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Main factors influencing the market valuation of alternative energy companies in Europe: the effect of announcement of green policies

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List of abbreviations

CAPM – Capital Asset Pricing Model

EEA – European Environment Agency

EECS – European Energy Certificate System

EREF – European Renewable Energies Foundation

ETF – Exchange Traded Fund

ETS – Emission Trading System

EU – European Union

GHG – Greenhouse Gas

GO – Guarantee of Origin

IPCC – Intergovernmental Panel on Climate Change

kWh – kilowatt-hour

Mtoe – million tonnes of oil equivalent

MW – mega watt

NFFO – Non-Fossil-Fuel-Obligation

NREAP – National Renewable Energy Action Plan

RE – Renewable energy

RES – Renewable Energy Source

RES-E – Renewable energy-source electricity

RES-H&C – Renewable energy-source heating and cooling

RES-T – Renewable energy-source transport

Solar PV – solar photovoltaic

SRI – Socially Responsible Investments

UN – United Nations

UNFCCC – United Nations Framework Convention on Climate Change

WEF – World Economic Forum

Introduction

In the beginning of the 21st century, the world society was confronted to a completely new type of problem that was supposed to transform the world economy functioning: the problem of ecological sustainability of our planet. The conviction of combustible energy resource limitlessness that led the industrial revolution in the late 18th century resulted in important ecological and climate change (Vis and Delbeke, 2016) which today threatens the peaceful future of human beings.

In this scope, the world saw the emergence of renewable energies that completely transformed global energy markets. The year 2016 marked a turning point for this kind of energy source as the World Economic Forum (WEF) announced that for the first time, in many parts of the world, solar energy became as expensive as or even cheaper than fossil fuels (Chow, 2016). Today, renewable energy is a large contributor in terms of achievement of sustainability goals such as greenhouse gas emission reduction and climate change mitigation, economic and social development, access to energy and energy security, particularly on the European continent (EEA, 2017).

That is why, it was interesting to have a look on green energy industry from an investors perspective and try to understand its evolution and development. In this way, the first objective of this work was, based on existing academic literature, to give an overview of factors that by the past had an influence on stock exchange price movements of companies active in renewable energy sector and in this way, give the potential investor some indications of possible patterns of the industry.

The second objective and the empirical core of this work consisted in seeing weather the announcement of a governmental intervention as a potential influencing factor, has a significant impact on the renewable energy industry from the financial market's point of view. The general hypothesis was formulated as follows: the European stock market of renewable energies reacted positively on the 2016 Proposal for a directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources. The studied directive was supposed to bring market confidence on the green energy industry development for the period after the year 2020, the reason why positive market reaction was expected. This basic hypothesis was tested statistically by the mean of an event study methodology proposed by Lamdin (2001) which is an adapted version of classic event sturdy to the specific case of a regulatory change. In this way, 15 event dates related to the earlier mentioned proposal were tested on the appearance of abnormal returns on the basis of daily data of a sample of 26 European renewables companies.

This study is a continuation of works of Ramiah et al. (2013, 2015a, 2015b, 2016) in which the authors analysed the influence of various green policy announcements on the overall stock market in different countries. Consequently, this paper contributes to the existing literature in two regards: as the European area have not been covered yet by the authors, this thesis aims to complete this geographical gap; secondly, as it has never been made before, this work focuses on a particular market of renewable energies which allows to carry out a deeper analysis of the impact on this industry, compared to previous works.

This thesis is structured in following way. Part I explains the situation on the renewable energy market in Europe by exposing the degree of progress that was made compared to the year 1990 and by giving an overview of the current share of renewables in the economy. This part also explains the regulatory evolution in the world and in Europe that triggered this change.

Part II brings to light different factors that influenced the movements of the world renewable energy stock market which includes oil price moves, technology indexes evolution, changing investment behaviours, growing awareness of energy consumers, legal interventions and other unpredictable causes as nuclear catastrophes. This list exposes the most known factors of influence and is not supposed to be exhaustive.

Part III is a literature review of the stock market reactions on regulatory interventions which exposes the works that were done on the subject of industry specific regulatory announcements and explains the event study methodology that is conventionally used in these kinds of studies.

And finally, Part IV is the description of the event study realised starting from input data and methodology explanation and finishing by exposure of empirical results and their interpretation which enabled us to confirm or infirm the basic hypothesis.

PART I: RENEWABLE ENERGY MARKET IN EUROPE

Current situation on the Sustainable Energy market

1. What are the current challenges?

The main cause of existing climate problems is related to the massive use of fossil fuels that marked the industrial revolution in Europe in the late 18th century (Delbeke and Vis, 2016). First, the coal and then, oil and gas use resulted in a high level of greenhouse gas emissions (GHG) which dangerous global consequences were not known at that time.

In their 5th Assessment Report published in 2013, the Intergovernmental Panel on Climate Change (IPCC), gave a clear message that "warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia" and that "human influence on the climate system is clear" (IPCC, 2013, p. 6).

The major problem that our society is facing today is growing global average surface temperature, commonly known under the term of global warming. Scientists found that during the period from 2000 to 2010, the global temperature was around 0.45 °C higher than between 1961 and 1990 (IPCC, 2013). At the first sight, such a small change cannot be significant and provoke any critical change but if the temperature rise continues, it will result in disastrous consequences. It will be followed by the increase of the sea level and melting of old glaciers of Greenland and Antarctica resulting in smaller habitable surface and complete change in ecosystem, flora and fauna, all this coming with addition to the ozone layer depletion, air and water pollution and land fertility exhaustion (IPCC, 2013).

That is why, the world has two major challenges which are the combat against the global climate change and sustainable economic development and the only way to progress in this field is to pass by decarbonisation of today's energy systems. Recently, world leaders managed to fix concrete objectives in the field of climate change and it is forecasted that to achieve them, the global GHG emissions have to reduce by 41%-72% in 2050 compared to 2010 level and by 78-118% in 2100 (IPCC, 2014). The percentage superior to 100% means that we will have to find technologies to capture the existing CO_2 emissions and store it. It is a very challenging objective and some progress was already made, more specifically on the level of the European Union, which will be explained further in this chapter.

2. What are the recent trends?

The European Commission announced 2017 as the year of implementation of the EU energy Union and declared its objective to become “the world number one in renewable energies” (EREF, 2017).

According to the definition given by Eurostat (2017) “renewable energy sources include wind power, solar power (thermal, photovoltaic and concentrated), hydro power, tidal power, geothermal energy, biofuels and the renewable part of waste”. These are the main energy sources that are supposed to ensure ecologically sustainable economic development and prevent future deterioration of climate situation.

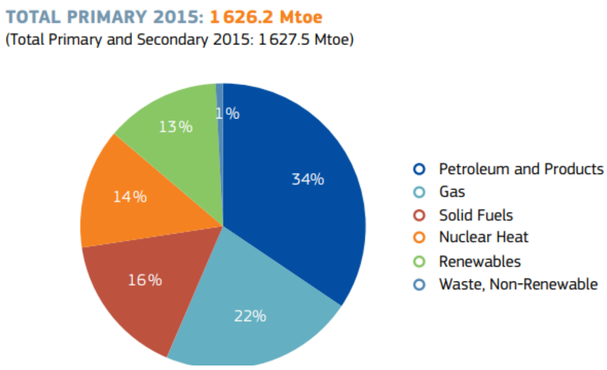
Only 10 years ago, the industry of renewable energies was considered as a niche market in a few countries but today we can see that it becomes a mainstream technology. And the main change in comparison to the previous decade is that today costs of green electricity production declined sharply and we can benefit from technological improvement, mostly in solar photovoltaic (PV) and wind technologies (Delbeke and Vis, 2016). In fact, in 2015 EU was the global leader in the field of technological innovation with 30% of world patents in renewables technologies (European Commission, 2017a).

Another major change is happening in general energy sector. According to the European Environment Agency it “is currently shifting from a centralised, supply-based system dominated by few technologies owned by a small number of large players to a more decentralised and evenly distributed one” (EEA, 2017, p. 9) and it definitely has its influence on figures evolution.

Overall renewable energy consumption and production

Renewable energy (RE) consumption experienced a significant rise mostly as a reaction on the legally binding targets for increasing the share of these energies that was introduced by the 2009 directive on the promotion of the use of energy from renewable sources (Eurostat, 2017). As shows Graph 1, in 2015 renewables represented 13% of the

Graph 1: EU-28 Gross Inland Consumption of energy in 2015 (energy mix in %)

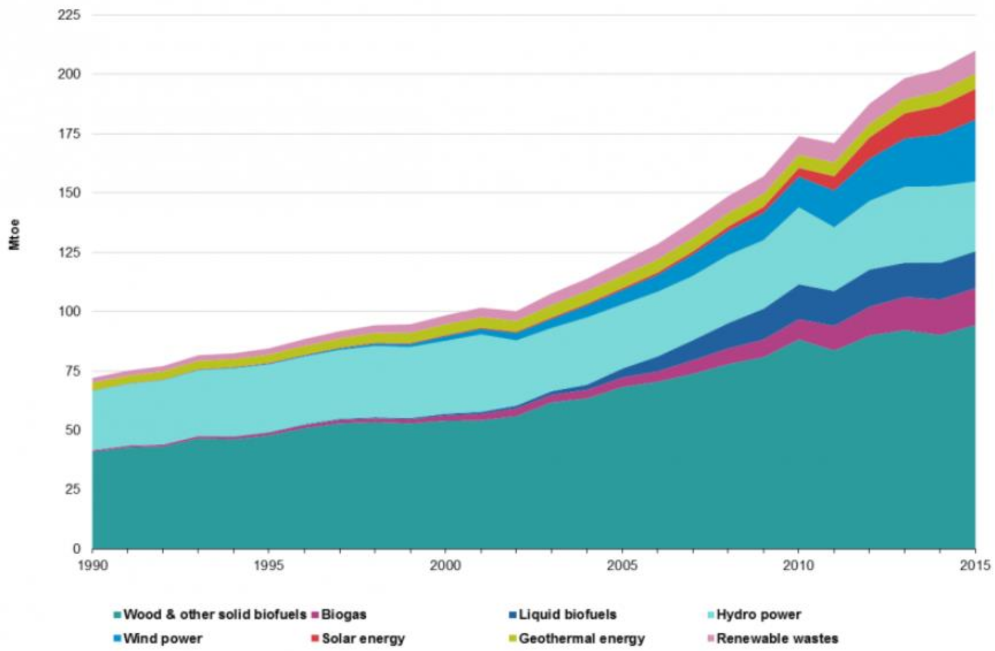


Source: European Commission (2017b), EU energy in figures Statistical pocketbook 2017, p. 22

overall gross inland energy consumption[1] comparing to 5% in 1995 which marked an important evolution in this field. It also represents 26.2% of energy produced in EU (European Commission, 2017b).

As concerns the gross final consumption[2] on which European regulators focused to fix their objectives, Europe has well attained all the targets: in 2014 it reached 16% (instead of aimed 12.1%) and in 2015 it amounted to around 16.4% (compared to the 13.8% objective) (European Commission, 2017a). The degree of evolution can be seen through the Graph 2. As for the repartition among green technology sources consumption, biomass and renewable wastes stands on the first place with 8.4% share from overall energy consumption, then goes hydropower energy with 1.8%, wind energy with 1.6%, solar with 0.8% and geothermal with 0.4%.

Graph 2: EU-28 evolution of Gross Inland Consumption of energy (energy mix in %)



Source: Eurostat (2017), Online: http://ec.europa.eu/eurostat/statistics-explained/index.php/Renewable_energy_statistics

[1] **Gross inland energy consumption** is the "total quantity of energy resources used for all purposes" (Eurostat)
[2] **Gross final energy consumption** is "the energy commodities delivered for energy purposes to industry, transport, households, services (including public services), agriculture, forestry and fisheries, including the consumption of electricity and heat by the energy branch for electricity and heat production and including losses of electricity and heat in distribution and transmission" (Eurostat).

