FOUNDATION FOR ECONOMIC & INDUSTRIAL RESEARCH

11 Tsami Karatassou, 117 42 Athens, Greece, Tel.: +30 210-9211 200-10, Fax: +30210-9233 977 *www.iobe.gr*

The impact of the economic crisis on wind energy investment in Greece

June 2014

The Foundation for Economic and Industrial Research is a private, non-profit, public benefit research organization. It was established in order to promote scientific research on the current and emerging problems of the Greek economy and to provide reliable information and generate proposals useful to policy makers.

The present study was prepared by a team of IOBE researchers, comprising Katerina Touriki, Nikos Paratsiokas and Svetoslav Danchev. The team would like to thank George Maniatis and Grigoris Pavlou for their assistance.

Foundation for Economic and Industrial Research (IOBE)
11, Tsami Karatasou Str, 117 42 Athens
Tel.: (210 9211200-10), Fax: (210 9228130 & 210 9233977)
E-mail: iobe@iobe.gr - URL: http://www.iobe.gr

Contents

List of Figures

List of Tables

Summary

Wind power is a major pillar in the effort to overhaul electricity generation systems across the globe, as together with small hydro it is by far the most commercially mature renewable energy technology. Despite its long-term significance and the return to half-on-half growth since the second half of 2012, the annual installation rate of wind energy in the past two years in Greece has fallen below the 2011 rate, which was a record year for wind energy investments in the country. The purpose of this study is to examine the reasons why the penetration of wind power slowed down in 2012 and to evaluate whether the economic crisis has had an impact on the attractiveness to invest in wind energy in Greece.

Greece and the global economic crisis

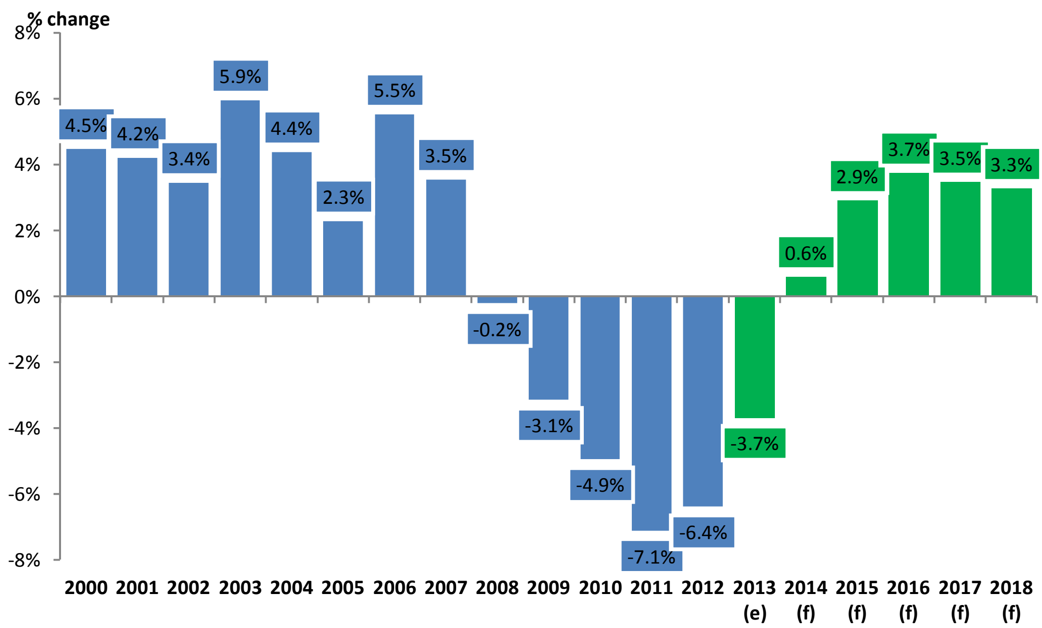
The global economic turmoil started with the US mortgage crisis in early 2007, which soon expanded to Europe through the exposure of European banks to financial products, backed with US mortgages. Taking into account the chronic structural problems of the Greek economy, including a large and growing sovereign debt, the confidence of the investment community about Greece began weakening in early 2008.

The spreads on Greek sovereign debt over German bonds, which had fluctuated around 30 basis points in 2006 and 2007, started to grow in early 2008, doubling to 67 basis points in August 2008. Meanwhile, direct investment, measured in terms of Gross Fixed Capital Formation started falling sharply from the first quarter of 2008, long before the Lehman Brothers collapse. In parallel, GDP slowed down significantly to marginally negative growth rates (Figure 1). Since then, the economy has been in the midst of an extraordinary economic recession, already lasting for six years. During the current recession, Greek GDP has shrunk by almost a quarter (24% contraction of GDP per capita between 2007 and 2013).

The causes for the depth of this contraction can be found in the pervasive structural imbalances of the Greek economy prior to the crisis. The risks of running a large twin deficit (of the fiscal and current account), while having a large debt overhang, well above the Maastricht criteria of 60% of GDP, were repeatedly noted by official sources, including the Bank of Greece and independent research centres, such as IOBE.

Currently, the Greek economy is in the process of stabilisation. The perception of risk for investment in Greece is also subsiding, as evident by the course of sovereign bond spreads and the general index of the Athens Stock Exchange. The fundamentals have improved as well, as the sustained twin deficit that essentially pushed the Greek economy over the edge has turned into a small twin surplus. Meanwhile, the large debt overhang is not creating serious threat of a payment moratorium, given its long average maturity and low average interest rate. As a result, Greek GDP is projected to grow marginally in 2014, accelerating to an average of around 3.5% in 2016-2018. Following these developments, on April 2014 Greece returned to the sovereign debt markets (for the first time since 2010), raising EUR 3 billion in 5-year bonds at a yield close to 5%. Meanwhile, banks (e.g. Piraeus Bank and National Bank of Greece) and other Greek companies (e.g. PPC and Hellenic Petroleum) took advantage of the renewed confidence in the Greek economy and successfully issued corporate bonds in the past two months.

Figure 1: GDP % change (2005=100)



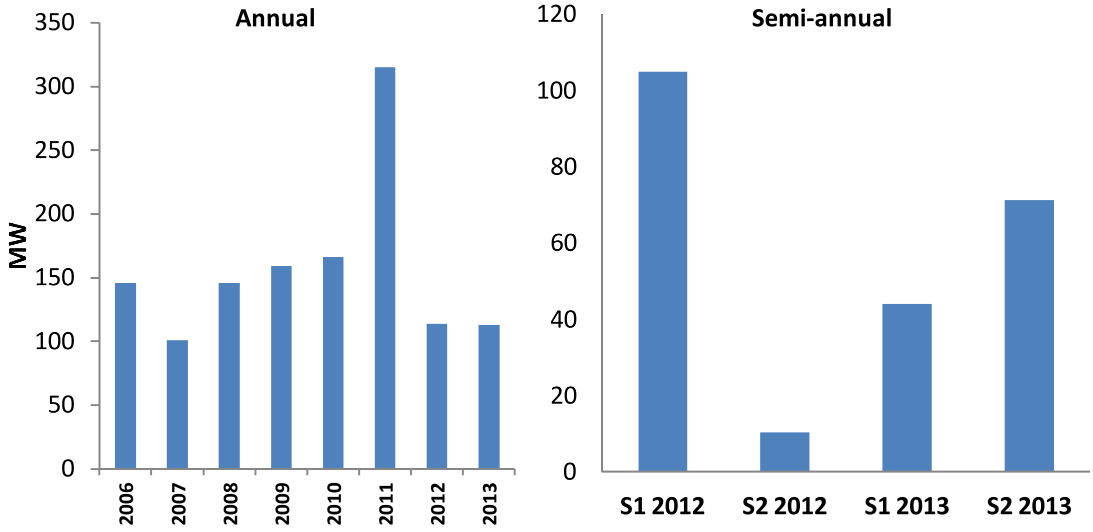
Source: EL.STAT., Projections 2013-2015: AMECO, Projections 2016-2018: IMF, data processing IOBE

Impact of the economic crisis on wind investment

Despite the severity of the crisis, which had a profound impact on investment in the country, the penetration of renewable energy sources accelerated during the years of economic contraction. The crisis did not have an impact on RES penetration largely because RES investments are not exposed to trade risks from demand fluctuations and thus their attractiveness is not directly related to the general economic conditions and in particular with the country risk coming from doubts over the ability of Greece to serve its public debt.

During 2010-2013, approximately EUR 6.3 billion were invested in renewable energy technologies in Greece, almost five times as high compared with the investments made during 2006-2009. Wind energy, in particular, experienced an investment boom in 2011, at a time when the sovereign bond spreads were considerably higher than today. Investment in wind fell sharply in the second half of 2012 and has returned to half-on-half growth since then (Figure 2).

