertainty, forecasts error of VRE generation need to be accounted at short notice which is costly,

leading ultimately to the reduction of the market value. In addition, as transmission costs reduce the value of wind power for instance, the value of electricity depends on where it is generated, causing far away locations to be costlier than nearby sites.

Hirth in his paper also provides measures that could reduce the RE output, for instance, in order to stabilize wind's market value, the wind turbine rotor diameters can be increased as well as the hub heights so that, it could reduce the output variability and could be helpful to reach that objective. Furthermore, VRE need mid and peak load generators as complementary technologies, gap which can be filled by Biomass as well as efficient natural gas-fired plants. Hirth found as well that a high carbon price alone does not make wind and solar power competitive at high penetration rates. In addition, he found that without technological innovations, wind and solar power will have difficulties at becoming competitive on large scale.

After analyzed several papers and articles, in which were studied all the important variables in regard of this paper it is time to refer where the data comes from, identify the main variables studied in this paper, the data frequency and also the sample period used in the thesis.

5. Data

The thesis aims to study the risk factors of clean energy stock price, in which is fundamental to establish connections among different variables such as oil prices, alternative energy stock prices, technology stock prices, S&P 500 and interest rates.

To analyze clean energy stock prices the WilderHill Clean Energy Index (ECO) is chosen, because it was the first index for tracking the stock prices of RE companies and had become a benchmark index (Henriques and Sadorski, 2008). The main purpose of ECO is to define and track the clean energy sector, namely businesses that help in the transition to a greener society. Individual investors cannot buy directly ECO, they can instead invest in an exchange fund which mirrors it, the PowerShares Wilderhill Clean Energy Portfolio, with a symbol PBW[30]. PBW aims to invest in companies that focus on greener and renewable sources of energy and currently is composed by 50 companies from different activity sectors: information technology (49.08%), industrials (20.38%), materials (9.76%), utilities (8.18%), energy (6.72%) and consumer discretionary (5.87%)[31].

Figure 12 – WilderHill Clean Energy Index Evolution from 2001 to 2013

Source: Thomson Reuters Datastream

[30] http://www.wildershares.com
[31] www.invescopowershares.com

Figure 12 illustrates the evolution of WilderHill Clean Energy Index from 2001 to 2013. As it is represented in the figure, during the sample period, the WilderHill Index suffered huge losses twice bounded by the shadow areas. The first one respects the Dot-com Bubble crisis in the beginning of the century, whereas after it the Index recovered and grew at a constant rate until reach its highest value in this sample period coinciding with the beginning of the global financial crisis. Thus, the second time where the WilderHill Index registered a sharp decline was in 2007/2008, with the global crisis, being the greatest loss in the period under analysis. The Index value continued to decline in the following years, although it had seen a slightly recovery in the past couple of years.

Kumar et al. (2012) advocate that investors tend to see clean energy firms as technology firms and so, it is important to draw some conclusions regarding it. In order to examine the importance of the technology stock prices, the Arca Tech 100 Index (PSE) was chosen. The objective of this index is to provide a benchmark for measuring the performance of technology companies, since it was launched in 1982 by the Pacific Stock Exchange. PSE selects companies from different industry sectors as: computer hardware, software, semiconductors, telecommunications, electronics, aerospace & defense, health care equipment, and biotechnology, always ensuring that the technological innovation is at the core of their business[32].

The impact of rising oil prices on alternative energy stock prices is positive, because it fosters the transition to cleaner energy sources that don't use petroleum (Henriques and Sadorsky, 2008). To this end, it is fundamental to study the oil prices variations, thus, the closing price of West Texas Intermediate (WTI) is used, crude oil futures contract, which trades on New York Mercantile Exchange (NYMEX). The WTI is used as a benchmark to set other oil product related prices. In addition it is the most traded futures contract which provides relevant information between buyers and sellers (Sadorsky, 2008).