As concerns the repartition among Member States, the leaders in the RE inland consumption are Iceland (84.9% of all consumed energy), Norway (44.7%), Sweden (42.2%) and Latvia (35.1%). As concerns the gross final energy consumption, we have the same leaders which are Sweden (53.9%), Finland (39.3%), Latvia (37.6%), Austria (33.0%) and Denmark (30.8%) (Eurostat, 2017).

The major three sectors to which renewable energy sources are attributed are heating and cooling, electricity and transport. In 2014, the biggest part of the renewables consumption referred to the heating and cooling sector where solid biomass continued to be the largest contributor to heat production with 82% share. Renewable energy sources (RES) contributed to an extent of 18% the overall energy consumed for heating and cooling making it the dominant RES market in Europe. Renewable electricity occupied the second place where around 28% of all electricity consumed in 2014 came from renewable sources. And finally comes the transport sector in which for the moment only 6% of all energy consumed was related to green sources (EEA, 2017).

As for the generation side, the overall European primary production of renewable energy in 2015 was comparable to 204 million tonnes of oil equivalent which represented the increase by 70.2% between 2005 and 2015 (Eurostat, 2017).

Renewable energy consumption evolution per sector

Concerning the source of **renewable electricity** (**RES-E**) in Europe, over the 2005-2014 period, the compound annual growth rate of RES electricity consumption was equal to 7%. It was the highest for solar PV systems (59%), on the second place was the offshore wind (29%), then biogas (18%) followed by onshore wind (14%). Hydropower experience 0% growth[3] (EEA, 2017). It can be explained by the fact that hydropower energy is a mature technology for power generation. Investments in large-scale hydropower projects were made before the year 2000 and now they are just following their exploitation (Ecofys, 2014). However, small and medium hydropower projects (<10 MW) still have an important technical potential. Hydropower has a big potential in terms of a balancing system as hydropower reservoirs (dams) can provide energy storage capacity and balance the renewable energy from more intermittent sources as wind or solar (EEA, 2017).

[3] For more details, consult Annex 1

The largest contributors of the onshore wind power generation are Germany and Spain. It experienced an overall EU increase of 13.2 million tonnes of oil equivalent (Mtoe) between 2005 and 2014 which was equal to a compound annual growth rate of 14%. Today, it is also considered as a rather mature and lower cost green technology that is why an 8% growth rate in the period up to 2020 will be sufficient to attain the EU objectives (EEA, 2017).

In fact, wind power occupies a very important place in Europe. The biggest EU project that became the world’s second largest offshore windfarm is the Gemini windfarm on the Netherlands’ coast that was connected to the grid last February. This one is followed by two other largest European windfarms: Gode Wind farm of 582MW power in Germany and Westermeerwind project of 144MW power in Netherlands (Vaughan, 2017).

The growth rate of solid biomass was equal to 7% over the 2005-2014 period. The leaders in the biomass electricity generation are Germany (17% of total electricity generated from biomass), then the UK (15%) and Finland (11%) (EEA, 2017). However, it is predicted that the industry growth can be altered by the implementation of sustainability criteria on such source of energy, but it will not become effective before the year 2020 (European Commission, 2016a).

Solar PV systems experienced a very considerable growth overpassing in 2014 the EU 2020 objective. As in other sectors, Germany is on the first place and represented in 2014 39% of EU solar PV electricity production, then followed by Italy (24%) and Spain (9%) (EEA, 2017). Such a rapid growth was first driven by technological development in this area and cost reduction but also a relatively short project development time (Ecofys, 2014). The peak years of PV installations were the 2011 and 2012 but then the development took a decreased spate because of increased taxes on electricity self-consumption and reduction of financial support. It is expected that these changes will slow down the future development of PV solar systems.

Another technology that is also expected to decrease its development spate is biogas one more time because of policy changes in leading countries as Germany and Italy. However, during the 2005-2014 period the compound annual growth rate was equal to 18% that overpassed the expectations (EEA, 2017).

Concerning installed electricity capacity, renewable energies slowly gain their field. In 2015, combustible fuels were on the first place with 47.4% of installed electricity capacity, hydro on the second with 15.5%, then wind 14.4%, nuclear with 12.4%, solar PV with 9.7% and other sources with 0.5%.

Another issue in which the European RES-E industry is making progress is the matter of interconnectedness. Currently, a new project is being put in place that will connect Britain and Norway's hydroelectric power plant by putting the longest undersea power cable of 45 km long (Plester, 2017). The improved interconnectedness is the key for reliable RES-E supplies as it will help to smooth the electricity produced from more intermittent sources as wind or solar technologies.

Heating and cooling from renewable sources (**RES-H&C**) represented 17.7% in 2014 of the overall energy consumption in this sector which can be translated in a 3% annual growth. The largest contributions came from solid biomass (84% of EU28 RES-H&C), heat pumps (9%) and biogas (3%)[4] (EEA, 2017). To achieve the EU objectives, a growth rate is expected to attain 4% per year until 2020.

Concerning **renewable transport fuels** (**RES-T**) in 2014, 5.9% of fuels consumed by transport sector were renewable sources (EEA, 2017). Biodiesel is the main renewable source of energy for transport, representing 79% of use of biofuels and bioethanol stays on the second place with 20% (Eurostat, 2017)[5]. To attain 2020 objectives, the annual growth will have to be equal to 14% and for the moment most of countries do not attain the levels of their National Renewable Energy Action plans (NREAPs). Renewable electricity has not managed to attain the objective neither, reaching 13% lower share than expected (Eurostat, 2017). This sector is still in developing regulatory frame because of the existing concerns on GHG emissions of first-generation biofuels.

Fossil fuel savings and CO_2 emission reduction

The estimated contribution of renewables to fossil fuel savings in 2015 was equal to 16 billion euros and is expected to reach 25 billion euros in 2030 (European Commission, 2017). In this way, the additional use of renewable energies since 2005 enabled to cut the consumption of fossil fuels by approximately 11% (of total fossil fuel consumption) which is comparable to the fossil fuel consumption of Italy. It resulted in approximately 10% reduction of GHG emissions in Europe between 2005 and 2015 [6](EEA, 2017).

[4] For more detail, consult Annex 2
[5] For more detail, consult Annex 3
[6] For more details on GHG emission evolution and projection, consult Annex 4 and 5

In conclusion, comparing to other world regions, today Europe occupies an important place on the renewable energy market. It managed to improve the industry and boost technological development. European Union was the biggest solar PV capacity in the world until 2015 and for the period 2005-2012 it represented the highest level of investments in renewable technologies every year, until it was overpassed by the Chinese continent. In terms of RES-E capacity installation in general, the EU is today on the second place after China. As we are actively approaching the critical year 2020, Europe has to fix new challenging objectives to continue the industry growth.

Regulation of climate change in Europe

The environmental issue started to raise concerns of scientists and regulators at the end of the last century which provoked the necessity of actions from governmental bodies.

The first important initiative on the international level was taken in 1988 (Delbeke and Vis, 2016) by the creation of the Intergovernmental Panel on Climate Change (IPCC) which was an open forum where scientists from all over the world could express their views and concerns on the state of the climate. In this way, with help of scientific community, regulators could start a series of actions to tackle the problem of future climate change.

The first important agreement took place in 1992 (Delbeke and Vis, 2016). This year at the Earth Summit in Rio de Janeiro the United Nations Framework Convention on Climate Change (UNFCCC) was adopted. The objective of this agreement was to stabilize greenhouse gas concentration in the air in order to prevent interference in the climate system, but no binding target was fixed. Five years later, United Nations (UN) decided to extend the previous agreement and in December 1997 the Kyoto protocol was adopted by which developed countries agreed to take the lead to reduce considerably their greenhouse gas emissions. It was the moment, when the journey of building of EU climate policy took the start (Delbeke and Vis, 2016).

In 1996, the EU Environmental Council had already agreed to limit the global surface temperature rise to below 2°C above preindustrial levels (European Commission, 1996). After the Kyoto protocol approval, Europe had to take concrete measures to put in practice its commitment on the way of decarbonisation. Since the Single European Act of 1987, the environmental issues have been pushed to the European level as it was recognised that pollution does not have borders and neighbour countries need to have homogeneous policy to efficiently tackle environmental issues. It was also necessary for the European Union to have a single and powerful voice on the international scene. In this way, the adopted measures first took the form of Voluntary Agreements made by Member States, but after were replaced by more binding but still flexible regulatory instruments taking form in most of cases of European Directives.

It was quickly recognised that the development of renewable energies was key for the reduction of GHG emissions. In this way, the first initiatives to promote the green energy industry were: *the Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market*; *Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport* and *Regulation (EC) 1099/2008 of the European Parliament and of the Council established definitions for different types of energy from renewable sources*.

The next step for Europe was to determine what kind of instrument was the best to be used to reduce CO_2 emissions from other industries. The way of control through taxation was abandoned after a decade of negotiations firstly because the decisions in the area of tax regulation has to be adopted with unanimity of Member States which is usually difficult to achieve, which would slow down the decision making. That is why the EU shifted to the solution of cap-setting on greenhouse gas emissions and emissions trading system (ETS). In this way in March 2007, on the basis of the Commission's proposal, European Council declared about its independent commitment to reduce by the year 2020 by 20% the greenhouse gas emissions compared to the level of 1990. The objective of this decision was to create a competitive edge in the sector of new technologies and reduce economic vulnerability of the EU by decreasing its dependence on fossil fuels imports. This target resulted in numerous legislative initiatives that were commonly named "Climate and Energy package" that consisted of following legislations:

- *Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community;*
- *Decision No 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020, (Effort Sharing Decision)*
- *Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC;*

- *Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels;*
- *Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO2 emissions from light-duty vehicles;*
- *Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide.*

As different countries were on different levels of economic development, Europe managed to engineer a combination of targets that would respect the principle of fairness and solidarity among Member States. At the end of the day, this primary objective of fairness resulted in a big flexibility and divergence among measures adopted on the national levels. In order to clarify the pathway of achievement of taken commitments, in 2011, the European Commission issued a Low Carbon Roadmap (European Commission, 2011a) and an Energy Roadmap (European Commission, 2011b) to give general indications of the EU objectives for such a long time frame as the year 2050 and give available insights on the feasibility of such a project by exposing different possibilities of development for different industries.

The next important step in European Climate policy development was the official announcement by the European Council of a new series of targets to achieve by the year 2030. In October 2014, in the run-up to the coming UN Climate Change Conference in Paris, Europe committed itself to achieve minimum 40% reduction in GHG emissions, minimum 27% share of renewable energy consumed, and other targets as reformation of the emission trading system (ETS), improvement of functioning of the connected internal energy market, decrease of energy dependence and elimination of administrative burdens. These objectives were consolidated by the Paris agreement by which 196 nations agreed to limit the global temperature rise below 2°C during this century.

The issue of European energy mix attracts the attention of regulators as much as other environmental issues. In fact, energy use in the EU contributes to an extent of 80% of greenhouse gas emissions. In addition, it comes with an increasing dependency of the Union on its energy imports: in 2012 EU imported 86% of consumed oil and 66% of gas (Eurostat, 2014) which threatens seriously the stability of energy supply. The first directive on renewable energy promotion that was adopted in 2009 was based on National Renewable Energy Plans of Member States and was fixing national targets and it addressed three main sectors that were the electricity, heating and cooling and transport. It was the year when EU for the first time adopted specific provisions relating to energy policy including the promotion of energy efficiency and development of new forms of clean energy.

In February 2015, the Commission published a Framework Strategy for a Resilient Energy Union with a forward-looking Climate Policy, which gave birth to a new climate package in November 2016, called “Clean Energy for All Europeans”. This package included a new directive on future promotion of renewable energies until the year 2030. It was made to address the issue of investment uncertainty by fixing long term binding objectives. Today, this objective becomes crucial as the investment needs for the EU are estimated to be around 1 trillion euros until 2030 in renewable electricity generation alone (European Commission, 2016b) that is why it is necessary to create a certain regulatory environment for investors. It is also expected that these investments will come from the private sector as after 2020 already mature renewable technologies may not need state subsidies mostly due to lowered costs of clean energy (European Commission, 2017c). The fundamental shift from the previous directive is that the Commission proposed a binding target of 27% on the EU level without any translation into national targets, which aim is to promote partnerships and harmonisation among Member States. An overview table of all world-wide and European regulatory advancements on the subject of climate control may be found in the Annex 6.