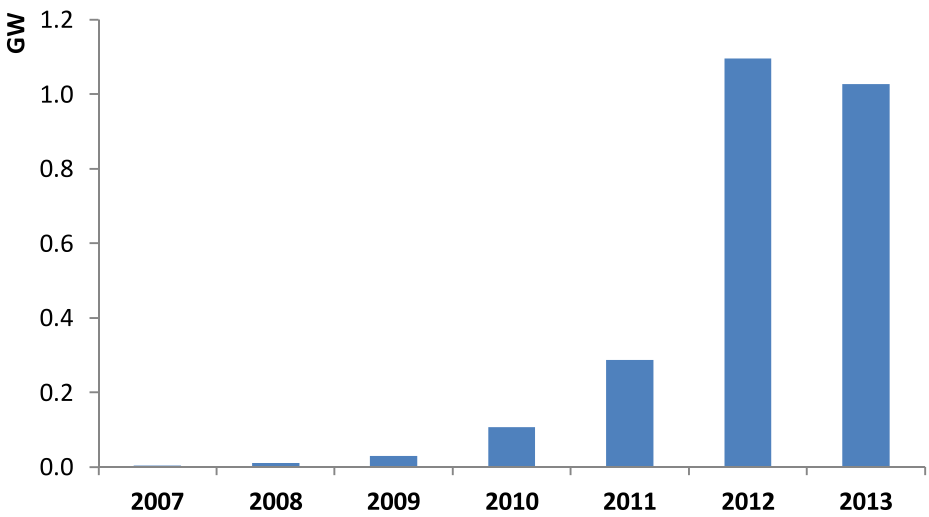
Figure 2: New wind capacity



Source: ELETAEN

The main reason of lower investment in wind in 2012 and 2013, compared with 2011, appears to be the boom experienced in photovoltaic technology during these two years. In practice, there is a significant overlap between investors who consider wind and PV investment, as part of a strategy of building a portfolio of renewable energy installations.

Figure 3: New PV capacity



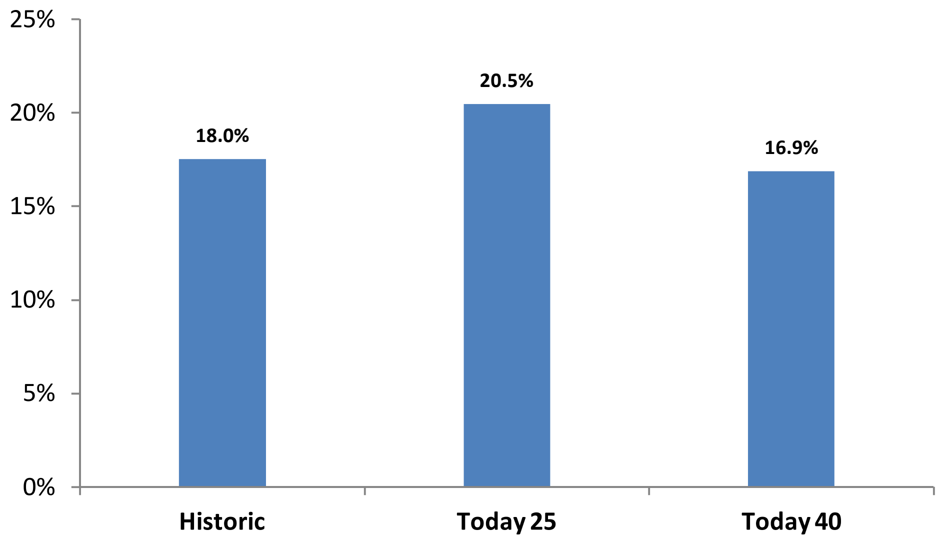
Source: ELETAEN

The higher return observed for PV in the past two years, driven by the sharp fall in PV panel prices, as well as the prospect of lower PV feed-in tariffs in the future, were the main reasons for the switch from wind to PV. The policy measures to decelerate the PV boom and limit its impact on the energy cost portend stronger interest in wind investment, which perhaps explains the half-on-half growth of wind investment since the second half of 2012, despite the continuous difficulties in the domestic banking system.

Investment returns in a typical wind farm

Evidently, the economics of wind are to a significant extent isolated from the overall course of the economy. In fact, the return on investment for a project with comparable wind energy characteristics and capital structure today is considerably higher than at the beginning of the crisis. A project with 25% equity participation today (Today 25 Scenario) yields an equity IRR of 20.5%, which is higher by approximately 2.5 percentage points, compared with a similar project undertaken in the beginning of the crisis (18% in the Historic Scenario, Figure 4).

Figure 4: Equity IRR, Historic and Today scenarios



Even if the entrepreneurs cover as much as half of the capital grant that was available before the crisis with equity capital instead of debt (Today 40 Scenario), the internal rate of return on equity is still about the same, despite the unfavourable change of the capital structure. The main reason for this is the lower capital expenditure, gains in productivity and higher feed-in tariffs.

Even in the case of lower feed-in tariffs by 10%, the sensitivity analysis shows that the premium over placements in safe-haven assets remains high enough, especially for sites with average or high net capacity factors. In particular, the IRR in the Today 25 scenario falls from 20.5%, to 16.1% (i.e. slightly above the return rate expected back in 2008, as indicated by the Historic scenario, Figure 4), while in Today 40 scenario it reduces to 13.8% from 16.9%. The sensitivity analysis shows further that changes in capital expenditure and feed-in tariffs have almost equivalent impact on equity return (with an inverse sign).

Conclusions

The prospects for wind energy in Greece are brightening up. Its main rival as destination of investment funds for renewable energy – PV – has already covered the targets for 2020 and is not expected to attract major funds until it reaches grid parity. Meanwhile, the economy is in the process of stabilisation.

Greece emerges from the crisis with a stronger economy, where many of the significant imbalances of the recent past, especially on the fiscal front and on the front of cost competitiveness, have been corrected. The economy is currently in the look-out for a new model of sustainable growth, centred on investment and exports. Given the imperative to tackle the global warming phenomena, the commercial maturity of wind technology and the healthy return to wind investors, wind energy could form a significant part of the new growth paradigm of Greece.

1. Introduction

To limit as much as possible the damage from the change of the climate, the electricity system, especially in the developed economies, need to be radically overhauled. The European Union's energy security and climate change policy envisages a gradual replacement of conventional production with low carbon technologies and mainly with Renewable Energy Sources (RES). Wind power is a major pillar in the effort to overhaul electricity generation system, as together with small hydro it is by far the most commercially mature renewable energy technology.

Although the prospects for the penetration of wind in Greece's energy mix remain positive, the rate of installation of wind farms has slowed down on an annual base after 2011. Despite the fact that from the second half of 2012 wind energy investments has shown a rapid return to growth, the installed wind capacity has diverged substantially from the path to achieve the national targets set for 2014 and 2020. The purpose of this study is to examine the reasons why the penetration of wind power slowed down and to evaluate whether there has been a change in the attractiveness to invest in wind energy due to the economic crisis.

The study is structured as follows: the next chapter outlines the prolonged recession of the Greek economy. In the third chapter, we assess the impact of the economic crisis on wind investment, analysing the main investment drivers. Then we calculate the investment returns for a typical wind farm, using sensitivity analysis for different levels of a set of important parameters. The study concludes with a summary of the basic results.

2. Greece and the global economic crisis

The Greek economy more than doubled in real terms between 1974 and 2007. Since then, the economy has been in the midst of an extraordinary economic recession, already lasting for six years. During the current recession, Greek GDP has shrunk by almost a quarter (24% contraction of GDP per capita between 2007 and 2013).

Meanwhile, the business cycle in the EU economy overall has been significantly less volatile. The GDP per capita in the EU overall has contracted by only 2.7% over the same period. As a result, the rapid convergence of Greece prior to the crisis, and particularly since the adoption of the euro, gave way to even sharper divergence ever since. Greek GDP per capita as a percentage of EU28 gained 9 percentage points between 1995 and 2007, but today has fallen significantly and is now 8 percentage points below the 1995 level. Evidently, the global financial crisis exposed the lack of sustainability of the country's economic paradigm.