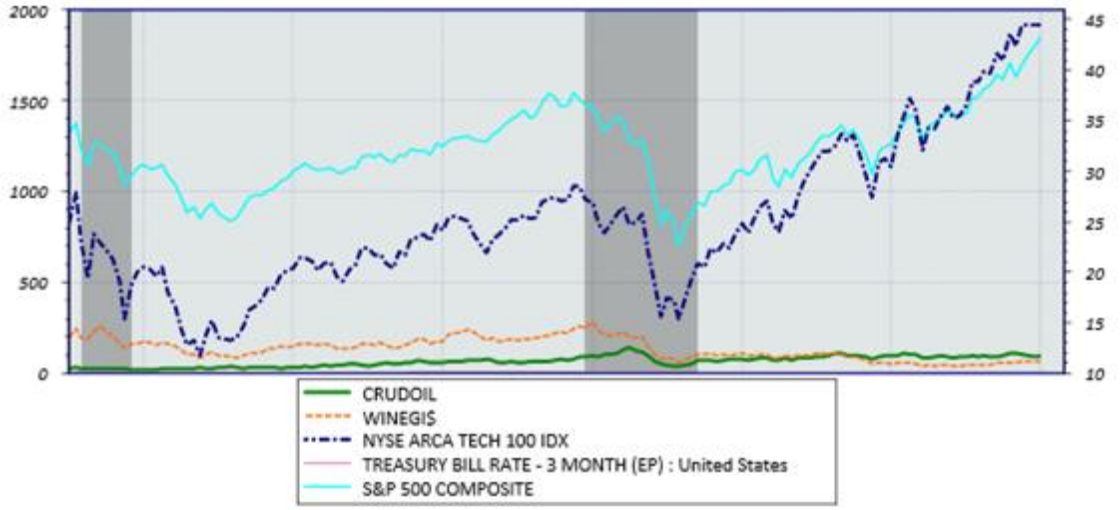
Previous researches showed that there is a relationship among interest rates and stock prices (Sadorsky, 1999, 2001). Therefore, in this paper is used a 3 month US Treasury bill interest rate (Rf).

[32] http://www.nyse.com/about/listed/pse_i.shtml

After referred which variables are used in this paper, it is fundamental to set the sample period. For this study, weekly data was collected from Datastream between the years of 2001 and 2013 which is divided in three sub-periods: 2001-2002; 2003-2007 and 2008-2013. This period was selected in order to better understand the relationships among the aforementioned variables, since the beginning of the 21st Century and the sample period was divided in three different parts so the study could focus on distinct events.

The sub-periods were chosen in order to analyze what might have changed, in the scope of the dissertation theme, between those periods addressing different events occurred in the World. The first sub-period concerns the analysis of what might had changed with the Dot-com bubble and the terrorist attacks of 11th of September of 2001 (2001-2002), the second regards the period prior the global financial crisis of 2008 (2003-2007) and the last, the crisis era (2008-2013).

Figure 13 – Crude Oil, WilderHill, Arca Tech 100, 3 month Tres Bill Int Rate, S&P 500 Evolution from 2001 to 2013



Source: Thomson Reuters Datastream

Figure 13 represents all variables used in this paper from 2001 to 2013, West Texas Intermediate (Crudoil), WilderHill (Winegi), Arca Tech 100 Index (NYSE Arca Tech 100 Idx), 3 month risk free interest rate (Treasury Bill Rate- 3 Month US) and S&P 500 Composite. As it can be seen in the figure, in the beginning of the sample there was a huge loss in the majority of the variables, in accordance with the Dot-com bubble crisis in the years 2000-2001, where the ones with the biggest losses were S&P 500, Arca Tech 100 Index and Wilderhill Clean Energy Index. After this period these variables had a constant growth until the year of 2007-2008, the global financial crisis, where once more, these three variables suffered large falls. After this crisis, the Arca Tech 100 Index growth sharply ended up in 2013 with a higher value than the S&P 500. Regarding the remaining variables, West Texas Intermediate kept a constant growth reaching a superior value than the WilderHill Index in 2013, where the 3 month risk free interest rate kept the lowest value during the sample period.

Relating the results found by previous papers with those shown in Figure 13, according to Henriques and Sadorski (2008) they found that stock prices of alternative energy companies are more influenced by shocks in technology stock prices than by oil prices movements, which can be observed in the figure, when Crude oil during the Dot--com crisis remain constant, WilderHill decreased along with Arca Tech 100 as well as S&P 500. After it, Arca Tech 100 registered a sharp growth along with a recovery period by WilderHill, while Crude oil kept constant values. Moreover, this relationship can be understood as investors see clean energy firms as technology firms (Kumar et al. 2012). However, following the financial crisis, all variables suffered a huge loss, there was a change in the WilderHill Index behavior, instead of going after the sharp increase in value of S&P 500 and Arca Tech, the clean energy index remain constant along with Crude oil until 2013, which can be related to the results found by Managi (2013), which suggest that after structural breaks, the case of the global crisis, there are positive relationship between oil prices and clean energy prices.

In Table 5 is presented the Summary Statistics regarding the variables used in this paper: WilderHill Clean Energy Index (ECO), West Texas Intermediate (WTI), Arca Tech 100 Index (PSE), S&P 500 and Risk Free Rate (Rf).