At the moment, the new Renewable Energy proposal already went through the first reading in the Parliament, where it already proposed to review the 27% share of renewable energies target and fix a more ambitious objective, and today it is going through the Council discussions. The latest advancement in the procedure consisted in the recent proposal of the European Parliament’s environment committee to increase the target up to 35% (Renewables now, 2017).

PART II: FACTORS INFLUENCING STOCK MARKETS OF RENEWABLES

In this part, we are going to explain main factors discussed in the scientific literature that can have an influence on renewable energy markets. This list aims to give a general idea of pattern dependency of prices and is not pretended to be exhaustive.

Oil market prices

The historical evidence showed that oil prices always had a great impact on overall stock markets. More precisely, according to numerous studies (Hamilton, 1983, 2003; Huang and Masulis, 1996; Jones and Gautam, 1996; Sadorsky, 1999, 2001, Henriques and Sadorsky, 2008, Park and Ratti, 2008; Kilian and Park, 2009) and consequently adopted conventional wisdom, increase in oil prices have a negative impact on economic activity and stock prices. However, there are some exceptions for specific industries and we suppose that renewable energy industry is one of such exceptions.

Scientific investigations showed that if we consider the pre-crisis period, existing studies such as the one of Sadorsky (2012a) fail to prove positive dependence of clean energy companies on oil prices. The situation changed with time when scientists started to study more recent data that concerns the post-2007 period. One of these studies belongs to Managi and Okimoto (2013) who found a clear evidence of positive relationship between oil and clean energy prices. They discovered that this dependence was not constant during the overall period of research but clearly occurred only after the structural break that took place in late 2007, the year which was characterised by an important increase in oil prices. Authors consider it as a permanent trend that will persist in future thanks to decarbonisation policies rather than a transitory and temporary situation.

Another study confirming these findings was carried out by Inchauspe (2015) who found that oil prices became much more influential from the years 2005 – 2007, but still not being the most important factor that influence clean energy price changes.

In another recent study, Reboredo (2015) analysed the dependence and systemic risk between oil and renewable energies by computing the covariance measure of symmetric risk. Based on the period from December 2005 to December 2013, he came to a considerable conclusion that oil price changes contribute to an extent of around 30% to upside and downside risks of sustainable energy companies, confirming in this way the existence of symmetric positive dependence. This result was applicable to all the renewable energy industries except the solar index.

Technology index prices

The subject of relationship between renewable energy companies and technology companies has been treated in numerous studies, in particular by the pioneer in this field Perry Sadorsky, using different kinds of statistical models. All these studies unanimously came to a conclusion that there is a sufficient statistical evidence that returns of clean energy and technology companies are highly correlated.

These studies were usually conducted in scope of comparison of relationship with technology companies and oil markets, to see which one has a greater impact on returns of renewable energy companies. In this way, Henriques and Sadorsky (2008) in their work analysed the dynamic relationship between stock prices of clean energy companies, interest rates, oil market and a technology index and came to a conclusion that renewable energy companies have more in common with technology companies than they do with oil markets. This study was carried out using a vector-autoregressive model to analyse concretely the relationship between returns in equity investments and oil prices.

According to another research (Sadorsky, 2012a) in which the author analysed the correlation and volatility spillovers between returns of clean energy companies, oil prices and technology stocks, we have proof of evidence of higher relationship with technology companies rather than oil prices.

Another recent and considerable work belongs to Inchauspe (2015). The aim of this study was to analyse abnormal returns of clean energy companies using an asset pricing model with time-varying factors. Basing on explanatory factors that were identified in previous researches, in particular oil prices, interest rates, global stock index and technology index, the study came to the same conclusion that renewable energy returns are highly correlated with technology stocks and are influenced by oil prices to lower extent.

An explanation of such an important correlation was suggested by Inchauspe, Ripple et Truck (2015, p.8):

> "Authors suggest that investors might see renewable energy stocks as similar to high technology stocks (…). A possible explanation for this phenomenon is that high

> technology and renewable technology companies often compete for the same inputs. These resources might include high-qualified engineers and researchers, research facilities, semi-conductors, integrated circuits and thermoelectric materials, among others".

Another explanation of similar patterns of technology and renewable energy stocks could be the fact that they both benefit from government policies aimed to promote new technologies and switch to a de-carbonized economy (Managi et Okimoto, 2013).

This relationship can also be explained by the simple logic: knowing that the first mover of renewable energy industry is technological development which enables to reduce the price of such a new kind of energy and improve its availability, it is easy to conclude that when a technological discovery takes place, it influences in the same positive way these both industries.

Growing climate awareness and investment possibilities

As the environmental concerns became a publicly discussed issue these last years, more and more citizens developed their own attitude and adopted a more responsible approach for their consumer choices. Thanks to today's information technologies, people have access to all kinds of information which enable them to stay informed and take thoughtful decisions. This gave birth to such current trends as responsible and local consumption, zero-waste life style, etc. which spreads on the choice of clean energy sources. The European Union started to encourage this tendency by ensuring the transparency of information coming from energy sellers with the Electricity Market Directive (2003/54/EC) of 26 June 2003, according to which retailers have to publicly disclose their energy sources and its environmental impact in terms of CO_2 emissions and nuclear waste. It is also amplified by anti-nuclear movements that benefits the shift to renewable energy sources.

Analysts also studied the willingness to pay of European consumers for different types of green products. In this way, Bigerna and Polinori (2014) found that Italian households are in general sensible for green energy goals and have a noticeable willingness to pay for a premium of green electricity. According to Hansla et al. (2008), Swedish households demonstrated a gradual increase in willingness to pay for sustainable electricity and it is mostly related to their awareness of consequences of environmental problems on the planet. Another study was carried for micro-generation technologies (solar PV, micro wind, heat pumps) in the UK market. The author came to a conclusion that renewable energy adoption is valued by households but the overall willingness to pay still is not sufficient to cover the cost of these technologies (Scarpa et Willis, 2010). In conclusion, we can affirm that consumers' behaviour definitely changed in terms of responsibility of choice, and this change can be a serious support for the development of renewable energy market.

Changing scope of the investments

1. Portfolio management

The rise of socially responsible investors gave a boost to such financial instruments as socially responsible ETFs (Exchange Traded Funds) and indexes. Some of them cover all companies that in a certain way contribute to the common welfare of the society, others specialize in environmental concerns as renewable energy, with further division on specific industries (as solar, wind, biomass, etc.) or regions. These products generally refer to the practice of Socially Responsible Investments (SRI). According to Eurosif (2016), such strategy as Impact Investing experienced an immense compound annual growth rate of 120% between 2013 and 2015, compared to other strategies as Exclusion, Norms-Based screening, Sustainability themed investment and other which growing rates were between 14% and 57%. As concerns the absolute value, Sustainability themed investments attained 145 billion euros in 2015 and the share of investments in renewable energies accounted for 19.68%.

Individual stocks active in clean energy also started to gain a significant interest of investors. According to Nicol et al. (2017) the move towards the low-carbon economy will have a great impact on the financial sector. It will be translated by an important transitional risk in coming years. As companies will have to drastically reduce their carbon emissions to achieve national and international objectives, it can create important risks for financial institutions and investors who work with highly carbon dependent companies. It will result in reduction of financial performance and consequently credit, counterparty, liquidity and operational risks accompanied with a great level of uncertainty.

Because of existence of such risks, investors get preoccupied by the composition and diversification of their portfolios. In this way, the alignment of portfolios with a low-carbon pathway may be a solution, when investors expressly exclude high emission companies and include those that are already taking great efforts in development and adoption of low carbon technologies which undoubtedly has a positive influence on renewable energy industry.

The European Commission admits that "(environmental) commitments and the growing awareness of the urgency to address environmental challenges and sustainability risks call for an effective EU strategy on sustainable finance" (European Commission, 2017d). That is why further development in this field will be ensured by recently created High-Level Expert Group on Sustainable Finance which aim is to suggest solutions in the field of environmental and sustainable finance that would permit the EU to achieve Paris Climate Agreement objectives.

2. Citizen participation

Besides traditional investment, today environmentally concerned citizens have a possibility to use several other financing channels by directly participating in renewable energy infrastructure projects. It can give an important boost to the clean energy industry development because according to Özgür (2014, p.677) "public authorities lack the needed capital and institutional private investors are generally averse to restraints such a high transaction costs and risk-return-concern <…> consequently, alternative financing concepts must be developed to keep the energy transition going". This study discusses alternative concepts based on the financial citizen participation experience in Germany. This Member State would serve a good example for the rest of Europe as citizen participation occupies there an important role: 48% of installed capacity for solar energy, 50,4% for wind and 42,2% for biomass is owned by citizens. In most of cases it would consist of small-scale renewable energy infrastructure projects as they are financially unappealing to big energy companies and interesting for individuals thanks to their comparatively low investment volume in stake.

On the example of German market, here are the most common financing schemes available for citizen participation.

- <u>Equity-based schemes</u>
  The first and the most common type of an equity-based scheme is a *cooperative.* This business model of citizen financial commitment has a long history starting at the end of 19th century to provide far rural areas with energy. This tendency sank by the middle of the 20th century and was recently rediscovered thanks to new opportunities for renewable energy production decentralization. We can make a distinction between resource-based and activity-based cooperatives. The first differentiates according to the energy source (wind, solar, etc.) the second by the stage in the value chain of energy production (production, selling or service). In 2012, 754 registered cooperatives in Germany raised approximately 426 million euros equity. Energy cooperatives do not

only give a possibility to participate in project financing but also is an organisational instrument which enables citizens to participate in decision-making of local energy policy. This business model presents a big interest for concerned citizens also because of the fact that cooperatives are financially screened by auditing companies.

Another form of an equity based scheme is a c*losed-end fund.* The specialty of this instrument is that it aims to raise capital for different project needs through a large number of investors. Initiators of these funds are usually farmers' holdings, plant producers or energy suppliers and citizens only have the role to bring their financial participation. In this way, they do not participate in decision-making and act as limited partners whose responsibility is limited to their initial capital participation.

- <u>Debt and mezzanine capital based schemes</u>

  With the debt structure, the citizen receives a guarantee of returns for a predetermined period of time. Providers of bonds are usually local savings banks or private banks specialized on environmental topics or project developers. The main advantage of this investment form is the save conditions. Mezzanine-finance usually consists in profit participation rights provided by project development companies.

These forms of "producing consumers" enable the decentralization of the energy market. As a result, today the European Federation of Renewable Energy Cooperatives counts 1240 initiatives, which members invested 2 billion euros in installations and the combined annual turnover represents 950 million eur (EEA, 2017).

These financing schemes gain more and more importance, but they are still based on highly reliable underlying technologies that present minimum risks (Özgür, 2014) and in this way, they cannot be seen as a solution for innovative technologies that still need important financing.

Other unpredictable causes

The history knew in the past several catastrophes involving energy producing centres, and these events by their unpredictable character and direct involvement of certain industries undoubtedly had an influence on world stock markets including the markets of renewable energy.

The academic world provided us with evidence that such events as accidents on nuclear stations have a great impact on public electric utility stock markets in general and especially on firms with current or planned nuclear relations. Three Mile Island accident of March 1979 studied by such authors as Bowen et al. (1983), Hill and Schneeweis (1983), Barrett, Heuson, and Kolb

(1986), resulted in significantly negative abnormal returns for US public utility firms as well as an increase in risk premia, in the month and the following month after the accident. Fields and Janjigian (1989) and Kalra et al. (1993) studied US public utility stocks after the Chernobyl nuclear disaster of April 1986 and one more time found evidence of significantly negative abnormal returns on market, especially for firms involved in nuclear relations.