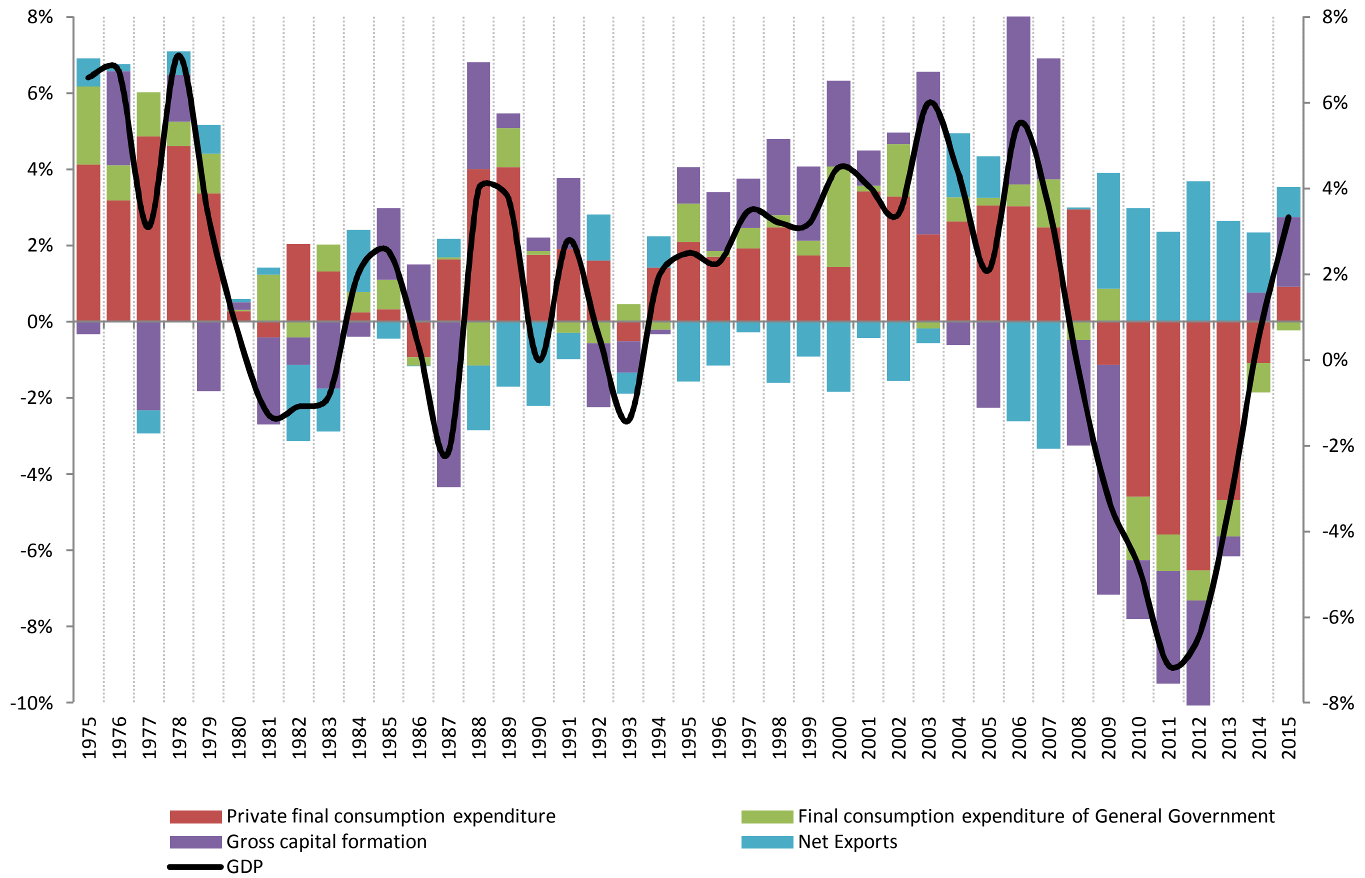
2.1 Before the bailout

Even though the Greek economy was converging rapidly to the EU average before the crisis, it was recognised even at that time that the adopted economic paradigm involved serious structural imbalances. The strong growth in the years leading up to the crisis was accompanied with a significant deterioration of both the country's competitiveness and its public finances.

The main drivers of economic growth between 1974 and 2007 were private and public consumption and occasionally investment (as in 2003 when the preparation for the 2004 Olympic games peaked and investment's contribution to GDP growth reached 4.3% of GDP, out of the 6.0% overall GDP growth). The performance of the external sector was largely deteriorating during this period (Figure 2.1).

The consumption drive was largely linked to the expansion of the state, with employment in general government almost doubling since 1980s, while the liberalisation of the consumer credit sector since the late 1990s also played a role in boosting domestic consumption. Exports and investment activity, which would have provided for a more balanced and sustainable growth, were hindered by fundamental structural weaknesses (Figure 2.2). As a result, production was oriented largely towards domestic consumption rather than exports, focusing on goods and services of relatively low or medium technological intensity, with innovative goods and services accounting for a small ratio of the total. Only a very limited number of branded Greek products have managed to penetrate in the world market.

Figure 2.1: Contribution to GDP growth 1975-2015



Source: Eurostat, Data processing: IOBE

The expansion of the state, combined with the ineffective tax collection mechanisms and high tax evasion, resulted in higher fiscal deficits in Greece compared with the EU average and substantial public debt accumulation even before the crisis. Both international organisations (OECD, EC) and Greek institutions (IOBE, Bank of Greece) regularly raised their concern about structural imbalances, even when the Greek economy was growing strong. As early as in January 2005, Mr Garganas, Governor of the Bank of Greece at that time, stressed the risks of both high general government deficit and debt, indicating the necessity for structural reforms in the social security system and the labour market, for privatisation and for reduction of bureaucracy. Additionally, IOBE has repeatedly underlined its concern about exports and competitiveness' of the Greek enterprises, at least since 2002. The structural imbalances and the growing debt were generating serious risks of economic derailment in case of a global economic crisis.

Extensive reforms were required to correct these imbalances. Even before Greece entered the Euro area, reforms were initiated (e.g. in the social insurance system), which however remained on paper due to strong social reactions. The climate of prosperity among the general public after Greece's entry in the Euro further dissuaded the political system about the urgency of significant, painful and politically costly economic reforms.

Figure 2.2: Main obstacles to entrepreneurship and economic growth prior to the crisis

- Complex and unstable tax regulation
- Inefficient judicial system
- Time consuming and costly procedures for starting a business
- Labour market rigidities
- Obstacles to export activity
- Complicated public procurement procedures
- Poor research and innovation
- Old fashioned institutional set up in education
- Ambiguous attitude towards entrepreneurship

Source: IOBE (2011), Cloud computing and the competitiveness of the Greek economy.

A series of events culminated in the collapse of Lehman Brothers in September of 2008, which became a milestone in the inevitable process of crisis contagion from the financial markets to the real economy at a global scale. That contagion process resulted in a loss of confidence by the foreign debt markets towards Greece.

Meanwhile, signs of the crisis had become visible well in advance. The sustained increase of home prices in the US in the years before the crisis, fueled by a strong expansion of the housing sector, made the issue of mortgage loans lucrative for both home owners and banks. As a result, US banks extended loans without assessing properly their consumers' credibility. The lax regulation following reforms instituted in late 1990s, combined with complex financial products and practices, such as the aggregation of subprime loans into mortgage bonds with risk insurance, concealed the threat to the global financial system from the US housing bubble.

The mortgage crisis started in early 2007, when housing prices slowed down. As more and more subprime loans became non-performing, the complex instruments that used these loans for collateral lost their value. The huge asset write-off led either to bankruptcy or the nationalisation, through bailout schemes, of major US financial institutions. In September 2008, Lehman Brothers, the fourth largest US investment bank at the time, went bankrupt. Meanwhile, the US government essentially nationalised two major pillars of the US secondary mortgage market - Fannie Mae[1] and Freddie Mac[2].

With the US financial sector in turbulence and the contagion spreading to the balance sheets of bank institutions worldwide, through their holdings of toxic US securities, the attractiveness of risky assets significantly dampened. As a result of the strong cross-border integration of the global capital markets, the crisis spread to Europe as well. In April 2007 the short-term credit markets froze up after the French bank BNP Paribas suspended three investment funds worth EUR 2 billion, citing problems in the US sub-prime mortgage sector.

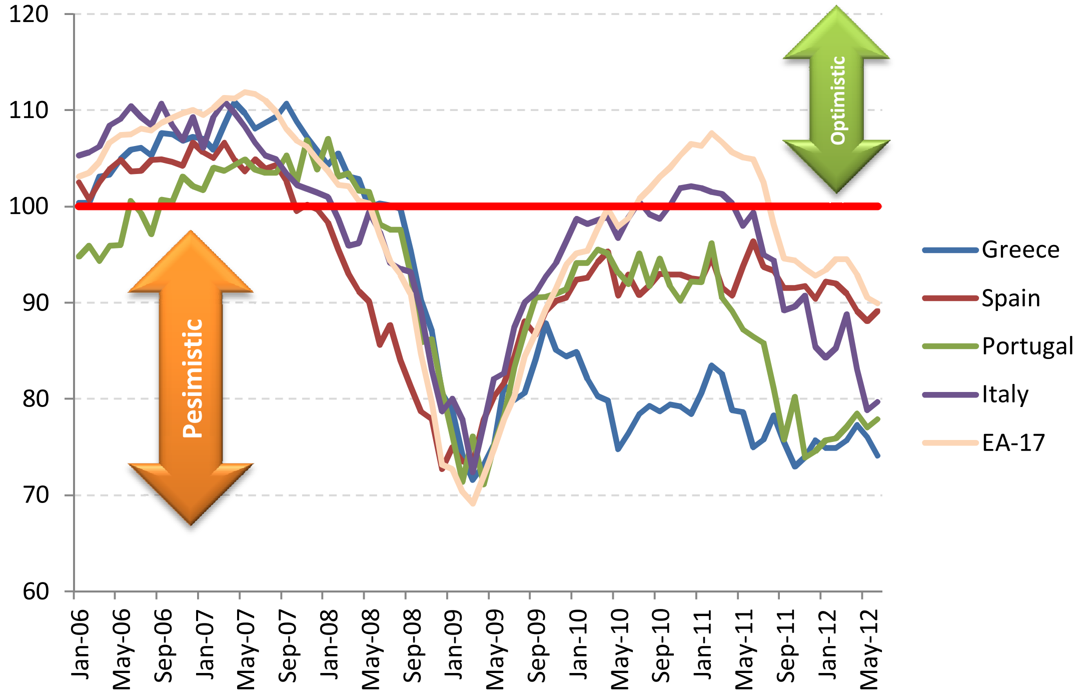
Shortly after, in October 2007 the Swiss bank UBS revealed losses of USD 3.4 billion in its fixed income and rates division and in its mortgage-backed securities business. In December 2007, it reported a further USD 10 billion write-down caused by non-performing debt in the US housing market. Finally, UBS revealed in April 2008 a further USD 19 billion of asset writedowns.