Table 5 – Summary Statistics

Variables	Mean	Sd	Max	Min	N
ECO	-0,1246%	4,9263%	0,145088	-0,15194	673
WTI	0,1896%	5,5472%	0,273306	-0,36075	674
PSE	0,0934%	3,2222%	0,093155	-0,09559	674
S&P 500	0.0478%	2.7243%	0.129509	-0.14908	674
Rf	0,0411%	0,0347%	0,00122	0.0000394	674

ECO is the only variable with a negative mean, reaching -0.1246%, followed by Rf with 0.0411%, S&P 500 with 0.0478%, PSE with 0.0934% and finally WTI with 0.1896% being the variable with the highest mean value. Regarding the standard deviation, as it would be expected Rf has the lowest value, 0.0347%, followed by the S&P 500 with 2.7243%, PSE with 3.2222%, ECO with 4.9263% and finally WTI with the highest standard deviation value, 5.5472%. Considering the highest and lowest values achieved, WTI has the highest value, 0.273306, followed by ECO, 0.145088, S&P 500 with 0.129509, PSE with 0.093155 and finally Rf with 0.00122, whilst the lowest value registered, -0.36075 represents the WTI, where ECO comes after (-0.15194), S&P comes next with -0.14908, followed by Arca Tech -0.09559 and ultimately Rf with 0.0000394 being the only positive value.

The variable with higher mean and standard deviation values is WTI as well as higher Max and Min values, which illustrates that it is the one with higher values for the majority of the sample period as it has the most risk achieving ultimately the Max and Min values of the sample period. WTI is the variable with the most unstable and volatile values representing the values with more fluctuation along the sample period. ECO regardless of its negative mean value, it is similar to WTI having the second bigger standard deviation, the second higher Max value and the second lower Min value, having this way a big fluctuation along the sample period. In the other hand, Rf is the one with the lower risk and has a positive mean and although it has not a great Max values it has not negative Min values representing a safe bet.

After noting the variables used, the sample period, its sub-periods, the evolution of the variables during the sample period as well as the summary statistics presents itself then, the empirical analysis used in order to address the topic.

6. Empirical Analysis

In this paper, a multivariate regression examines the relationship between alternative energy stock prices, oil prices, technology stock prices, S&P 500 and interest rates. Several tables are presented next in order to analyze the variables, such as Summary Statistics, Correlation Matrix and the regressions analysis.

Regression analysis is one of the most used tools in market research because it allows analyzing relationships among one or more independent variable and one dependent variable, where the independent variables are used to explain the output (dependent variable). Regression analysis is used to produce an equation that will estimate the dependent variable, as it was explained before, thus the equation is the following:

$$Y = \sum \beta i \, Xi + \alpha + \varepsilon i \qquad (1)$$

Where:

- Y - Dependent variable
- βi - Coefficients or Multipliers
- Xi - Independent variables
- α - Constant
- εi – Residual Variable

The Y is the dependent variable that the equation tries to predict, βi are the coefficients that multiply the size of the effect the independent variables have on the dependent variable, Xi are the independent variables used to predict Y and α is the constant, thus when all independent variables are equal to zero, Y is equal to α and finally εi are the residuals present in the estimation equation.

Regression analysis have some advantages such as, it indicates if independent variables have a significant relationship with the dependent variable, indicates the relative strength that independent variables have on explaining the dependent one and it is used to make predictions.

The Table 6 presents the Correlation Matrix between the variables used in this paper.

Table 6 – Correlation Matrix

	ECO	WTI	PSE	S&P 500	Rf
ECO	1				
WTI	0,2370	1			
PSE	0,8049	0,1751	1		
S&P 500	0,8012	0,2375	0,8724	1	
Rf	-0,0023	-0,0142	-0,074	-0,0626	1

ECO correlates the most with PSE, 0.8049, followed closely by S&P 500, 0.8012, while the variable with the lowest correlation value with ECO is Rf (-0.0023). Considering WTI, the highest correlation appears to be with S&P 500, 0.2375, followed by ECO with 0.2370, being Rf the one with the lowest correlation values, -0.0142. PSE and S&P 500 have the bigger correlation values, 0.8724, being Rf, once more, the variable that PSE has the lower correlation values with, -0.074. S&P has the higher correlation values with PSE, 0.8724 and the lower with Rf, -0.0626. Regarding Rf has the higher correlation with ECO -0.0023 and the lower with PSE with -0.074.

The highest and lowest correlation values are 0.8724 and -0.074, respectively, being the first one among PSE with S&P 500 and the latter PSE with Rf. It implies that PSE and S&P 500 have a high correlation and so one variable can help to predict the value of the other, whereas, although PSE and Rf have the lowest correlation values they have approximately no correlation one with the other because it is close to zero, thus one variable cannot help to predict the values of the other.

As previous studies state, the clean energy companies are more alike with technology companies than with oil prices movements, which can be explained by their high correlation, ECO and PSE have 0.8049 of correlation values so, one variable could help to predict the values of the other, rather than WTI that have a correlation value of 0.2370 with ECO, which is considered a low correlation.