The last study on the subject concerns the Fukushima 2011 accident which was carried by Ferstl, Utz and Wimmer (2012). The paper shows that on the first trading day after the accident, German, French and Japanese nuclear energy companies showed abnormal negative returns which persisted during the event window contrarily to the US market that did not react. Authors could also observe the opposite reaction of clean energy markets except in the US. They took great advantage during the event window: the abnormal returns were especially high for solar energy firms in France and in Germany. The effect disappeared in the medium term, for both nuclear and renewable energy companies, except for Japanese nuclear producers for whom significantly non-zero cumulative abnormal returns remain for the longer period. Authors supposed that it could be explained by the fact of overreaction of the market on this event as most of the significant abnormal returns were observed only within two trading days after the accident. Knowing that the US market hasn't been impacted at all, that would also mean that the majority of abnormal returns in post-event window were justified by other country specific events.

Legislative intervention in the market

The renewable energy industry experienced an important development only in these last decades which explains the fact that it still contains numerous barriers that impede its full expansion. Even if power markets get highly liberalized, government still play an important role in evolution of energy industry in Europe, and it is still the main power that has the possibility to remove existing barriers and promote the clean energy industry. The European Union had a significant experience in adopting clean energy promoting policies: some were judged to bring considerable results, others resulted in a failure.

In their work, Beck and Martinot (2004) presented a taxonomy of possible government policies that could give a push to renewable energy sector. They can be summarized as following:

- Price-setting and quantity-forcing

  Favourable pricing regime or a feed-in approach consists in fixation of price for which a unit of power has to be sold, and oblige utilities to buy it. This is empowered by giving subsidies to clean energy producers. Another variant is to fix a minimum quantity of renewable energy generation to be supplied. Another measure is the already adopted system of Green Certificates that by trading possibility enable companies to meet their green objectives.

- Cost-reduction policies

  The aim of this kind of measures is to attract investors by reduction of cost of an investment in clean energy industry. Here we can enumerate following measures: direct subsidies and rebates on initial investment aimed to switch to clean energy, paying the cost of the system for households and businesses, personal or corporate tax reliefs for using renewable energy, production tax credit depending on quantity of generated power or provision of loans for clean energy equipment or other financial help.

- Direct public investment or market facilitating activities

  Here we can mention such measures as infrastructure, construction or permitting policies aimed at creating unique homogeneous standards and certifications. We can also include customer education about the possibility of choice among different providers as well as educational campaigns to increase customers' awareness.

- Emission norms

  Emission reduction policies put a cap on NOx and CO_2 emissions allocated to each company. In Europe, it was enacted by a carbon allowance trade system (ETS) enabling companies, including those active in clean energy, to sell their allowed quotas of emissions to other companies that need it. Advocates of this system suggested that it would be advantageous for renewable energy companies because thanks to the trade system they could have an additional source of benefit.

- Power-sector restructuring policies

  The objective of these measures is to make electricity become a competitive market commodity, to remove utilities monopolies and open competition to wholesale power markets. It aims to enable self-generation by householders and end users, development of cogeneration technology options and interconnection allowing regulations. It would consist in breaking vertical integration of utilities, which historically detained monopoly on generation, transmission and distribution of energy. Such kind of competitive retail power markets enables environmentally aware customers to opt for green power suppliers.

A lot of studies came to a conclusion that government policies have an important role in the development of renewable energy industry. According to Sadorsky (2012b), a strong factor that influences systematic risk of renewable energy companies is the companies' sales growth. For him, "one way for governments to reduce the systematic risk of renewable energy companies is to either directly create a stable and predictable demand for renewable energy or indirectly via policies designed to spur consumer purchases of renewable energy" (Sadorsky, 2012b, p.47)

Subsidies, feed in tariffs and fixed-price guarantees

Direct subsidies or feed-in policies are recognised to have the biggest power of influence. According to the European Commission (2008), "well-adapted feed in tariff regimes are generally the most efficient and effective support schemes for promoting renewable electricity". It consists in offering by the government of guaranteed prices for a certain period of time to electricity producers that deploy renewable energy technologies. It takes form of payments for every kWh and represents an important incentive for different kinds of investors such as small businesses, homeowners, farmers, etc.

According to Couture (2010) feed-in tariffs based on costs required by renewable energy projects and guaranteed payments during the lifetime of technology, significantly reduce investment risks and in this way conduct to a considerable market growth of clean energy technologies. Government interventions guarantee at a certain extent the stability of remuneration scheme and maintain investors' confidence.

There are several different ways to structure such kind of payment scheme and they have different degrees of impact on renewable energy investment risk. The first main group consists of fixed-price policies where they guarantee fixed minimum prices and this form is the most currently used (Mendonca, 2007). It fixes a guaranteed payment level that is based on cost of technology development and is supported by a purchase guarantee. The second type is represented by feed-in premiums. It consists in paying a fixed premium amount which goes in addition to the market price of electricity. Market-independent or fixed-price model is seen to be more efficient because it creates greater investment security and more predictable future compared to simple fix feed-ins based on the unpredictable market price which can lead to an under- or overcompensation. Market-independent method represents a more adapted approach as it is based on technology costs (Couture, 2010).

The case of governmental subsidies has also been analysed by Beck (2004) where he came up with a conclusion that competitively and correctly determined subsidies effectively lead to price reduction of renewable energies as it was the case of British Non-Fossil-Fuel-Obligation (NFFO) adopted in 1990s. But the factor of price decline was not sufficient for market development boost as in most cases these subsidies did not lead to successful realisation of renewable energy projects because of low final returns.

Contrarily to fixed price guarantees and feed in tariffs, other policies that were put in place by the European Union were not judged to be such effective and some of them even raised contradictory opinions concerning their benefit for the renewable energy sector.

<u>Carbon emission permit</u>

In 2005 the European Union launched an Emission Trading System (ETS) which enabled trading of greenhouse gas emissions allowances (The Guardian, 2011). For the period from 2005 to 2011, the market of emissions permit was equivalent to 150 billion dollars annually and according to a study of the Institute for Climate Economics (The Guardian, 2011), it resulted in reduced emissions by 120-300 megatonnes in two years after its creation. Regardless these facts, ETS does not seem to have a considerable impact on renewable energy industries. In their study Kumar, Managi et Matsuda (2012) analysed the dependence between clean energy stock prices and carbon emission permit prices and came to a conclusion that there is no significant relationship between these two variables.

<u>Guarantees of Origin or Green Certificates</u>

A Guarantee of Origin (GO) is a certificate that proves the source of sold energy and is regulated by the European Energy Certificate System (EECS). This measure was used to bring transparency to the energy market and enable interested parties to identify suppliers that provide energy extracted from renewable sources. These certificates have a possibility to be sold further through the chain to retailers or other players of electricity markets who acquire in this way the authorisation and proof that they are selling green energy. But this trading option makes that this policy instrument does not achieve its goals of renewable energy promotion.

In his work, Mulder (2016) raised the problem of existence of international trade for these Green Certificates. According to the author, the biggest problem is that these certificates are decoupled from their original electricity flow and can be sold separately which means that companies and countries that do not make effort to increase their own green energy production are able to use imported GOs to reach targets for renewable energy. In the end, GO system does not promote national markets of renewable energy and does not reflect the real improvement on national levels. In case of the Netherlands, in 2014 the country reached a figure of 34% of renewable electricity compared to the total electricity supplied, a good improvement comparing to previous years but we can see that it did not result in the additional green electricity production but simply in increased imports of GOs from Norway.

Another problem of this system is the price of GOs which is not high because of the abundance of such certificates in certain countries. The low price attracts retailers who would like to sell energy under the "green label" without making any expense to deploy their own renewable energy technologies. In conclusion, we can suppose that the system of Guarantees of Origin is benefiting only to retailers who target several environmentally aware groups of consumers who are ready to pay higher price for renewable energy. According to Mulder (2016) Green Certificates appear to be a simple marketing instrument.

But we cannot deny the fact that this system can still be profitable for clean energy producers in the way that by selling these certificates, they gain additional revenue that can be redirected to the development of the industry.

It is clear that in order to evaluate the effectiveness of government intervention, we have to go beyond the simple consideration of a support scheme type by taking into account a wider range of attributes as the administrative framework of the scheme, the duration of the support, etc. What can be concluded with certainty is that to have a considerable influence on renewable energy market, the implemented policies need to have a long-term framework which would provide a clear signal to investors and bring certainty on the market.

This part analysed the post-factum influence of regulations on the markets, further in this work we are going to tackle the subject anticipated regulation influence.

PART III: STOCK MARKET REACTION ON REGULATORY INTERVENTIONS

Literature review: market reaction on new regulations

The interest for the stock market reaction on new regulatory interventions was manifested in the academic world a long time ago. The aim of these studies was to identify and analyse different governmental body announcements that precede the change in legal environment of the companies in order to project the potential impact on company's wealth. The most of times academics were using industry specific announcements. As an example, we can name the work of Prager (1992) who studied cable television deregulation or Berk and Rauch (2016) who targeted the US oil and gas sector and its reaction on a series of the Commodity Futures Trading Commission's announcements. The food sector has also been several times covered in this scope by works of Shaufele and Sparling (2011), Mazzocchi et al. (2009), Detre et al. (2006, 2008) and others. They were all using an event study methodology to analyse the impact of new food regulations on stock prices of companies active in the agribusiness.

These last couple of decades, governments and people focus their attention on environmental aspects of the economy which inevitably awakened the interest of scientists. These researches were mostly focused on the impact of the news about a company's poor environmental performance (Laplante and Lanoie 1994, Konar and Cohen, 2001, Lorraine et al., 2004) or in the contrary, company specific environmental and Corporate Social Responsibility actions and efforts, on the question weather "being green" brings value to a company or not (Lorraine et al., 2004; Al-Tuwaijri, 2004; Van Stekelenburg et al., 2015; Andriana and Panggabean, 2017). But, according to our best knowledge, very few studies have been carried out on the subject of green policy announcements and its impact on the overall stock market and no author until today analysed the concrete impact of these events on the renewable energy industry.

The first study on the impact of green policy announcements was conducted by Kahn and Knittel (2003). They used an event study methodology to estimate the reaction of the US electricity and coal mining companies on significant environmental announcements that were supposed to "surprise" the market. The authors studied 4 event dates starting with the announcement speech of the Environmental Protection Agency director William Reilly and finishing by the adoption of the Clean Air Act Amendment proposal in June 1989 on new acid rain regulation which marked the start of George Bush presidency. The study came to a surprising conclusion that these events did not manage to affect targeted polluting power plants companies. For the authors it was the proof that electricity firms managed to pass the increased cost onto final consumers without affecting their own profits. It was possible because electricity in the US at that period was working on basis of rate-of-return price regulation, the advantageous situation that was amplified by the inelasticity of demand, which in the end made that new regulation did not have any impact on the wealth of polluting companies.

The rest of the academic literature in this area is represented by works of Vikash Ramiah and his colleagues. Each year starting from 2013 he carried out researches on the impact of environmental policy announcements on the overall stock market in different regions by the mean of the event study methodology.

His first work (Ramiah et al., 2013) examines the effect of 19 local green policy announcements on the Australian Stock exchange during the period between 2005 and 2011. According to their results, 60% of the Australian stock market was influenced by the announcements but surprisingly the most polluting industries like electricity industry were not affected by these events. As in their work, authors were analysing different industries separately, we could isolate the effect applying to the alternative energy sector. According to the figures, it did not react to these kinds of announcements except on the day when Australian government submitted its targets for carbon reduction to the Copenhagen accord, the day when the industry experienced significant negative abnormal returns. This report was telling that the country will not commit to a 5% emission reduction target unless other global emitters are clear about their "share of the deal". According to authors, the conditional character of this announcement could explain the negative effect on abnormal returns.