The losses in a number of key European banks (UBS, HSBC, Royal Bank of Scotland, Deutsche Bank, Credit Agricole, Credit Suisse and Barclays) totalled USD 89 billion, signalling upcoming shortage of bank financing, especially in weak economies with structural problems. In parallel, other European economies faced severe problems with their banking sector as well, e.g. Iceland where the banking sector collapsed at the end of September 2008. To ease the credit crunch, the European Central Bank pumped EUR 95 billion into the Eurozone banking system during this period.

Inevitably, the global crisis hit first the European economies whose banking sector had greater exposure to toxic products related to the mortgage crisis. Early indications of the crisis could be seen in the attitude of the public and the investment community since there was a clear shift towards risk assessment after the beginning of the 2007 crisis in US which led investors to a gradual change of the way of accounting for risk premia. In Spain the Economic Sentiment Indicator (ESI) started declining from September 2007 and turned pessimistic in early 2008. The average ESI of the Eurozone (EA-17) turned pessimistic in mid 2008 (Figure 2.3).

[1] The Federal National Mortgage Association (FNMA)
[2] The Federal Home Loan Mortgage Corporation (FHLMC)

Figure 2.3: Economic Sentiment Indicator, 2006-2013

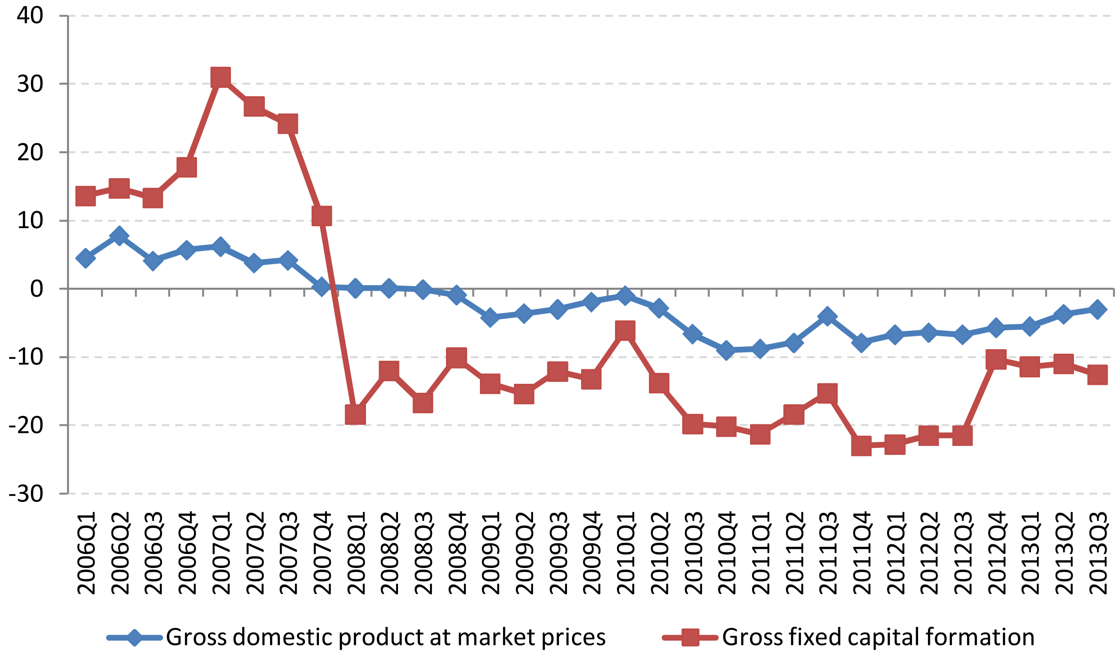


Source: DG ECFIN

The culmination of the crisis in Greece was delayed due to the limited exposure of the banking sector to toxic assets. However, with the risk appetite falling in the global markets and Greece being a weak economy with chronic structural problems and rising public debt, the confidence of the investment community about Greece was shaken. The spreads on Greek sovereign debt over German bonds, which had fluctuated around 30 basis points in 2006 and 2007, started to grow in early 2008, doubling to 67 basis points in August 2008 (Figure 2.5). Meanwhile, direct investment, measured in terms of Gross Fixed Capital Formation started falling sharply from the first quarter of 2008 (Figure 2.4) long before the collapse of Lehman Brothers.

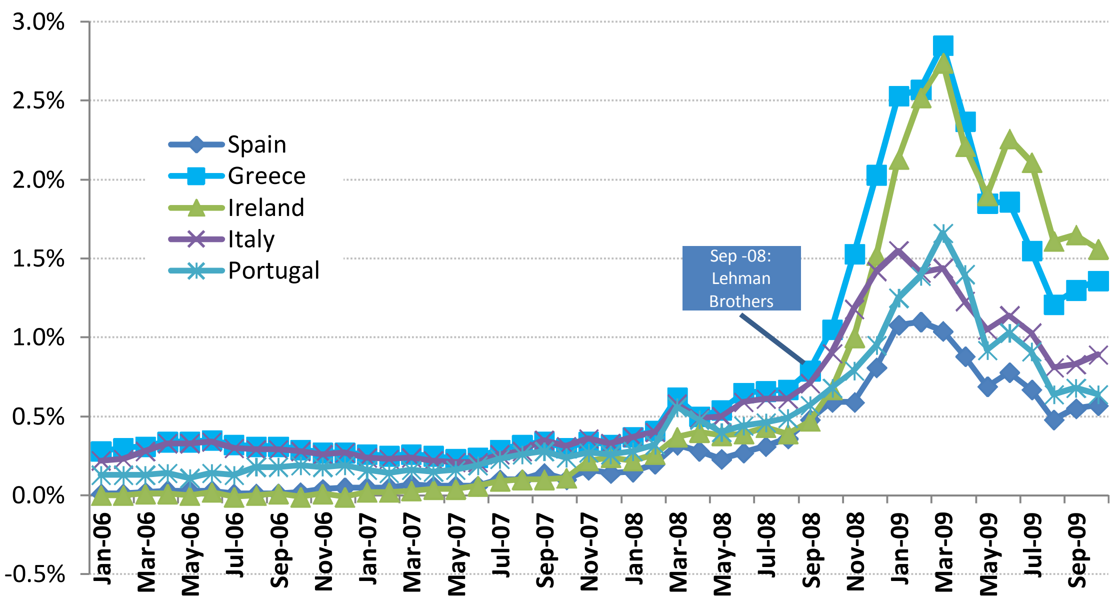
Despite the early warnings, the required painful measures for economic adjustment in 2008 were not carried through due to political reactions, while the domestic political establishment failed to agree on a plan of measures to avert the crisis. The attention of the European Commission and other global institutions (eg the IMF) was turned to the more pressing at that moment crisis in countries like Iceland, Ireland, Spain and Portugal. With the economy slowing down, the Greek government implemented measures to boost aggregate demand through government spending. However, the measures taken by the Greek government, especially following its reshuffle in early 2009 were not sufficient to prevent the fiscal derailment of Greece a few months later.

Figure 2.4: Gross Fixed Capital Formation and GDP of Greece (year-on-year percentage change)



Source: Eurostat

Figure 2.5: The spreads of government bond yields of select countries (over German Bonds) during the first period of the crisis (January 2008- October 2009)



Source: ECB, Data processing: IOBE

Until November 2009, when the newly elected government announced publicly that the projected fiscal deficit for 2009 would be significantly higher than previously estimated, the spreads on Greek sovereign bonds followed a similar course with those of other countries in the Euro periphery. The announcement, in light of the already significant public debt, led to a downward spiral of downgrades by the credit agencies, raising further the spreads on Greek bonds. By May 2010, the spreads grew to levels indicating that the cost of borrowing for the Greek government has become prohibitively high, pushing the Greek authorities to seek international assistance in order to avoid the declaration of a moratorium on the country's debt obligations.

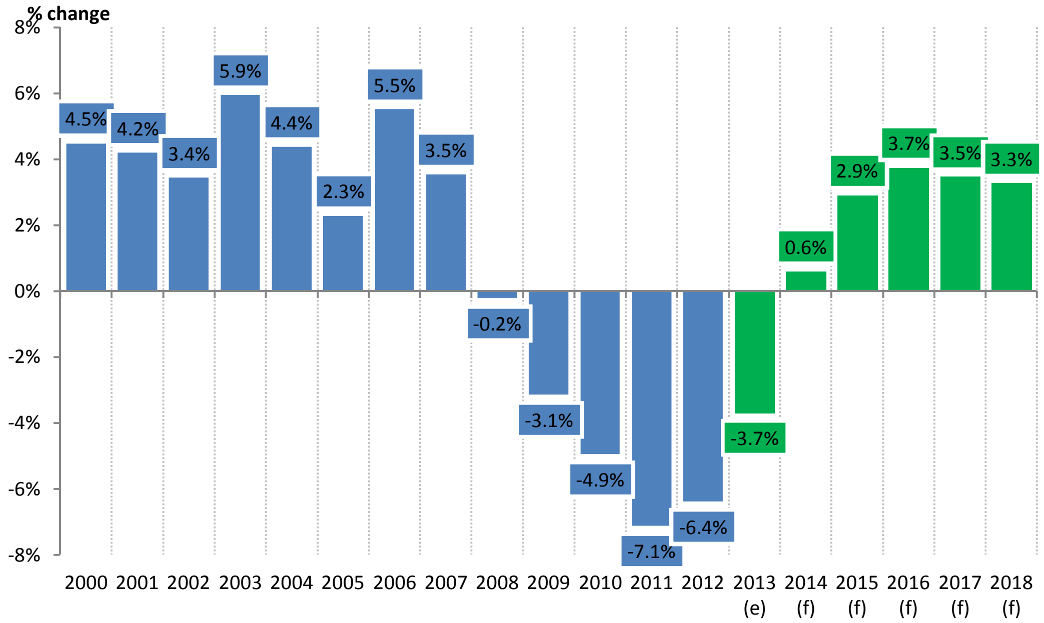
2.2 The protracted recession under the Economic Adjustment Programme

The ambitious fiscal consolidation of the Economic Adjustment Programme that came in May 2010 with the bailout agreement had a significant negative impact on the depth and duration of the contraction of the Greek economy. The readiness and the ability of Greek society to implement the needed reforms were apparently overestimated. Meanwhile, the economic activity was also severely undermined by sustained uncertainty over strategic features of the socioeconomic environment, such as the solvency of the banking system and the threat of exit of Greece and other economies from the European Monetary Union.