The robust regression is an alternative to least squares regression and it is used in order to eliminate the effect of outliers, an extreme observation distant from the others, which could influence the findings of the paper[33]. The errors are robust to control for heteroskedasticity, which means that the standard deviations of a variable through time are non-constant[34]. In Table 7 is presented the Regression Outputs. It shows three different models: Model 1 with five independent variables WTI, PSE, Rf, Oil Vol and S&P 500; Model 2 with four independent variables WTI, PSE, Rf and Oil Vol, and Model 3 with seven explanatory variables, WTI, Oil Pos, D oil Pos, PSE, Rf and Oil Vol. In every model the dependent variable is ECO. It is also shown, in parentheses the corresponding P-value, the number of observations, the R-squared, the Adjusted R-squared and the t-statistics that are statistically significant for a 10%, 5% and 1% significance level.

Table 7 - Regression Outputs

	Model 1	Model 2	Model 3
WTI	0,0580**	0,0869***	0,0082
	(0,021)	(0,002)	(0,885)
PSE	0,6973***	1,2087***	1,2040***
	(0)	(0)	(0)
Rf	8,0797***	8,2820***	8,4167***
	(0,008)	(0,008)	(0,007)
Oil Volatility	0,0060	-0,0207	-0,0440
	(0,901)	(0,709)	(0,486)
S&P 500	0,7072***		
	(0)		
Oil Positive			0,0737
			(0,454)
D Oil Pos			0,0078**
			(0,029)
Number of obs	673	673	673
R-squared	0,696	0,661	0,665
Adjusted R-squared	0,694	0,659	0.662

Dependent Variable: ECO; t-statistics * p<0.10, ** p<0.05, *** p<0.01; P-values in parentheses

In order to analyze the Model 1 regression outputs, R-square shows the amount of variance of ECO explained by WTI, PSE, Rf, Oil Vol and S&P 500. Thus, the model shows that approximately 70% of ECO variance can be explained by the independent variables.

[33] http://www.ats.ucla.edu/stat/stata/dae/rreg.htm
[34] http://www.investopedia.com/terms/h/heteroskedasticity.asp

The Model 1 equation explains that ECO increases 0,0580, 0,6973, 8,0797, 0,0060 and 0,7072 when WTI, PSE, Rf, Oil Vol and S&P 500 go up by one unit, respectively. In addition the equation also states that, when all independent variables are equal to zero, ECO is -0,0059. Thus, the betas (independent variables) which have more relative strength in explaining the dependent one are Rf followed by S&P 500 and PSE.

In Model 2 regression outputs shows that 66% (R-square) of ECO variance can be explained by explanatory variables, illustrating a decrease when comparing with the regression previous analyzed.

The Model 2 equation explains that ECO increases 0,0869, 1,2087, and 8,2820 when WTI, PSE and Rf go up by one unit, respectively whilst it decreases 0,02078 when Oil Vol increase one unit, meaning that the increase in the riskiness of oil hurts ECO's evolution. In addition the equation also states that, when all independent variables are equal to zero, ECO is -0,0050. Thus, the betas which have more relative strength in explaining the dependent variable are Rf followed by PSE and finally WTI.

The Model 3 regression output, has a 66% R-square, which show the amount of ECO variance that can be explained by the explanatory variables. The estimation equation shows that ECO increases 0,0082, 0,0737 0,0078, 1,2040 and 8,4167 when WTI, Oil Pos, D Oil Pos, PSE and Rf go up by one unit, respectively whilst it decreases -0,0440 when Oil Vol increase one unit, meaning that the increase in the riskiness of oil hurts ECO's evolution. Moreover, the equation also states that, when all independent variables are equal to zero, ECO is equal to -0,0096 Thus, the betas which have more relative strength in explaining the dependent variable are Rf followed by PSE.

The coefficients with more relative strength in explaining the dependent variable in the three models are Rf and PSE and in the first model, S&P 500, and in the second model, WTI, appear to have also more relative strength than the remain variables.

The R-square shows the amount of variance of ECO explained by the independent variables. Thus, Model 1 shows that 69.6%, Model 2 66.1% and Model 3 66.5% of ECO variance that can be explained by the independent variables, whilst the Adjusted R-square represents the same as R-square but adjusted by the number of observations as well as the number of variables in the regression, which provide a more truthful association among the variables. For instance, when the number of variables is

small and the number of observations is very large, the Adjusted R-square is closer to R-square. Which is exactly what happens in the models, both have a large number of observations (673) and a small number of variables, the R-squared is equal to 69.6%, while the Adjusted R-squared is 69.4% in the first model, a 66.1% R-squared and a 65.9% Adjusted R-squared in the second one and finally 66.5% R-squared and 66.2% Adjusted R-squared in the third model, thus according to Adjusted R-squared the explanatory variables can explain 69.4%, 65.9% and 66.2% of ECO's evolution.

When the estimators are analyzed to check if they are statistical significant or not, the Model 1 has WTI (b=0,0580; p=0,021), PSE (b= 0,6973; p=0),Rf (b=8,0797; p=0.008) and S&P 500 (b=0,7072; p=0) are statistically significant making them related with ECO's evolution, whilst Oil Vol (b=0,0060; p=0.901) is not statistically significant and so it seems to be unrelated with ECO. Thus, when WTI increases and because its coefficient is positive it is expected that ECO grows as well, where the same happens with PSE, Rf and S&P 500. The results found are consistent with previous studies.