The next work of the authors (Ramiah et al., 2015a) was treating the Chinese stock market during the period between 2001 and 2011 and its reaction on 25 international and national announcements. Disastrous environmental situation related to the rapid economic growth of this country during past years made the Chinese government to take measures in terms of environmental and health protection of their citizens. Interestingly, such big events as the Kyoto protocol and announcement that Beijing would host the Olympic games (and as a consequence the necessity to improve the ecologic situation in the city), did not have any significant influence on the stock market. In particular, such polluting industries like coal, were presenting both positive and negative reactions on different environmental announcements proving that green policies initiated by the politicians did not have much effect. According to the authors, the main conclusion is that environmental policies turn out to be inefficient in terms of influence on biggest polluters as they obtained the evidence that policy announcements have only a marginal effect and often do not achieve their primary goals. This can be explained by the lack of enforcement of environmental regulations and unsupportive work environment for environmental regulators. Unfortunately, as this research took the overall energy sector for a unit of study, we could not isolate and see the concrete impact on the industry of alternative energy.

For the next research (Ramiah et al, 2015b), the authors moved to the American continent to analyse green initiatives taken under Obama presidency on the US industry portfolios. They also analysed the risk profile change provoked by green policy announcements. They obtained diverse results depending on the industry and the type of announcement but one more time came to a general conclusion that green policy announcements do not necessarily have negative impact on polluting companies such as oil and gas exploration and production, industrial machinery, etc. Another surprising result was that environmentally friendly companies such as environmental and facilities services remained unresponsive to such announcements. Among 133 event days analysed, the most influential ones were the Bill Clinton signing of the Kyoto protocol and Bush unveil of voluntary plan to reduce global warming which provoked small positive abnormal return for alternative energies; and Western Regional Climate recommendation release for a cap-and-trade system and a reassessment of historical climate data for key atmospheric features which resulted in negative abnormal returns.

The last study published by the authors (Ramiah et al., 2016) deals with the same subject, this time in application to the UK market. In particular, it studies the effect of 75 international, local green policy announcements and announcements in the nuclear sector on the British equities during the period between 2003 and 2012. This time authors came to a conclusion that in general, international announcements had stronger impact than local ones and that in case of international events, abnormal returns continued to occur during five days after the announcement, contrary to the local ones. As for the alternative energy equities, only 4 announcements had a significant impact. The release of recommendations for a cap-and-trade system by the Western climate initiative, the Northern Ireland nitrates action programme regulation and the Northern Ireland producer responsibility obligations regulation had a positive impact on green energy industry and a Northern Ireland regulatory amendment of landfill regulation had a negative impact.

In this way, from these studies we could see that green policy announcements did not seem to have response from the market regardless the studied region. It was not necessarily value-destructive for polluting companies and the renewable energy sector was not impacted positively neither which makes us to put the efficiency of these regulatory interventions under question. Through all these studies we also learn that green policy announcements boost systematic risk of businesses in all the studied regions.

Another research has been conducted on the question of volatility reaction. A study on the impact of regulatory interventions on the industry stock returns volatility in the solar sector has been carried out by Schiereck and Trilling (2014). They came to a conclusion that positive political news items provoked a significant decrease in volatility response, the degree depending on the exposure to political risk, and negative news did not have any impact. More precisely they found that political news that appeared on the European level had less influence on the volatility than national German regulatory interventions. As it was seen in the research of Ramiah et al. (2016), local announcements have a tendency to have bigger impact than international ones which can be explained by the higher level of concreteness and smaller time span given for the application.

In this way, according to our best knowledge, there is no study that analyse the impact of diverse green policy announcements on the alternative energy industry in terms of its stock price. So, we would like to continue and complete the existing academic literature by deepening the research question.

Literature review: event study methodology

As it was explained earlier in this work, during the last decade Europe did a lot of efforts to move towards the decarbonisation of the economy and to promote renewable energies. The first tool of these changes was and still is a regulatory intervention that would encourage or repress certain industries or practices. But how can we value the impact that these kinds of interventions have on the industry?

In our case, we chose to focus on financial markets to try to evaluate this impact. According to Investopedia (2017), “a company’s stock price reflects investor perception of its ability to earn and grow its profits in the future”. Stock prices can in fact be a good indicator of the “health” of the industry because by decomposing the value of a stock we can see that it is represented by discounted future cash flows that will be generated by the company (Kahn and Knittel, 2003). Investors expect positive cash flows from a firm or industry that has promising perspectives in the future (of course taking into account the interest rate that is used for the discount). In this way, by studying the stock price today, we can capture the potential impact that some news, like a regulatory change, will have in future.

One of the statistical methods used in the academic world to study stock price evolution is an "event study" methodology. It was initiated by the work of Fama, Fisher, Jensen, and Roll (1969) where the authors first tested the semi-strong form of market efficiency which postulates that the financial market and market prices reflect all publicly available information at any given time. This work was analysing the reaction of stock prices on an announcement of a stock split. In fact, authors came to a conclusion that possession of publicly available information can in no way be used to increase trading profits which means that stock markets are efficient and quickly adjust to new information on the market.

After that, the event study methodology was often used to test the effect of a new piece of information on stock markets. The core framework of this methodology was described by Brown and Warner (1980, 1985) and it is being used until today. It consists in computation of abnormal returns of a stock during the period of interest. The test is composed of several steps. First, we have to identify the event window that we would like to analyse by fixing the event date, the control period before the event and a post-event window. The concept of a "news" and novelty of the information is central in event study methodology. According to Lamdin (2001, p.172) "news represents new information that investors receive that might change the expected value of the affected firms and thereby cause abnormal returns". So, in order to make a good quality test and capture the potential reaction of the market, we have to identify the event day that was not anticipated by the market. The second step is the choice of the benchmark in relation to which we are going to compute expected returns during the studied period. This is the step where several options of modelling of expected or normal returns of the sample exist, they are as follows: mean-adjusted returns, market adjusted returns, market model residuals and Capital Asset Pricing Model (CAPM). The third step consists in computation of abnormal returns by subtracting expected returns from the effective returns of the sample during the studied period. This is made to then carry out significance tests on the deviation of returns around the event of interest.

If we come back to the core element of an event study, the day of event, a regulatory change appears to be challenging for being analysed with this statistical method and an adapted proceeding must be applied. For the first time, the question of event studies of regulatory changes was addressed in 80's in works of Schwert (1981) and Binder (1985). They identified main difficulties of a regulatory event study. The first is that a new regulation goes through several steps: it is first proposed, then debated and finally approved or defeated, and the information about these steps is freely available for the market. The time span can take more than one year and the researcher has to identify the dates that were the least anticipated by the market. “In sum, it is extremely difficult to find announcements in the regulatory process that are unanticipated by the market, even when the announcements are carefully studied to eliminate those that do not appear to have a major effect on expectations” (Binder, 1985, p.181). Even if it is difficult, we can however try to find the day when the information about the potential regulation appears for the first time or when specific events during the regulatory procedure “suddenly and radically increase the likelihood of a law’s passage” (Kahn et Knittel, 2003, p. 3) which can be source of observable abnormal returns.

The second challenge is that in the same industry for some companies the new regulation can be beneficial and for other it can be deteriorating. It can depend on the size of the company (Stigler, 1974) or the concrete type of the activity (James, 1982). And finally, the existence of industry specific information can also distort the interpretation. It means that when a researcher finds significant abnormal returns during the studied period, it is not certain whether it was generated by the new regulation or by another industry-specific shock.

In this work we are going to use the methodology of Lamdin (2001) who made an overview of existing event studies on regulatory change and highlighted the specificities of implementation and interpretation of such kind of studies. The works of Ramiah (2013, 2015a, 2015b, 2016) which are the closest among existing academic literature to our research question do not use the adapted methodology, so we unfortunately cannot take them as a basis of our study.

According to Lamdin (2001), the first adaption would concern the event window determination. As the moment of the impact is uncertain, the event window of a regulatory change has to encompass the whole time frame of regulatory adoption, starting from the proposal and finishing by the adoption. Instead of a classical instant change, we will address a flow of news between the first mention of potential intervention and the moment when it becomes certainty. This event window will comprise smaller event periods when the probability of enactment of a regulation was affected or when new substantial elements were introduced.

In order to implement this modelling (Lamdin, 2001), the modification has to be brought into the market model. This modification employs dummy variables for smaller event periods that are included in the studied event window. It will enable to calculate the regression parameter on the dummy variable and in this way capture the abnormal return of each event period. There is a possibility to take a single dummy to represent the whole event window and do not make separation on smaller event periods. But this strategy would imply the risk of inclusion of non-event observations. That is why it is preferable to introduce several dummy variables.

In this way, the market model would take the following form:

$$r_t = \alpha + \beta rm_t + \sum_{a=1}^{A} \gamma_a D_a + e_t$$

Where r_t is the return of a security or a portfolio during a certain period t, rm_t is the return on a representative market in relation to which we compute the expect returns and e_t is an error term. The estimated parameter α is the model intercept, and β is market coefficient. D_a represents the dummy variable for each event period included into the event window and γ_a is the estimated parameter that represents the additional or abnormal return related to this event period. If a dummy variable is applied to several consecutive dates during which we expect to see the effect, the γ estimate will represent the cumulative abnormal returns for these days. However, knowing that our computations will be made with an Excel tool, obtained γ estimate in case of several days encompassing will represent the average abnormal daily return during the period that this estimate includes. In this way, making the link with the traditional event study methodology, the regression model is applied to a period including the control window before the studied events and the event window itself.

In previous works (Beneish, 1991, Binder, 1985) authors were using a practice of dividing the regression period in several subperiods to carry out separate regressions. This was made to obtain better estimates of beta and in this way increase the quality of information on abnormal returns estimation.

The parametrized approach exposed above aims to obtain the same results as a traditional event study approach which separates the steps of expected return and abnormal return computation, and is solely the matter of presentation (Lamdin, 2001) which is more adapted for the study of regulatory change.

Concerning the data selection, according to the author "if one can confidently place the event periods on a certain day or two, daily data are appropriate" (Linder, 2001, p. 174). Daily data is also preferable because it will give more accurate information about the impact of studied event by eliminating the external market noise.

Another point raised by the author is the question of test power and its interpretation. Because of the event date uncertainty, the test can have low power and it will result in the Type II error when the analyst conclude that the regulatory change did not have an impact when in reality it did. It means that if we find statistically significant abnormal returns it will happen despite the low power of the test (Linder, 2001). That is why, this information has to be taken into account during the interpretation of empirical results.

More detailed methodology that was applied to our study will be explained in the next part of this work.

PART IV: EVENT STUDY OF THE 2016 RENEWABLE ENERGY DIRECTIVE

1. Input Data

Region of study

In this paper, we considered that it would be interesting to analyse the European stock market of renewable energy mostly because for a decade European Union has been undertaking a lot of initiatives to liberalize the energy market, create market friendly policies for the renewable energy industry and increase private participation in energy projects. For this reason, it would be interesting to analyse the reaction of the renewable energy industry in such a mature market. Moreover, no study on the treated subject has been carried out on the European continent yet and by this work, we would like to cover this gap.

Event selection

The aim of this work is to see whether political decisions in the context of clean energy promotion have a significant influence on renewable energy market prices. The best translation of a political decision would be an issue of corresponding piece of law with clear measures that will have concrete effects on the market. In this way, as the core event for our analysis, we chose the most recent regulatory advancement in the area of renewable energies promotion in Europe: **Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources** published on the 30^{th} November 2016. This event was chosen for the matter of relevance to the current situation on the market but also for the matter of data availability. In fact, a lot of companies active in renewable energies emerged in the first decade of the 21^{st} century as a reaction on the 2009 directive on promotion of renewable energy sources which was the first important initiative in this area. That is why, analysing earlier periods could be difficult as no enough data would have been available.

As in this work we are applying an adapted methodology to the event study of a regulatory change that was explained in the previous chapter, our event window will spread on a relatively long period with a series of events that are related to the 2016 Proposal that will be excluded or highlighted from the market model by the mean of dummy variables.