The uncertainty was largely fuelled by opportunistic political behaviour domestically and ambivalent political response at the European level. The EU political response was too weak and disconcerted to fill the void left by the inadequate institutional design of the monetary union with regard to tackling asymmetric negative shocks.

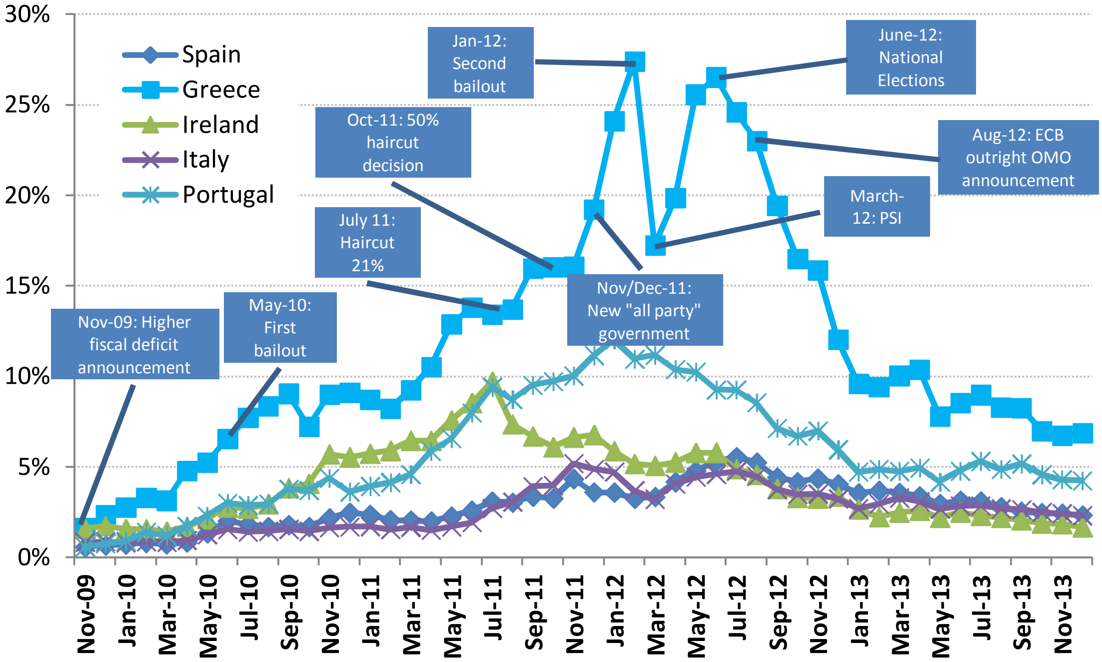
The Greek economy completed in 2013 its sixth consecutive year of contraction (Figure 2.6). With the formation of a coalition government after the second round of elections in June 2012 and its gradual adoption of the policies envisaged in the Economic Adjustment Programme the spreads on Government bonds started to subside. The normalisation process was further boosted with ECB's announcement of its determination to prevent the collapse of the European Monetary Union in August 2012. The political statements by EU political leaders became considerably more careful and concerted, which further ameliorated the uncertainty over the future of the Euro and Greece's place in it. By the end of 2013, the spreads on Greek sovereign bonds returned to mid-2010 levels, following a rapid decrease after the elections of June 2012 and the ECB announcement in August 2012 (Figure 2.6).

Figure 2.6: GDP % change (2005=100)



Source: EL.STAT., Projections 2013-2015: AMECO, Projections 2016-2018: IMF, data processing IOBE

Figure 2.7: The spreads of sovereign bond yields of select countries over German Bunds, Nov 2009 – Dec 2013



Source: ECB, Data processing: IOBE

2.3 The way ahead

By early 2014, the twin deficit of the fiscal and external sectors, which had constituted the major indications that the Greek economic model of growth is not sustainable, have practically closed. According to Eurostat's announcement, Greece achieved a primary surplus of EUR 3.4 billion or 1.9% of GDP in 2013 (excluding the one-off costs of bank recapitalisation following the PSI). Removing the impact of extraordinary costs and revenue, such as the retrospective reduction of interest on EU loans and return of profits on bonds held by central banks of the Eurosystem, the primary surplus for 2013 is estimated at 1.5 billion or 0.8% of GDP, almost double than initially projected (812 million). Additionally, the current account also turned positive, according to data from the Bank of Greece, from a deficit of EUR 4.6 billion or 2.4% of GDP in 2012 to a surplus of EUR 1.2 billion or 0.7% of GDP.

Meanwhile, in a sign of improved investor confidence towards the Greek economy, Greece returned to the sovereign bond markets in April 2014, for the first time since 2010. The Greek government raised EUR 3 billion in a five-year bond issue (after attracting orders in excess of EUR 20 billion) with a lower than anticipated yield (4.95%).

In addition, Greek "systemic" banks strengthened their capital base and liquidity by issuing equity and bonds. In March 2014, Piraeus Bank made the first corporate debt issue by a domestic banking institution since 2009, raising EUR 500 million at a 5.1% yield. Recently, the National Bank of Greece issued a 5-year bond (EUR 750 million at 4.5%), with the investors' demand surpassing EUR 2.1 billion. Finally, non-financial Greek companies, such as PPC and Hellenic Petroleum also raised substantial funds from the foreign debt markets.

The above indicates that the Greek economy is close to a turning point given the forecasts for stabilisation of the economy in 2014 and modest growth in 2015. Furthermore, the outlook over the medium term is cautiously optimistic. Greek GDP is projected to grow by around 3.5% per annum, on average, between 2016 and 2018 (Figure 2.6). This positive outlook is conditional on Greece remaining on the path of structural reform, fiscal discipline and banking sector consolidation as well as maintaining political stability and social cohesion.

Overall, the economic crisis resulted in lower consumption and investment, very high unemployment and a volatile sociopolitical environment. However, the reforms under the Economic Adjustment Programme that are being implemented have the potential to lay the foundation for a new "growth model", in which investment and exports play a key role.

Achieving the transition to a new paradigm of sustainable economic growth is the key challenge that Greece faces today.

Given the imperative to tackle the global warming phenomena, renewable energy technologies form an integral part of the new growth model. Wind power, in particular, is indispensible in minimising the cost of the transition towards fiscally and environmentally sustainable economy and energy system. Therefore, taking into account the favourable conditions for wind investment in Greece, the medium and long-term prospects for wind energy deployment in Greece remain bright, despite the severe economic crisis and the uncertain short-term economic outlook.

3. Impact of the economic crisis on investment

The economic crisis and the loss of confidence on the prospects of the Greek economy had a serious impact on investment in general. Gross capital formation in Greece experienced a sharp fall already from 2008, when it contracted by 10.4% (Figure 3.1). The contraction was even sharper in 2009 (-25%), with double digit reduction rates observed also in 2011 and 2012.

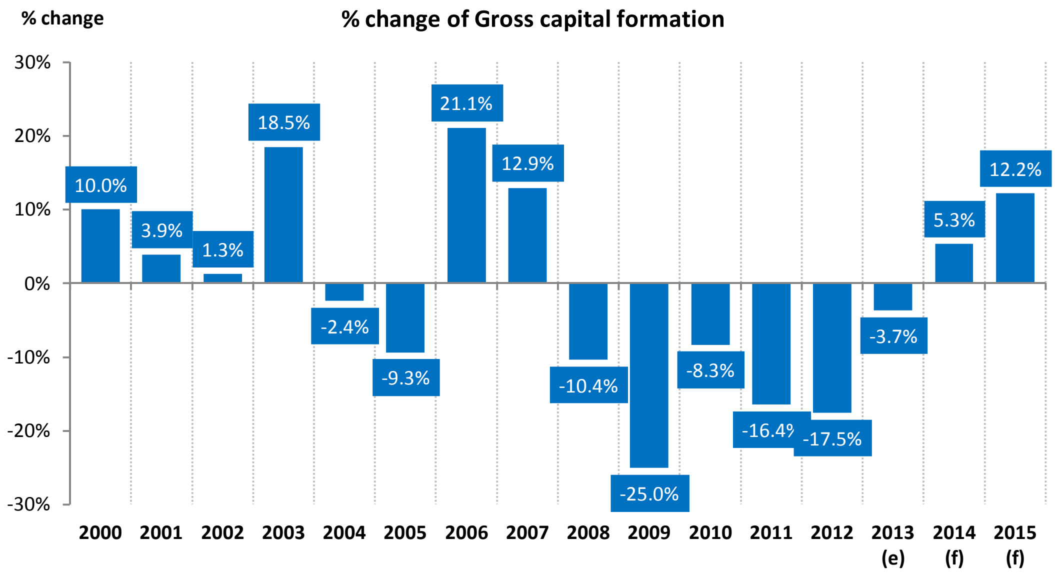
Part of the observed contraction, especially in 2010 and 2011, came from the fiscal consolidation process. In order to achieve the budget targets, the Greek government overcut its spending on investment to compensate for the shortfall of projected tax revenue. Additionally, private sector investment has been consistently shrinking, with rates ranging between 11.7% and 21.7% in 2008-2012. Despite the overall gloom, investment in renewable energy in Greece moved against the current during the economic crisis.