In Model 2 the variables WTI (b=0,0869; p=0,002), PSE (b=1,2087; p=0) and Rf (b=8,2820; p=0,008) are statistically significant making them related with ECO's evolution, whilst Oil Vol (b= -0,0207; p=0,709) is not statistically significant and so it appears to be unrelated with ECO. Thus, when WTI increases and because its coefficient is positive it is expected that ECO grows as well, happening the same with PSE and Rf.

In Model 3 the independent variables D Oil Pos (b=0,0078; p=0,029), PSE (b=1,2040; p=0,000), Rf (b=8,4167; p=0,007) are statistically significant making them related with ECO's evolution, whilst WTI (b=0,0082; p=0,885), Oil Pos (b=0,0737; p=0,454), Oil Vol (b= -0,0440; p=0,486) are not statistically significant and so seem to be unrelated with ECO.

The Figures 14, 15, 16 and 17 present rolling windows that show the evolution of WTI, PSE, Rf and Oil Vol along the sample period.

Figure 14 shows WTI evolution during the sample period, it registered three big losses. One in the beginning of the sample period due to the terrorist attacks and the Dot-com bubble crisis, then it grew to its maximum value in this sample period and registered its biggest loss caused by the financial crisis then recovered after it and

suffered one more fall at the end of the sample period. However WTI registered three big losses, its linear trend line is positive meaning that its evolution is positive, although most of it had been motivated by the huge growth prior the financial crisis.

Figure 14 – WTI Rolling Window

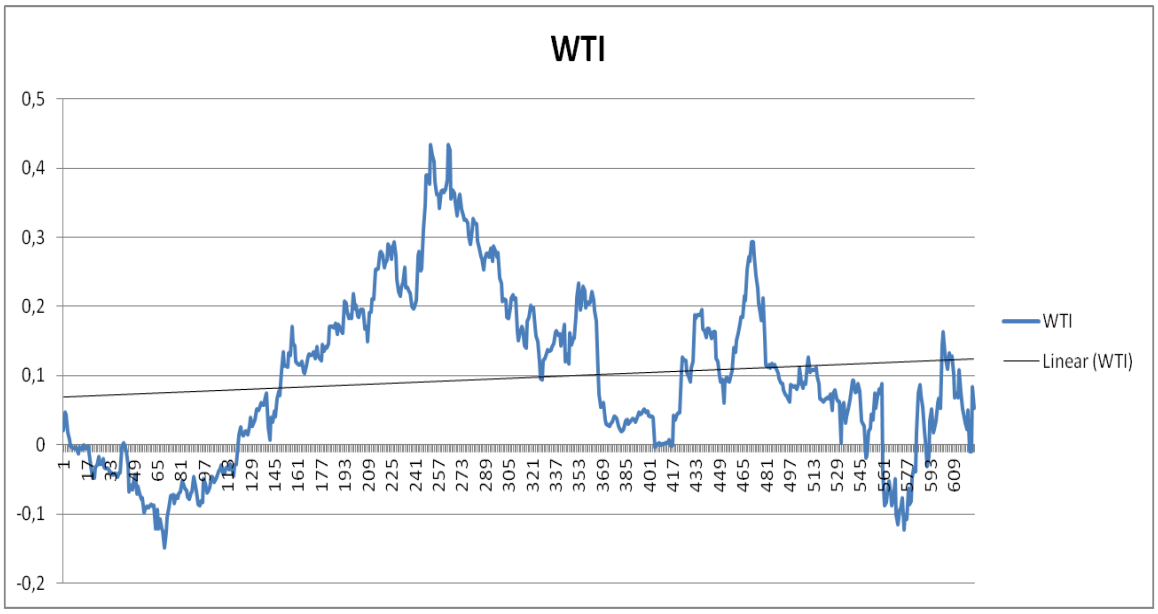


Figure 15 illustrate PSE evolution along the sample period and as it can be seen in the figure it had a constant growth with small variations having this way a linear trend line positive, initiating the sample period with 1 and ending with 1.5, which means that the sensibility to variations increased during the sample period.