The number of event days dummied out by analysts varies from one study to another. For example, Schaufele and Sparling (2011) analysed only 3 dates that correspond to the official day of new regulation issues in Canada. Berk et Rauch (2016) in their turn use 19 events including government's officials' speeches, publications of preparatory documents and others. As no study of this type was carried out on the European market, which means the absence of a benchmark, the relevant dates had to be chosen simply according to their expected importance for the market. In our case, the event period will include the preparatory stage for the proposal publishing and the afterwards development of this regulatory change, which resulted in 15 event dates that will be studied. We tried to identify the events that represented "information shocks" and that could have an impact on the formation of the proposal in question. Knowing that "the misplacing of an event would tend to put it after the true period rather than before" (Lamdin, 2001, p.174), we took the earliest dates that were making reference to the coming proposal. On different stages, different objectives were proposed and discussed, as it can be seen in Table 1 which describes all the analysed events.

Table 1: Event dates description

Event	**Brief description**
27 March 2013	Publication of the Green Paper "A 2030 framework for climate and energy policies" and of a Renewable Energy Progress Report
Event n°1: 22 January 2014	Commission Communication that established framework for future Union Energy and climate policies and first proposes that the Union 2030 target for the share of RE consumed in Europe should be **at least 27%**
Event n°2: 28 June 2014	Guidelines on State aid for environmental protection and energy
Event n°3: 24 October 2014	Conclusion of the Council that fixed new objectives for the 2030 climate and energy policy framework: - **Minimum 40%** reduction in GHG emissions compared to 1990; - **Minimum 27%** share of renewable energy consumed in the EU; - Elimination of administrative burdens, etc.
Event n°4: 25 February 2015	Commission Communication: A Framework Strategy for a Resilient Energy Union with a Forward-Looking Climate Change Policy (where we meet once more the target of 27% and which in practice is the green paper of the future directive)
Event n°5: 18 November 2015	"Consultation Questionnaire: Preparation of a new renewable energy directive for the period after 2020" issued by the Commission (gives more precise measures that are meant to appear in the future directive and aims at launching the consultation period for stakeholders)
Event n°6: 12 December 2015	The approval of the Paris Agreement (COP21)
Event n°7: **30 November 2016**	"Clean Energy for All Europeans" package publishing which includes the **Proposal for a directive on promotion of renewable energies (27% target)**
Event n°8: 23 February 2017	Publishing of the reviewed version of the proposal for a directive
Event n°9: 1 March 2017	Day of the First reading in the Parliament and conclusion publishing

Event n°10: 7 March 2017	The president of SolarPower Europe first calls for **35% target** for renewable energies share
Event n°11: 26 April 2017	Publishing of European Economic and Social Committee opinion (which asked for more ambitious targets to be fixed)
Event n°12: 1 June 2017	Trump announcement of US withdrawal from the Paris Agreement on Climate
Event n°13: 8 July 2017	Statement of the European Commission that Paris Agreement is irreversible and will be respected regardless the US declarations
Event n°14: 23 October 2017	The European Parliament's environment committee proposed a higher 2030 renewable energy target for the EU of **35%**
Event n°15: 13 November 2017	Publishing of the Environmental, Public Health and Food Safety Committee opinion (confirming the **35% target**)

However, a comment has to be made on the subject of the Proposal's Green Paper. As it was published in March 2013, its inclusion would oblige us to make an important extension of the studied period. The longer the event window, the larger is the risk to include non-event abnormal behaviours. For this reason, and additionally knowing that on the stage of the Green Paper no concrete objective on renewable energy share in the energy mix has been fixed, we decided not to take it into our market model. In this way, the event window starts with the first event on 22 January 2014, and including a control window of 3 months before, it results in the overall studied period that goes from 22 October 2013 until 24 November 2017.

As it can be seen from Table 1, events that are not directly related to the studied Proposal (events 2, 6, 12 and 13) were also included. These are events that were supposed to have an impact on the renewable energy market which we decided to dummy out from our market model in order to cut out atypical market movements and avoid beta bias.

Sample selection and market benchmark

According to De Jong (2007), studying stock price movements of separate companies would not be very informative because they are usually impacted by other firm-specific information, not related to the studied event. That is why it is preferable to use unweighted average abnormal returns of a range of companies that form a sample. For the matter of normality distribution assumption, the sample has to be large enough to give relevant results after a statistical test. It is assumed that the sample has to contain around 30 entities (De Jong, 2007), in our case the studied sample is composed of 26 companies.

When we want to study the impact on a whole industry, it is preferable to include the representatives of all the stages of the industry value chain. In this way, our sample includes companies selling raw materials for renewable energy technologies production (as silicon for solar panels), constructors of power plants, energy producers possessing clean energy generators and project designers and managers.

To make the primary search, we used Orbis database[7] and carried out an advanced research in companies' descriptions with the key words "renewable energy" and "green energy". Then, each company was analysed according the criteria that were predefined for our study. The criteria of selection were: i) the main part of the companies' activities have to be related to renewable energy; ii) it has to be headquartered in Europe and have the most of activities in the EU; iii) it has to be listed on the stock market at least starting from September 2013. The retained companies and their activity description can be found in Annex 7.

As for the market benchmark chosen for the returns computation, we use the Stoxx Europe 600 which represents the overall European stock market. A couple of companies from our sample has UK and Danish origins, that is way for the matter of conversion, for these companies we used FTSE 100 Index to represent the UK market and OMX Copenhagen for the Danish one.

Data collection

All the events that were selected for the analysis correspond to the date of official publication by the official regulatory bodies or to press communications of industry representatives. In this way, to identify the exact date of these events, the main source of information was the official European legislative portal EUR-Lex completed by other sources as press releases of the European Commission or communications on company websites. According to Binder (1985), in most of cases regulatory announcements that are discussed in newspapers and appear in histories of regulation are already anticipated by the market. It is the limit of the study which is difficult to overpass and that we will have to take into account during the interpretation stage.

Concerning the stock price data collection, it is better to opt for the daily data if we are able to place the event on a certain day or two (Lamdin, 2001), as it is the case in this study. To collect the information about and stock price evolutions of studied companies, we used the Orbis database and the Bloomberg platform. By the matter of price data harmonisation, we had to operate some manual adaptations in such cases when stocks have not been traded at the same

[7] Orbis is a European companies' database developed by Bureau van Dijk company

day. In these cases, the price of the previous trade has been duplicated for absent trading days. In the end, we arrived to 1050 observations that further enabled us to proceed to our statistical tests.

2. Empirical results

Using the Excel tool, we proceeded a linear multiple regression model using the average returns of our sample. Natural logarithm of company returns (or log-return) was used as it became conventional for event studies starting from the fundamental work of Fama et al. (1969). In fact, event study literature assumes that returns are log normally distributed and in this way, excess log returns follow a normal distribution (Campbell et al., 1997) which enables us to carry out further statistical analysis.

In addition, in the study of Duarte-Silva and Tripolski Kimel (2014) it was proved that specifying an event study hypothesis and outcoming statistical test in monetary value gives the same result as if the hypothesis was built referring to excess log returns. That is why, our decision was made in favour of log-returns use.

After that, the stationarity of the time series was tested with help of Phillips-Perron test, first introduced by their works in the end of the 20th century (Phillips and Perron, 1987, 1988). It was processed with XLSTAT tool and resulted in non-stationarity of collected data. For corresponding test statistics, consult Annex 10.

As it was explained earlier, in this work we did not use the traditional methodology of event study which is supposed to compute the abnormal returns for the whole event window period. In place of this, a market model with separate dummies that indicate the events of interest enabled us to obtain estimates that represent the abnormal return of each event date.

The market model adopted in this study, took the following form:

$$R_t = \alpha + \beta rm_t + \gamma_1 D_1 + \gamma_2 D_2 + \gamma_3 D_3 + \gamma_4 D_4 + \gamma_5 D_5 + \gamma_6 D_6 + \gamma_7 D_7 + \gamma_8 D_8 + \gamma_9 D_9 + \gamma_{10} D_{10} + \gamma_{11} D_{11} + \gamma_{12} D_{12} + \gamma_{13} D_{13} + \gamma_{14} D_{14} + \gamma_{15} D_{15} + e_t,$$

Where R_t is the return of the equally weighted portfolio of selected companies at the day t, rm_t is the return of a representative market and e_t is an error term. The estimated parameter α is the model intercept, and β is market coefficient. Knowing that we are analysing 15 events, each γ estimate represents the abnormal return of the event day that was dummied out with related D dummy. In this way, our hypothesis will take the following form:

H_0: $\gamma_a = 0$; H_1: $\gamma_a \neq 0$

Or in the literal form:

H_0: The stock price of renewable energy industry in Europe did not experience any abnormal return on the day D_a of the regulatory advancement;

H_1: the stock price of renewable energy industry in Europe experienced an abnormal return on the day D_a of the regulatory advancement.

T-test

In order to check our hypothesis and make reliable affirmations we have to carry out some significance tests. According to De Jong (2007) "the most common test of the null hypothesis of no abnormal returns <…> is a simple t-test". The test will be realized for several periods. In fact, different authors suggest using several-days windows that comprise days following the day of announcement in order to capture the effect on prices that occur after the stock exchange close (MacKinlay, 1997). In this way, the immediate impact of each announcement was measured on the day of the announcement by the mean of a t-test at different significance levels. To capture the post-announcement behaviour, we also analysed 2-, 3-, 4- and 5-day windows.

Table 2: Results of significance t-test on γ coefficient of event dates

Event	*99% significance*	*95% significance*	*90% significance*	t Stat (1 day)	Coef (1 day)	t Stat (2days)	Coef (2days)	t Stat (3days)	Coef (3days)	t Stat (4days)	Coef (4days)	t Stat (5days)	Coef (5days)
Event 1	*+/- 2,3264*	*+/- 1,96*	*+/- 1,6449*	-1,72632088	-0,01641912	-0,16535538	-0,00111293	-0,92513653	-0,00509448	-0,51080823	-0,00243842	0,64425615	0,00274948
Event 2	*+/- 2,3264*	*+/- 1,96*	*+/- 1,6449*	1,48356372	0,01411026	0,78908061	0,00531055	-0,55542652	-0,00305381	-0,14732577	-0,00070199	-0,12803297	-0,00054583
Event 3	*+/- 2,3264*	*+/- 1,96*	*+/- 1,6449*	-2,37239110	-0,02256548	-2,11191711	-0,01421425	-0,95157219	-0,00523101	-1,86870953	-0,00890047	-2,17207172	-0,00925817
Event 4	*+/- 2,3264*	*+/- 1,96*	*+/- 1,6449*	-0,53033535	-0,00504405	-0,93807143	-0,00631348	-0,66772923	-0,00367152	-0,47631339	-0,00226888	-0,53868460	-0,00229595
Event 5	*+/- 2,3264*	*+/- 1,96*	*+/- 1,6449*	0,70960815	0,00674919	0,08470782	0,00057002	-0,09382126	-0,00051577	-0,51346330	-0,00244557	-1,36094022	-0,00580118
Event 6	*+/- 2,3264*	*+/- 1,96*	*+/- 1,6449*	1,00602048	0,00958078	0,12816632	0,00086267	0,88650904	0,00487470	-2,45814381	-0,01171664	-2,55457529	-0,01089026
Event 7	*+/- 2,3264*	*+/- 1,96*	*+/- 1,6449*	0,04238069	0,00040310	-0,24646050	-0,00165846	-0,49694678	-0,00273198	-0,26094045	-0,00124283	-0,45676925	-0,00194692
Event 8	*+/- 2,3264*	*+/- 1,96*	*+/- 1,6449*	-1,15322421	-0,01096856	-1,99674564	-0,01343925	-2,09255144	-0,01150544	-1,61385277	-0,00768740	-1,27805147	-0,00556059
Event 9	*+/- 2,3264*	*+/- 1,96*	*+/- 1,6449*	0,35708963	0,00339964	-0,41429051	-0,00278909	-0,44337122	-0,00243790	0,09748245	0,00046433	0,04442357	0,00019710
Event 10	*+/- 2,3264*	*+/- 1,96*	*+/- 1,6449*	-0,24894740	-0,00236785	0,35399536	0,00238209	1,35606939	0,00745466	1,07675675	0,00512847	0,87863971	0,00382277
Event 11	*+/- 2,3264*	*+/- 1,96*	*+/- 1,6449*	-0,19045907	-0,00181165	-0,58992832	-0,00396971	0,40867061	0,00224655	0,41206662	0,00196263	0,34649046	0,00147684
Event 12	*+/- 2,3264*	*+/- 1,96*	*+/- 1,6449*	-0,95450733	-0,00907900	-0,71022605	-0,00477960	-0,53361821	-0,00293352	-0,75086634	-0,00357629	-1,15086601	-0,00490518
Event 13	*+/- 2,3264*	*+/- 1,96*	*+/- 1,6449*	1,04705076	0,00995922	1,39020295	0,00935492	0,99070233	0,00544727	0,72630251	0,00346012	0,56143278	0,00239345
Event 14	*+/- 2,3264*	*+/- 1,96*	*+/- 1,6449*	0,00479722	0,00004563	0,15887341	0,00106909	-0,58932919	-0,00324003	-0,52348204	-0,00249329	-0,14735150	-0,00062806
Event 15	*+/- 2,3264*	*+/- 1,96*	*+/- 1,6449*	0,55051601	0,00523713	-0,28276340	-0,00190344	0,17962912	0,00098793	0,39803418	0,00189600	0,19963584	0,00085100