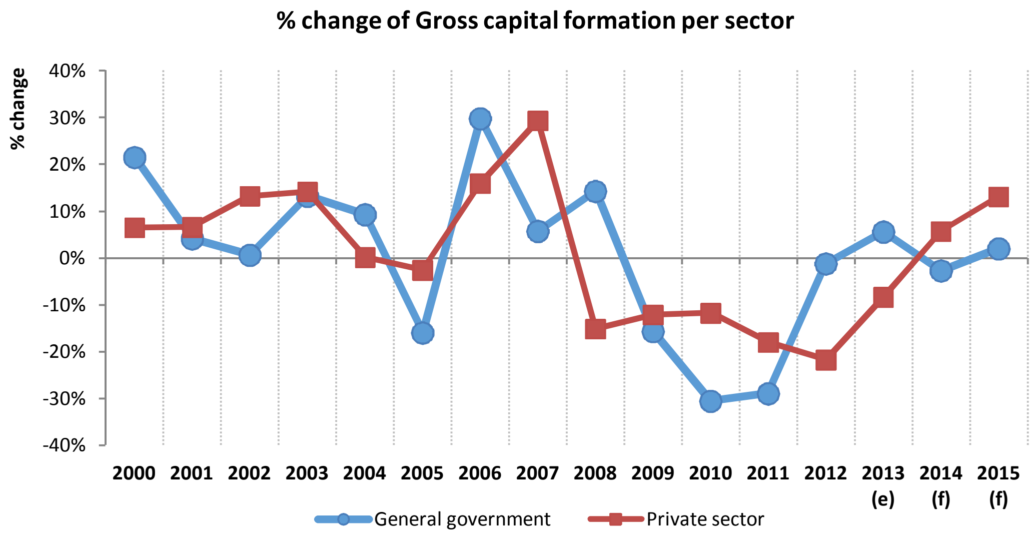
3.1 Investment in renewable energy sources

The renewable energy sources (RES) attracted over EUR 7.6 billion of investment in Greece cumulatively over the period 2006-2013. Despite the economic crisis, investment in RES accelerated between 2008 and 2012 (Figure 3.2).

Overall during 2010-2013 approximately EUR 6.3 billion were invested in renewable energy technologies, almost five times as high compared with the investments made during 2006-2009. PV technologies and wind power absorbed the largest share (93% share of total investments in RES over the period 2006-2013), responsible respectively for EUR 5.4 billion and EUR 1.7 billion of investment respectively. As a result, installed capacity in RES has grown at an average rate of 28% per year between 2006 and 2013 (Figure 3.3).

Figure 3.1. Gross Capital Formation % change (2005=100)



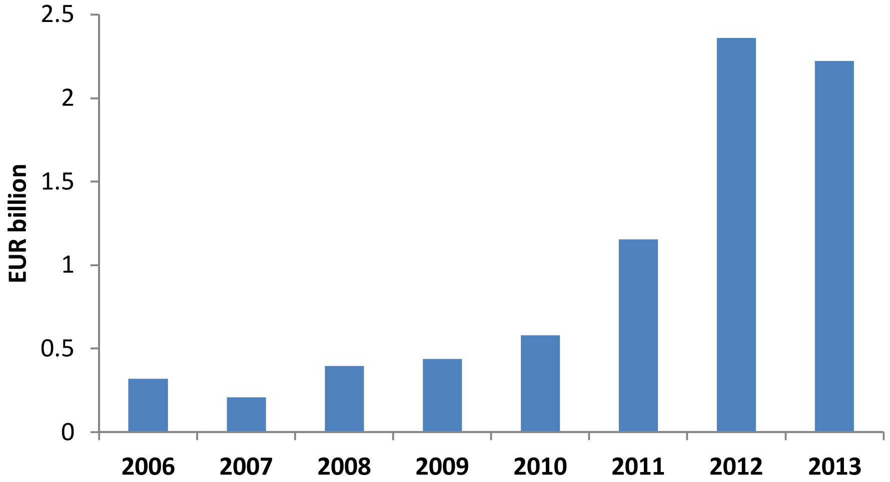


Source: EL.STAT., Projections 2013-2015: AMECO, data processing IOBE

On an annual basis, the new capacity of wind power installations in Greece increased from 146 MW in 2006 to 315 MW in 2011 which was an all-time record year, representing an average annual growth rate of over 16%. However, the total wind power installed decreased in the last two years to levels close to the average annual figures of the market in the pre-crisis period. In 2013, new wind capacity of 116 MW was added to the grid (Figure 3.4).

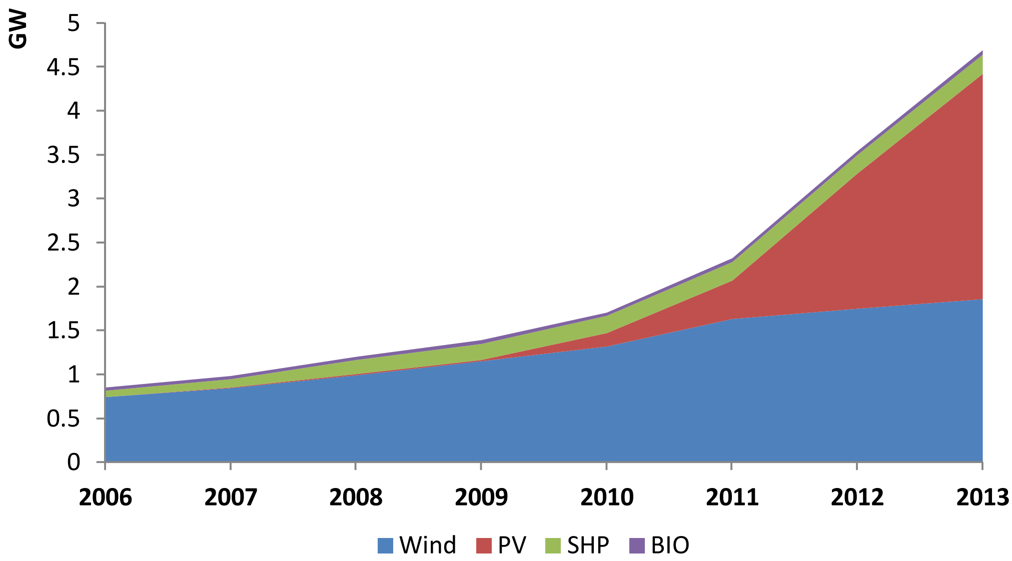
Meanwhile, wind energy installations were outpaced by photovoltaic systems. The total installed capacity of PV reached 2,564 MW by the end of 2013, accounting for more than half of RES installed capacity, out of which 1,028 MW were added in 2013 (Figure 3.5). In contrast, the development of PV installations between 2007 and 2010 was considerably slower, with the total capacity by the end of 2010 not exceeding 153 MW. In effect, the RES investor interest shifted almost exclusively to photovoltaic projects in 2012 and 2013, due to their very high returns from sharply lower panel installation costs. The decelerating feed-in tariffs in the law also contributed to this, causing a rush of investment in order to secure higher feed-in tariffs.