Figure 15 – PSE Rolling Window

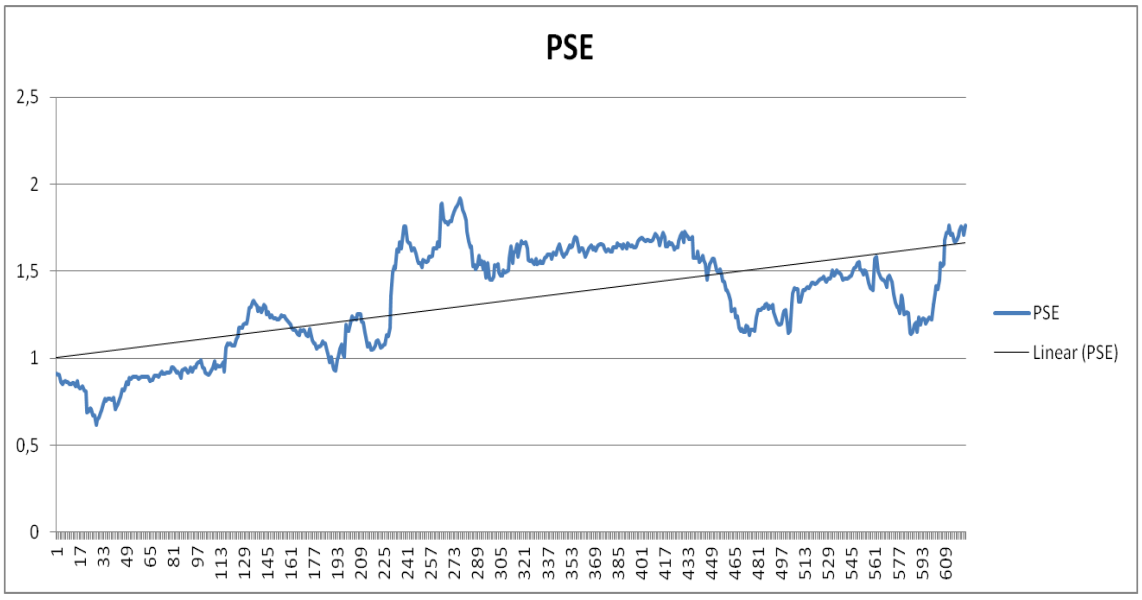


Figure 16 represents Rf evolution through the sample period, as the figure illustrates, values are mostly constant rounding 0, however there was a big fall in the middle of the sample period registering large negative values followed by a huge recovery achieving huge positive numbers, which means that there must be outlier values that influenced in a great way the coefficient estimation Followed this event, Rf note values rounding 0. The linear trend line indicates that Rf has been decreasing along the time.

Figure 16 – Rf Rolling Window

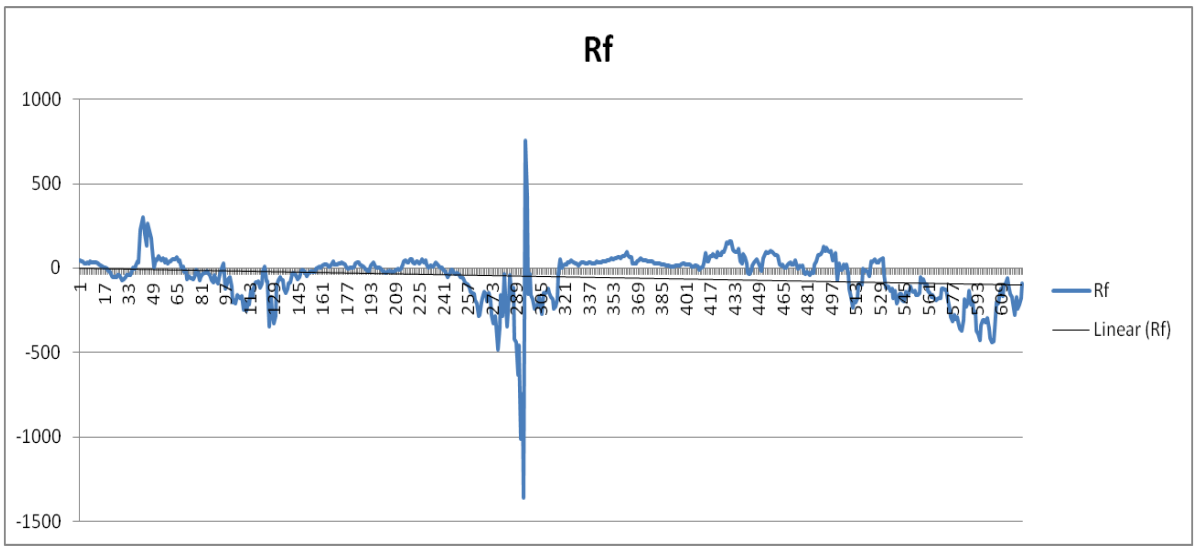
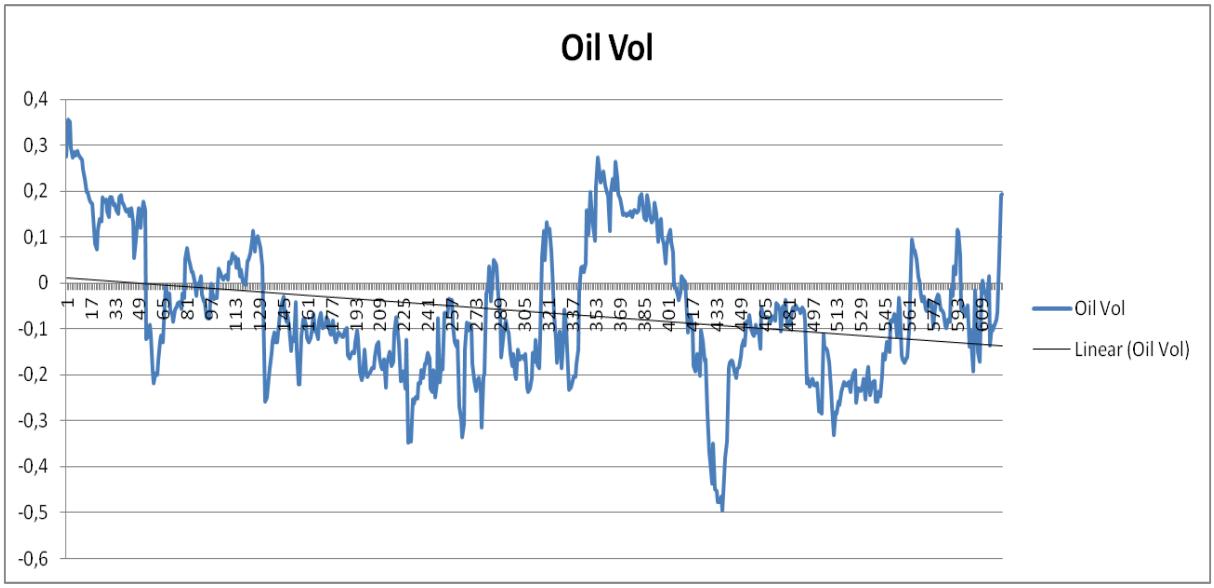