Table 2 gives a resume of realised t-tests for all the 15 events inside the event window at 90%, 95% and 99% significance levels. We can see that Event 3 and Event 6 experienced significantly negative abnormal returns at the level of 99% certainty on the 4th and 5th days for the event 6 and on the day of the announcement for the Event 3. In addition, this event showed significant abnormal returns on the 2-days, 4-days and 5-days periods which gives us the reason to think that this event had an important impact on the market which was confirmed by following trading days. Other events that experienced significant abnormal return deviations are the Event 8 with 95% significant negative abnormal returns on the second and third trading days after the announcement and 90% on the fourth; and the Event 1 with 90% significant abnormal returns on the day of the announcement.

All the other events did not show any significant return deviation.

Model with differentiated beta estimation

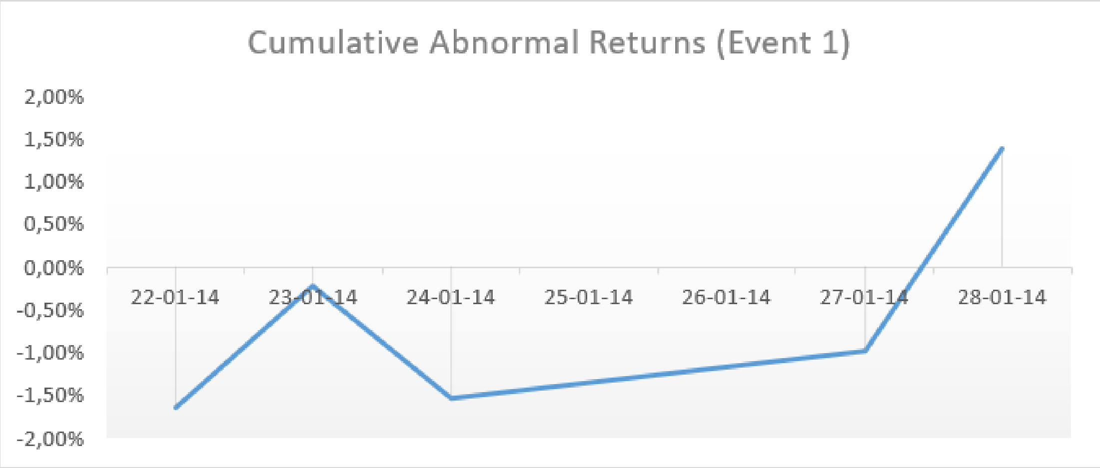
A further model adaptation for this kind of study exists as it was explained in the previous chapter. It consists in dividing the whole event window in several periods in order to have better beta estimation of the market model. In our case, we divided our event window of 1500 observations into 3 subperiods: from 23 October 2013 to 6 March 2015; from 9 March 2015 to 19 July 2016 and from 20 July 2016 to 24 November 2017. Using a proper market model for each period, we carried out t-tests and saw that no significant abnormal returns were found. It can be explained by the fact that this kind of modelling has bigger power of precision and describes better the price behaviour during a certain period which consequently minimises the possibility of detection of abnormal movements. This model will not be further discussed in this work, but will be taken into account during the interpretation stage.

Cumulative returns

In this part we are going to discuss cumulative abnormal returns for 5 consecutive days after the announcement of events that appeared to generate significant abnormal returns.

Event 1 represents the day when the European Commission in their communication announced the future framework for Union Energy and climate policies, proposing a 27% minimum share for renewable energies in 2030. On the day of the announcement, we observed a significantly (at 90%) negative abnormal returns which was later on gradually corrected by the market (Graph 3).

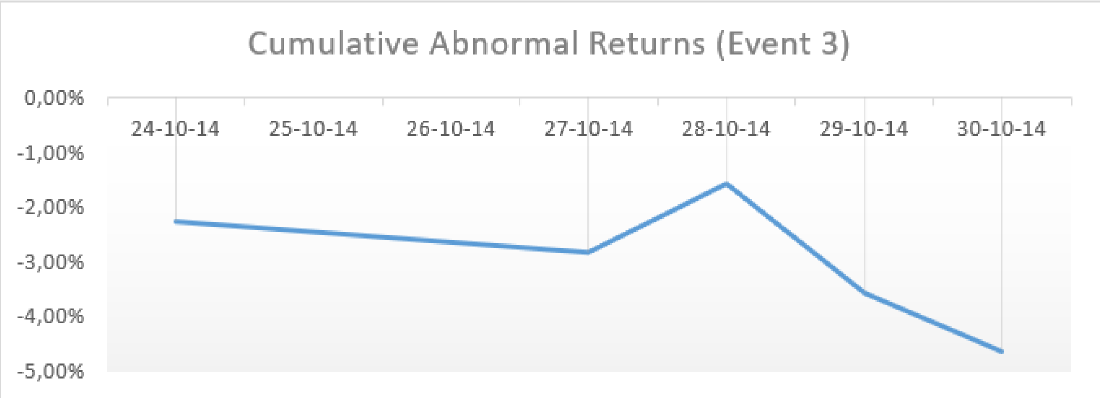
Event 1: 22-01-14					
Date	**22-01-14**	**23-01-14**	**24-01-14**	**27-01-14**	**28-01-14**
CAR	-1,6419%	-0,2226%	-1,5283%	-0,9754%	1,3747%



Graph 3: Cumulative abnormal returns for the 5-day period after Event 1

Event 3 was the day when the European Commission in its official conclusion fixed minimum climate and energy objectives for the year 2030, confirming the 27% objective for renewables and 40% objective for the GHG emissions. We observe strong significance (at 99%) of negative abnormal returns on the day of this announcement. The significance of this event was confirmed by the following days that exposed significantly negative abnormal returns with a slight regain of returns on the third day (Graph 4).

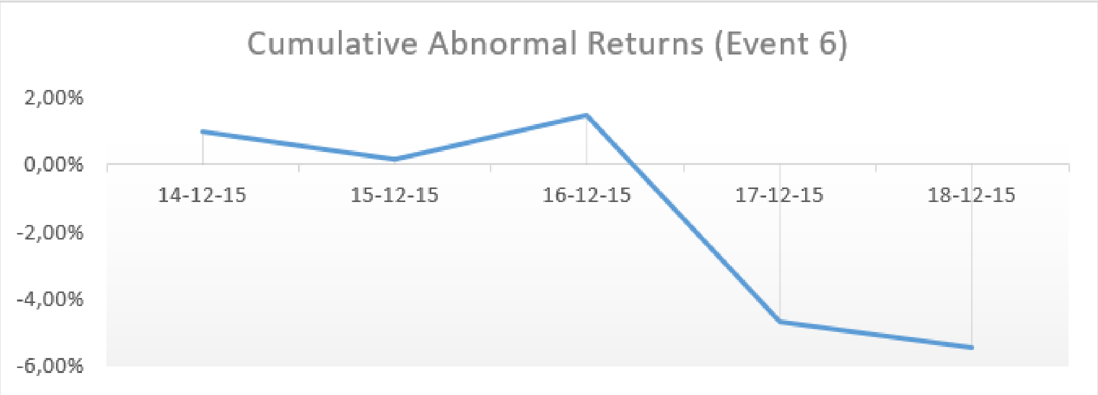
Event 3: 24-10-14					
Date	**24-10-14**	**27-10-14**	**28-10-14**	**29-10-14**	**30-10-14**
CAR	-2,2565%	-2,8428%	-1,5693%	-3,5602%	-4,6291%



Graph 4: Cumulative abnormal returns for the 5-day period after Event 3

The next significant event (Event 6) corresponds to the official approval of Paris Agreement on Climate Change (COP21). On the day of the announcement, the returns of the renewable energy industry in Europe were positive however not significantly. As we can see from the Graph 5, the contrary reaction came from the market on the fourth and fifth trading days showing significantly negative cumulative abnormal returns.

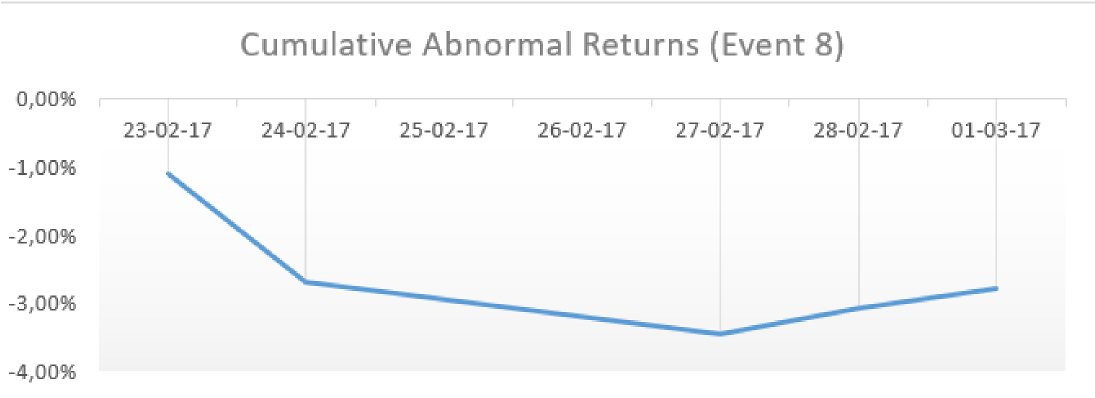
Event 6: 14-12-15					
Date	**14-12-15**	**15-12-15**	**16-12-15**	**17-12-15**	**18-12-15**
CAR	0,9581%	0,1725%	1,4624%	-4,6867%	-5,4451%



Graph 5: Cumulative abnormal returns for the 5-day period after Event 6

The last event that has to be discussed is Event 8, which is the day of publication of the reviewed version of the Proposal after its first publication one month earlier. The abnormal negative return was observed for the 2-day, 3-day and 4-day periods after the publication. From the Graph 6 we can conclude that the market was reacting gradually, at the end of the 5-day period, starting to correct slightly the market.

Event 8: 23-02-17					
Date	**23-02-17**	**24-02-17**	**27-02-17**	**28-02-17**	**01-03-17**
CAR	-1,0969%	-2,6879%	-3,4516%	-3,0750%	-2,7803%



Graph 6: Cumulative abnormal returns for the 5-day period after Event 8

The representation of cumulative abnormal returns for other event dates can be found in Annex 8.