Figure 3.2: Annual investment in RES in Greece



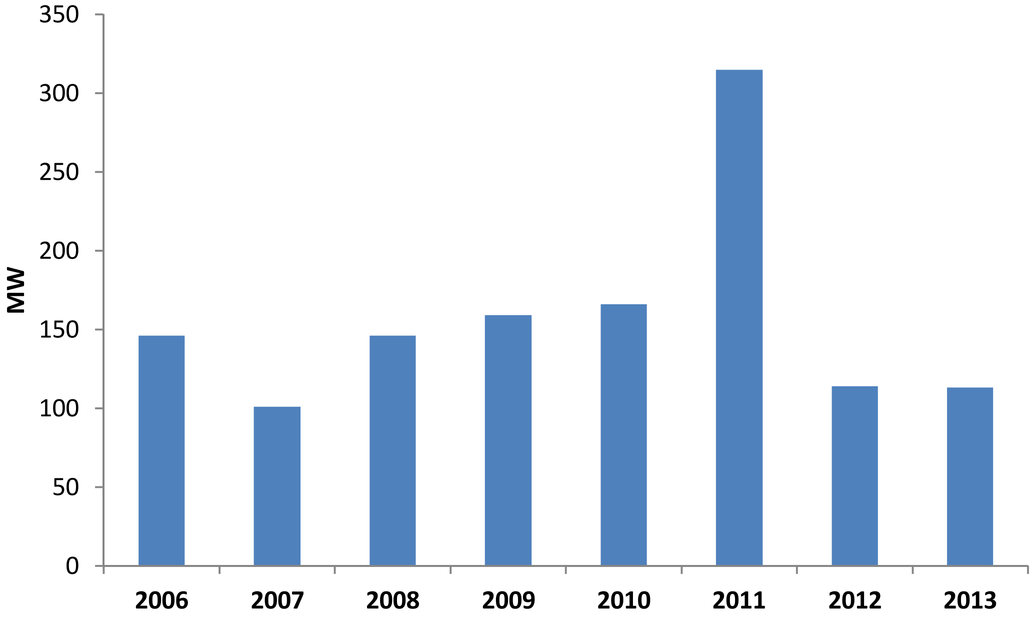
Source: ELETAEN

Figure 3.3: RES Installed capacity in Greece



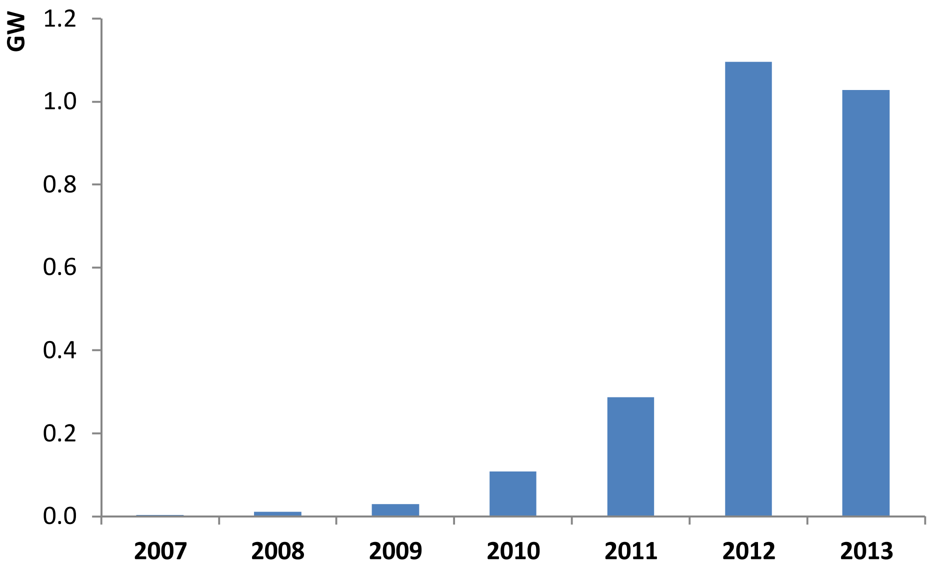
Source: ELETAEN

Figure 3.4: New wind capacity in Greece (2006-2013)



Source: ELETAEN

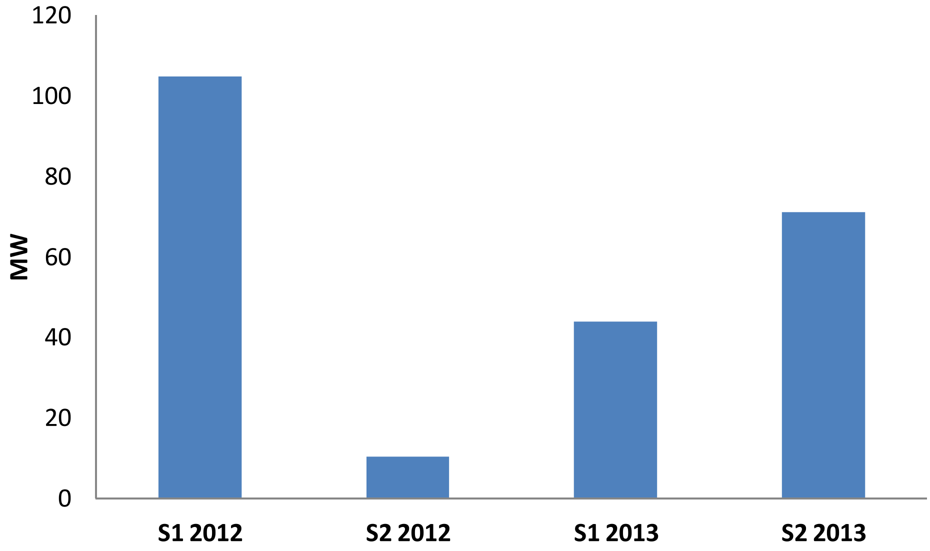
Figure 3.5: New PV capacity in Greece



Source: ELETAEN

A more careful review of the course of wind investment within 2012 and 2013 reveals that wind energy is again back on a growth path. After the second half of 2012, when only 10,3 MW were added to the grid, new wind installation accelerated to 44 MW in the first half of 2013 and 71MW in the second half of 2013.

Figure 3.6: New wind capacity in Greece, first half of 2012 with second half of 2013



Source: ELETAEN

The return to the growth path of wind energy in Greece is mainly driven by large Greek and foreign investors. In 2013 the French EDF and the Greek TERNA Energy, ELLAKTOR and PPC connected new wind parks to the grid. In parallel, new major players penetrated the Greek wind market, with the Hellenic Petroleum Group and the Greek-French EREN Group acquiring operating assets and the US based fund York Capital entering the share capital of TERNA Group. Meanwhile, the Italian ENEL Green Power, after a significant investment in the Greek PV sector, is expected to return to wind energy with the construction of a large wind park in the Kafireas area (140 MW), with the company operating 199 MW of wind parks in Greece already.

3.2 Investment drivers for wind energy

The pace of investment in wind energy accelerated during the first few years of the crisis, however it has slowed down after 2011, due in part to the PV investment boom in 2012 and 2013. It is noteworthy that the big investors in the PV and the wind industry in Greece are practically the same, therefore in periods when the investment appetite is driven to one of the two technologies, the other one slows down. In late 2013 a shift from PV to wind energy investment was already observed.

In order to understand the dynamics of wind investment over the crisis years in Greece, we need to examine more carefully the investment drivers. The return on the investment in a wind park in Greece depends on a number of physical, economic and regulatory factors. Setting aside the physical characteristics of each location, which largely determine a turbine's capacity factor, the height of the feed-in tariff for wind energy is the key driver on the revenue side under the current regulatory framework. Energy prices and the cost of other energy sources used for electricity generation do not influence directly the return on investment in wind energy under the current feed-in tariff regime, however under alternative policy regimes they could play a very substantial role and thus should not be left out of the analysis.

On the side of expenditure, the return on investment depends mainly on the investment cost, as wind generation is a capital-intensive activity. Investment cost is heavily dependent on wind turbines prices and it is further slightly affected by existing infrastructures such as the availability of electricity grids and accessibility of roads in the wider area of planned installation sites. A significant barrier to investment, especially during the current economic crisis, is the availability of funds to finance investments.

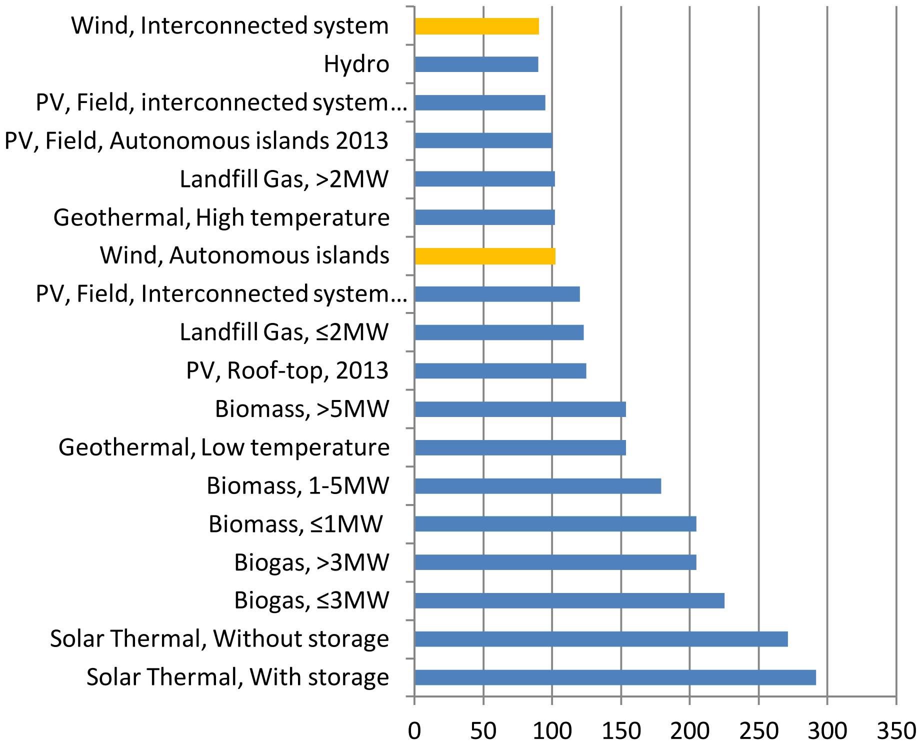
While the above factors, together with the wind regime, largely determine the feasibility and the profitability of an investment, the decision whether to commit funds to a project depends also on the degree of certainty about the likelihood of actually obtaining the expected return on investment.