Figure 17 exibiths Oil Vol evolution during the sample period which is very unstable as it can be seen in the figure, however its linear trend line is negative which means that the oil volatility has been decreasing along the sample period. In a general term, the coefficient values are not constant througout the time.

Figure 17 – Oil Vol Rolling Window



Having made the empirical analysis, where the regression outputs are analyzed as well as the several rolling windows of the variables, it is time to present the major conclusions.

7. Conclusions

The importance of alternative energies is expected to continue to increase in the coming years, due mainly to environmental concerns and energy security issues, which has great relevance for policy driver for renewable energies. Furthermore, the use of renewable energies can reduce fuel importation and detach the economy from fossil fuel price rises and variations, which would improve energy security. Therefore, the importance of this sector in the global economy is expected to grow and more firms have been appearing along the years.

Oil is the most traded commodity, crude oil alone accounts for 15%, which represents the commodity with the greatest importance, followed by Gold (11.5%), Natural Gas (9.4%) and Copper (7.5%) (Key World Energy Statistics 2013). However, oil consumption has been decreasing, which represents a change towards alternative energies.

According to IPCC 2013, human influence on the climate is clear, raising greenhouse gas concentrations in the atmosphere, forcing positive radioactive and global warming. So, it is fundamental not only, to further develop the alternative energies, but as well to reduce the human footprint on the environment, in order to build a greener society. In response to this, the US is implementing several policies and measures such as market-based solution to climate change, which provide economic incentives to those who pollute less, so that the cost of polluting reflects the economic harm caused to others. Cap-and-trade system and Clean Energy Standard are examples of market-based solutions (Economic Report of the President 2013).

This thesis analyzes the risk factors of investing in alternative energies, using for this purpose, a four variable regression where the factors are oil prices, technology stock prices, S&P 500 and interest rates. Due to their growing importance in markets, thus it is of interest of investors, managers and policy makers to know the risks of this kind of investments. The correlation matrix show that clean energy companies are more influenced by technology company returns than with oil prices movements. The regression analysis show that oil prices, technology stock prices, risk free rate and the S&P 500 have some relative strength in explaining clean energy stock price movements. In addition, it also demonstrates that technology stock price movements are more

important to explain alternative energy stock price movements than oil price movements because investors may see alternative energy companies similar to technology companies. This seems to suggest that investors care about technological innovations in this area more than the price of substitute goods.

According to IEA, there is a need for further subsidies to the renewable energy sector, because it is believed that further growth is essential for a secure and sustainable energy system, in order to stimulate costs reduction throughout technology deployment, as improvements in manufacturing, technology performances and economies of scale. There are some economic barriers that still remain and there is a need for costs to be reduced in order to achieve competitiveness.

In the future, the significance of the alternative energy sector is expected to continue to increase and particularly in the US, several policies and measures are being implemented to meet environmental targets, not only to reduce the human's environmental footprint but also to make the alternative energy markets more efficient and competitive to be able to change from fossil fuels to renewable energies. In the past years, several conferences have taken place in order to face the problematic of the climate changes. Thus, in the coming years is expected that more alternative energy related companies are going to appear, especially in the US. The scope of this paper could be extended to other countries and different indexes in order to study the relationships among the variables in different markets.