3. Interpretation

Making reference to the hypothesis of the beginning, we were expecting to obtain positive abnormal returns at one or several stages of the regulatory change advancement, as such kind of regulatory intervention as the studied directive was supposed to have a positive impact on renewable energy industry, and our primary hypothesis was that the market will reflect this positive influence. However, empirical results showed that the situation appeared to be the contrary of what was expected.

As concerns event dates that exposed significant abnormal returns, the market showed that all of them provoked negative returns. The first significant event was the 22 January 2014, when the future objective of 27% for renewables share in energy consumption for the year 2030 appeared for the first time. It was made through the official communication of the Commission and the Parliament that installed a policy framework for climate and energy in the period from 2020 to 2030 (European Commission, 2014). It exposed the key achievements of the policy in place at that time and gave indicative objectives for the year 2030 (27% for renewable energies share and 40% for GHG emission reduction compared to the year 1990) in form of minimum recommendations. The aim of this declaration was to announce future perspectives of development for the green energy industry, but surprisingly, the market reacted negatively on the day of announcement even if it recovered on the 5th day after. It can be explained by the fact that unmet expectations can also cause negative abnormal returns (Lamdin, 2001). Today, from numerous declarations of market participants (SolarPower Europe, 2017, Climate Action Network Europe, 2017), we know that renewable energy companies ask for higher binding objectives, that are needed to give a real boost to the industry development. That’s why we can suppose that already at that time, the market was expecting that regulatory bodies would fix more ambitious objectives. It was also interesting to look at individual stock evolutions to see whether some of studied companies experienced a firm-specific shock. In fact, on the day of the announcement, one of the companies which is MDI-Energy experienced a 40.54% return drop which could also distort the mean and lead to abnormal negative returns of the portfolio.

The same explanation of unmet expectations can be applied to the Event 3 of our study. In the run-up to COP21 Paris meeting, the EU decided on its own objectives that would have been exposed during this event. In this way, on 24 October 2014 the European Council issued the conclusion of their meeting where heads of EU governments confirmed previous recommendations issued by the Commission and the Parliament and fixed new objectives for the 2030 climate and energy policy framework as its contribution to the world climate agreement.

Here are the main binding targets that were fixed at this day (European Council, 2014):

- Minimum 40% reduction in greenhouse gas emissions by 2030 compared to 1990;
- Minimum 27% share of renewable energy consumed in the EU by 2030;
- Reformation targets for the Emission Trading System (ETS);
- Improvement targets for functioning of the connected internal energy market;
- Targets to decrease energy dependence;
- Targets concerning elimination of administrative burdens.

In this way, the Council preserved the same minimum objective, that could provoke the next "deception" of the market as the returns of renewable energy industry were significantly negative on the day of publication of this announcement and for the following 5-day period. After having analysed individual stocks, we one more time observed that on the day of this announcement, one stock, MDI-Energy, showed a 69.32% drop of return that could boost negative abnormal returns on this day.

The next event, for which significantly abnormal returns were detected was the day of Paris agreement approval, 12 December 2015. The market recorded negative abnormal returns at the 4th and 5th days after the announcement. As this event is not in scope of our study of the European Proposal adoption and was included in the model just to dummy out possible abnormal behaviour, we will not carry a discussion on potential causes of this reaction, even if it is still surprising. The primary data shows that one of the stocks (Energie Europe Service) experienced an extreme drop in returns equal to 150.68%. It is the most likely cause of such a downturn of the overall portfolio.

Knowing that the market reacted positively (even if not significantly) during the first 3 days from the announcement, another explanation of following negative downturn can be the fact that European market of renewable energies experienced on the 4th and 5th days another informative shock that provoked these negative returns. Such a shock could be the Council meeting on 17 and 18 December 2015, on which Heads of Member States or Governments discussed sensitive issues including the formation of Energy Union and the UK upcoming referendum on their membership in the EU (European Parliamentary Research Service Blog, 2015).

The last significant event happened on 23 February 2017, the day of publishing of the revised version of studied Proposal. The initial version of the Proposal, which is the core event studied in this work, was published on 30 November 2016 and was part of the “Clean Energy for All Europeans” (European Commission, 2016c) which included a number of other regulatory initiatives. The market experienced significantly negative abnormal returns on the day after the publishing of corrected version. The corrections that were brought were in most of cases the question of formulation and did not bring any new information on the market and consequently could not provoke sensitive return pattern change. That is why, we suppose that the market experienced the influence from another event, not related to the adoption of the Proposal in question. The possible impact event could be the 22-23 February European Economic and Social Committee plenary session during which numerous regulatory initiatives were discussed including Emission trading scheme on aviation activities (EESC, 2017). Some individual stocks also had a significantly negative downturn: Nordex SE dropped by 26.87% and MDI-Energy decreased by 20.43%. In this way, firm-specific events could also influence the portfolio return.

In general, 7 events out of 15 experienced negative abnormal returns on the day of the announcement and 8 of them showed positive abnormal returns even if they were not significantly high. In this way, we can see that several types of announcement generated positive reaction. The first is represented by the Event 2 and it is the date which experienced the highest positive returns on the day of information publishing compared to all the other studied events. It is the day of publishing of Guidelines on State aid for environmental protection and energy, which is logic as a piece of European legislation incorporated in national law has much bigger power and concrete application compared to the European Directive which needs time to show its impact on the market.

Other positive returns refer to the days that made the Proposal in question take a more concrete form, these are the days of Consultation questionnaire and the Proposal official publishing (Event 5 and 7). Following two events also generated positive impact: the day when the European Parliament’s Environmental Committee proposed a higher 2030 renewable energy target of 35% (Event 14) and the day when this figure was confirmed by the communication of the Environmental Public Health and Food Safety Committee (Event 15). But still, as these events did not show any significant deviation we cannot affirm that positive returns were generated by an event outside of the simple stock price evolution pattern.

The fact that no significantly positive abnormal returns were found at any stage of regulatory advancement was surprising, but it can however be explained by several reasons.

As it was explained earlier, event study methodology applied to regulatory change tends to underestimate the significance of abnormal returns. In fact, according to Lamdin (2001, p. 180) "the problem occurs because low power tests will cause the analyst to conclude that a change in regulation did not have any impact, though in fact it did (a Type II error)." Another fact and shortcoming of our statistical model that could underpin the significance exposure is the asynchronous trading that had to be corrected manually as it was explained in the methodology part. It resulted in numerous zero log-returns positions for several companies which stocks were traded less often than the others which could decrease the average portfolio return evolution and wipe out significant reactions of more actively traded company stocks resulting in not significant results. For these reasons, we can however accept that positive returns occurred on the days of announcement were in fact provoked by these announcement, but this statement is not supported by our statistical test.

Another issue that has to be beard in mind is the possibility of information leakage that can also provoke the insignificance of market reaction on the day of official announcement. It is possible that rumours about subjects that are going to be discussed on the level of European institutions are spread quickly, so the fact has to be accepted that the market could already get the information long before official declarations. Ramiah said in his work that "according to the efficient market hypothesis, the existence of cumulative abnormal returns five days prior to the announcements implies a potential leakage" (Ramiah et al., 2015a, p.18) To check this hypothesis, we carried out a significance test on 5-day period prior to declaration and found that no significant returns were observed during this time laps (see Annex 9) by which we could exclude the short-term information leakage but more distant in time rumours still could have their impact.

As it was stated earlier, it is possible that the market does not react until proposed measured become concrete and are applied on the national level. In fact, market participants, at the day of regulatory issue may not immediately evaluate the extent at which the concerned industry or firm will be affected (Ramiah et al., 2015a). It will give birth to an implementation gap which can be the result of "legislative shortcomings, poorly designed policy instruments, etc." (Hills and Man, 1998). And this explanation of significant return reaction absence is very relevant for the European market as the proposal for a new piece of legislation by European bodies has to pass through numerous stages before it really transforms in binding regulation that will be applied to national companies.

At the end, we do not have to forget that returns can also be influenced by other news that are not related to the studied event and it can be difficult to identify them because of the huge number of possible variables that can impact the market.

From the empirical results, we can conclude that market reaction mostly depends on the expectations of its participants. In our case we could conclude that generally in case of unmet expectations or deceptions, the market reacts more strongly rather than in case of expectation realisation that do not provoke significantly high results. From our study we can also conclude that regulatory intervention does not have any significantly positive impact on the renewable energy stock exchange market at one of the stage of the regulatory advancement which refutes our study hypothesis. We assume that the recent Proposal for renewable energy sources promotion can show its impact on further steps of approval and of the stage of transposition into national laws of Member States, but this will be a subject of another study.

Conclusion

Through this thesis, we could address various aspects that can have an influence on the industry of renewable energies in Europe from the financial market point of view, and in this way, give a potential investor some guidelines on market patterns.

The first part of this work gave an overview of factors that by the past were proved to have such an influence and that retained attention of numerous scientists. The explained factors included oil price moves, technology indexes evolution, changing investing behaviours, growing awareness of energy consumers, legal interventions and other unpredictable causes as nuclear catastrophes. Each factor was discussed by exposing the conclusions of researchers on market price behaviour in one or another situation. The aim of this part was to give a general overview and did not pretend to be exhaustive. Other factors such as expansion of electric cars or the cost evolution of renewable energy installations can be discussed and complete this list.

The second part of the work consisted in a detailed study of such an impact factor as a regulatory intervention in the market. An event study methodology has been used to test the hypothesis that the European stock market of renewable energies reacted positively on the 2016 Proposal for a directive on the promotion of renewable sources of energy. The test consisted in identification of different events that composed the creation and further advancement of the proposal in question and the search of statistically abnormal returns surrounding these days. We obtained four events out of fifteen that exposed significantly negative returns. After having analysed cumulative abnormal returns of the 5-day period after each event announcement, we observed that in all the cases we could explain this negative statistical deviation by firm-specific events rather than by the impact of the regulatory change itself. In two cases we could also apply the concept of “unmet expectations” that could also be the source of negative abnormal returns.

On other days that were important for proposal advancement, positive returns were systematically observed but their extent was not statistically significant. That is why, we could not retain the hypothesis of positive impact of green policy announcement on the European market of renewable energies.

The obtained result confirms the assumption that market prices include all the available information and do not give room for arbitrage. However, the obtained conclusions could be influenced by several limitations met in this work. The main challenge in this study was to identify the day when the information got available to the market. Our analysis was based on official publications which gives the possibility to information leakage that can take place before official announcements. As the study concerns a policy proposal, which is not a confidential or sensitive type of information, the primary rumours about it could spread within European bodies and in professional circles in big advance which makes it difficult to capture this kind of information expansion.

Another limit consisted in data availability and particularly in difficulty to find European companies active solely in the renewable energy market and that have a sufficient period of being listed on the financial markets. In fact, a lot of companies that operate in this industry are big energy companies that added “green” activity to their portfolios, which makes it difficult to isolate the industry specific impact. Secondly, a lot of green energy companies appeared after 2010 as a reaction on promotion policies adopted in 2009 and this market is still on the development stage. That is why it was difficult to compose a larger sample that would have been preferable to make more relevant statistical conclusions.

This work represents the first attempt to study the impact of European regulations on the EU-28 renewable energy industry and further development of this subject is needed. One of the possible improvements could be the deeper specification of the studied sample, as it is known that the same environmental announcement can have different impact on companies that differ according to their size (Van Beurden and Goessling, 2008), return on equity, specific financial or non-financial variables (Waddock and Graves, 1997). This specification could improve the quality of the study and enable to get more accurate conclusions.

The next step that would be complementary to this study can be the following analysis of further advancement of the studied Proposal in the legislative procedure. On 28 November 2017 a vote in the committee took place which led to the issuance on 6 December of a report tabled for the plenary session. According to the forecasts (European Parliament, 2017) the Parliament debate and the vote in plenary session are scheduled for 16 January 2018. The analysis of the renewable energy stock market on these days can give us more information about how a regulatory advancement of a legislative initiative affects the studied market and complete this research.

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