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9. Appendix

Appendix 1 - : ECO, WTI, PSE, Wrf, Oil Vol and S&P 500 vce (robust) Regression

					Number of obs	673
					F(5, 667)	256,65
					Prob > F	0
					R-squared	0,696
					Root MSE	0,02726
ECO	**Coef.**	**Robust St.Err.**	**T**	**P>t**	**[95% Conf.**	**Interval]**
WTI	0,0580013	0,0251093	2,31	0,021	0,0086986	0,107304
PSE	0,6973418	0,0877391	7,95	0	0,5250637	0,8696199
Weekly Rf	8,0797	3,0468	2,6500	0,0080	2,0972	14,0623
Oil volatility	0,0060063	0,0483321	0,12	0,901	-0,0888951	0,1009077
S&P 500	0,7072085	0,1059708	6,67	0	0,499132	0,915285
Constant	-0,0059273	0,002564	-2,31	0,021	-0,0109619	-0,0008928

Appendix 2 - ECO, WTI, PSE, Rf , Oil Vol and S&P 500 vce (robust) Regression

			Observations	673
			R-squared	0,696
			Adjusted R-squared	0,694
			p_diff	
ECO	**Coef**	**t-statistics**	**(*)**	
WTI	0,0580	2,31	(**)	
PSE	0,6973	7,95	(***)	
Rf	8,0797	2,65	(***)	
Oil vol	0,0060	0,12		
S&P 500	0,7072	6,67	(***)	
Constant	-0,0059	-2,31	(**)	
t statistics in parentheses * p<0.10, ** p<0.05, *** p<0.01				

Appendix 3 - ECO, WTI, PSE, Rf and Oil Vol vce (robust) Regression

					Number of obs	673
					F(4, 668)	232,13
					Prob > F	0
					R-squared	0,6608
					Root MSE	0,02878
ECO	**Coef.**	**Robust Std. Err.**	**T**	**P>t**	**[95% Conf.**	**Interval]**
WTI	0,086923	0,0283309	3,07	0,002	0,0312946	0,1425511
PSE	1,208664	0,0408294	29,6	0	1,1284940	1,2888330
Rf	8,282015	3,1216300	2,65	0,008000	2,1526260	14,4114000
Oil Vol	-0,0206998	0,0554114	-0,37	0,709	-0,1295012	0,0881018
Constant	-0,0049924	0,0028048	-1,78	0,076	-0,0104996	0,0005149

Appendix 4 – ECO, WTI, PSE, Rf and Oil Vol, vce(robust)

			Observations	673
			R-squared	0,661
			Adjusted R-squared	0,659
			p_diff	
ECO	**Coef**	**t-statistics**		**(*)**
WTI	0,087	3,07		(***)
PSE	1.209	29,6		(***)
Rf	8.282	2,65		(***)
Oil vol	-0,021	-0,37		
Constant	-0,005	-1,78		(*)
t statistics in parentheses * p<0.10, ** p<0.05, *** p<0.01				

Appendix 5 – ECO, WTI, Oil Pos, D oil Pos, PSE, Rf, Oil Vol vce(robust) Regression

					Number of obs	673
					F(6, 666)	157,44
					Prob > F	0
					R-squared	0,6649
					Root MSE	0,0286
ECO	**Coef.**	**Robust Std. Err.**	**T**	**P>t**	**[95% Conf.**	**Interval]**
WTI	0,008225	0,0566593	0,15	0,885	-0,1030275	0,1194774
Oil Positive	0,0737079	0,0983476	0,75	0,454	-0,1194009	0,2668166
D Oil Pos	0,0078047	0,0035715	2,19	0,029	0,0007918	0,0148173
PSE	1,204039	0,0404189	29,79	0,000	1,1246750	1,2834020
Weely Rf	8,416678	3,1134240	2,70	0,007	2,3033690	14,5299900
Oil Vol	-0,0439687	0,0630111	-0,70	0,486	-0,1676930	0,0797557
Constant	-0,0096106	0,0033555	-2,86	0,004	-0,0161992	-0,0030218

Appendix 6 – ECO, WTI, Oil Pos, D Oil Pos, PSE, Rf, Oil Vol vce(robust) Regression

			Observations	673
			R-squared	0.665
			Adjusted R-squared	0.662
			p_diff	
ECO	**Coef**	**t-statistics**	**(*)**	
WTI	0.008	0.15		
Oil Positive	0.074	0.75		
D Oil Pos	0.008	2.19	(**)	
PSE	1.204	29.79	(***)	
Rf	8.417	2.70	(***)	
Oil vol	-0.044	-0.70		
Constant	-0.010***	-2.86	(***)	
t statistics in parentheses * p<0.10, ** p<0.05, *** p<0.01				