3.2.1 Wind power feed-in tariffs

In Greece, the wind energy producers sign 20-year contracts to sell their production to the grid at a legally fixed price, called "feed-in tariff", per unit of generated energy (MWh). Compared with other renewable energy technologies in Greece, wind, together with small hydroelectric systems, enjoys the lowest feed-in tariff, which given the steady flow of new investment reflects the commercial maturity of this particular technology.

The feed-in tariffs for wind and some of the other renewable sources are upped by 20% in case the investment is carried out without public grants. In addition, if the investment project covers the cost of interconnecting an autonomous island to the interconnected system, the feed-in tariff is further increased by up to 25%, depending on the length of the connection and the total installed capacity of the connected installations. Finally, the Minister of Energy has the mandate to set higher feed-in tariffs for sites with low wind potential. The scope of such an increase in the future is to secure a minimum attractiveness for the profitability of such low-wind projects if most of the high-wind-potential sites will have been utilised, without however achieving the policy targets.

Figure 3.7: Feed-in tariffs for renewable energy sources in Greece as of December 2013



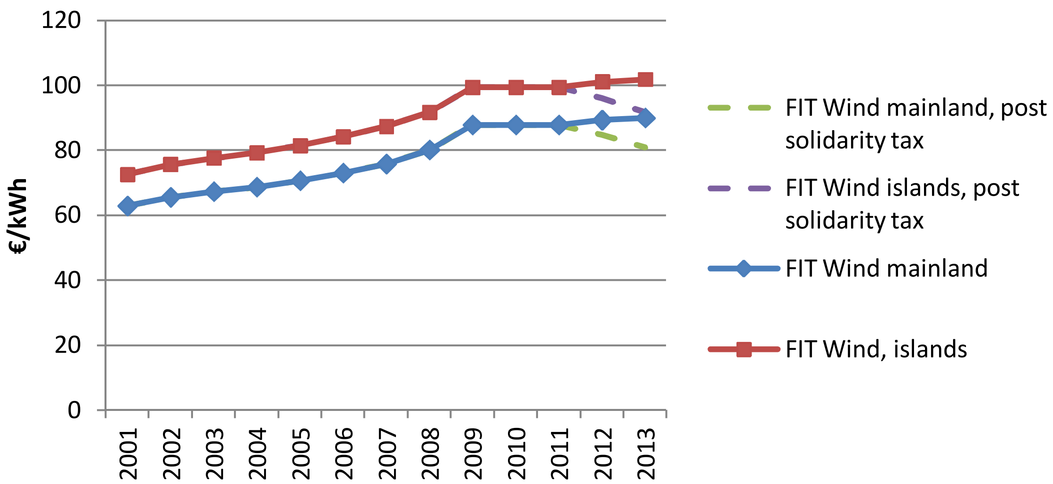
Source: RAE, YPEKA

The feed-in tariffs system is funded through a special account, administered by the market operator (LAGIE S.A.). The account receives payments from electricity suppliers in the interconnected system and the autonomous islands that in principle correspond to the opportunity cost of the energy produced with renewable energy sources.

The System Marginal Price (SMP) – the price that clears the mandatory electricity wholesale market – was used until recently as a proxy estimate for the opportunity cost of renewable energy. However, since mid 2013 the suppliers should pay at least the weighted average variable unit cost of thermal electricity (Law No. 4152/2013), to approximate better the full range of value provided by must-run renewables (capacity credit, merit order effects, etc.).

To the extent that the feed-in tariffs exceed the opportunity cost of renewable energy, the difference is covered, in principle, by charging the electricity consumers with a discrete fee on top of the retail tariff. However, the much more rapid than initially anticipated penetration of photovoltaic systems and the delay in adopting measures such as those introduced with Law No.4152/2013, have led to a deficit in the account that supports the feed-in tariff system.[3]

Figure 3.8: Feed-in tariffs for wind energy, 2001-2013



Source: ELETAEN

Various measures were introduced in late 2012 to tackle this deficit, including a levy on the pre-tax sales of electricity, produced with renewable sources (Law No. 4093/2012). The "solidarity tax" for PV ranged between 25%-42%, depending on the start date of the operation of each installation, while for wind and other RES the extraordinary levy was set equal to 10%. Even with the 10% levy, the feed-in tariff for wind energy in 2013 was higher in nominal terms compared with 2008 (Figure 3.8). However, the specific measure – which took effect from 1 July 2012 and was set to expire on 30 June 2014 - was repealed by Law No. 4254/2014 on 7 April.

In the new law, the feed-in-tariffs for new wind parks that will not receive a capital grant has been set at 105 EUR/MWh in the interconnected system and 110 EUR/MWh in the non-interconnected islands. In the case of a capital grant, the feed-in tariff in the interconnected system ranges between 82 EUR/MWh for installed capacity above 5 MW (which increases to 85 EUR/MWh in case the installed capacity is below this threshold) and 90 EUR/MWh in the non-interconnected islands. The feed-in tariffs were also adjusted for existing wind parks, at slightly higher levels than above (84-107 EUR/MWh, depending on size, location and connection date). In addition, the feed-in tariff remains fixed for the duration of the power

[3] The deficit of the account is analysed in more detail in the subsequent subchapter on entrepreneurial risks.

purchase agreement, without any adjustment to account for inflation. The impact of the new tariffs on investment return is analysed in the following chapter.

3.2.2 Capacity factor

Another major revenue factor is the availability of wind energy, which varies significantly across regions. A common indicator for wind energy availability is the capacity factor, which measures the actual energy production as percentage of the maximum production, given the capacity of an installation. In particular, the annual capacity factor is estimated dividing the annual production with the product of the average installed capacity for that particular year and the hours in a year (8760).

In 2012 the average capacity factor of wind parks is estimated at about 26%, while, despite the increasing productivity of new wind turbines, it is expected to fall in the future, due to the increasing utilisation of areas with lower wind regime.

This parameter can vary significantly across sites. The quality of the wind measurements campaign and the use of long term wind data of an area are important for the mitigation of the associated risk.

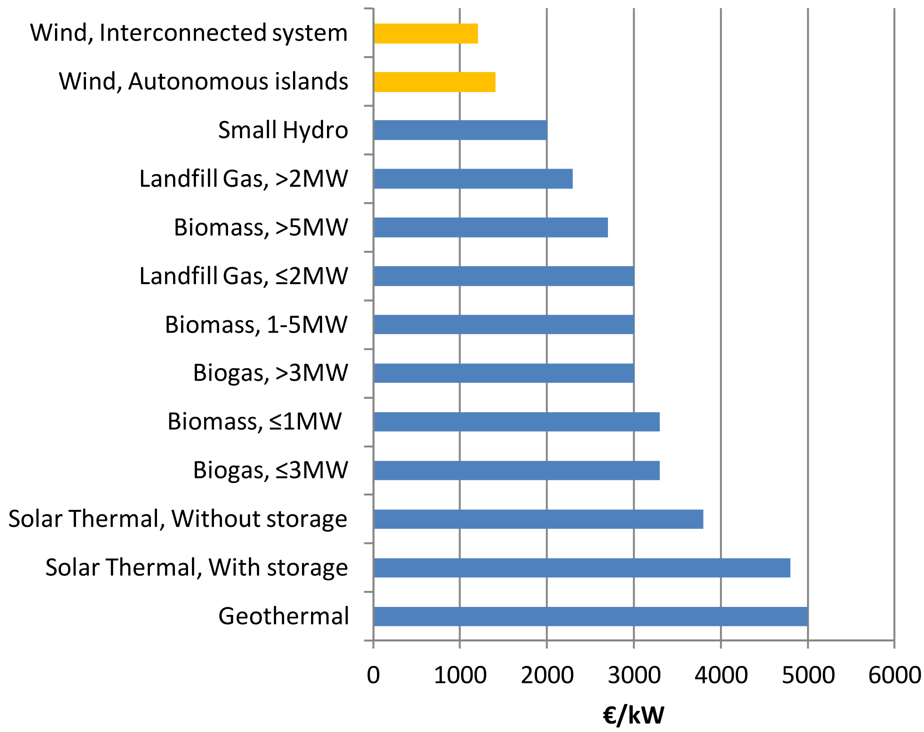
3.2.3 Investment cost

Wind energy generation is a capital intensive business. The production processes are largely automated, with little human intervention. Meanwhile, the primary input in the process – wind – is freely available and unlike the thermal energy sources does not involve exploration, extraction or transport costs. As a result, by far the most significant investment driver on the expenditure side is the initial investment cost.

The installation cost for wind parks in Greece is considerably lower, compared with other renewable energy technologies (Figure 3.9). In particular, according to RAE estimates the cost to install wind parks varies between EUR 1,200/kW in the interconnected system to EUR 1,400/kW in autonomous islands. The closest technology in terms of low installation cost is small hydroelectric systems, where the installation cost is estimated at EUR 2,000/kW, while the cost of installing solar thermal and geothermal installation is estimated to be a multiple of that of wind (EUR 3,800-4,800/kW and EUR 5,000/kW respectively).

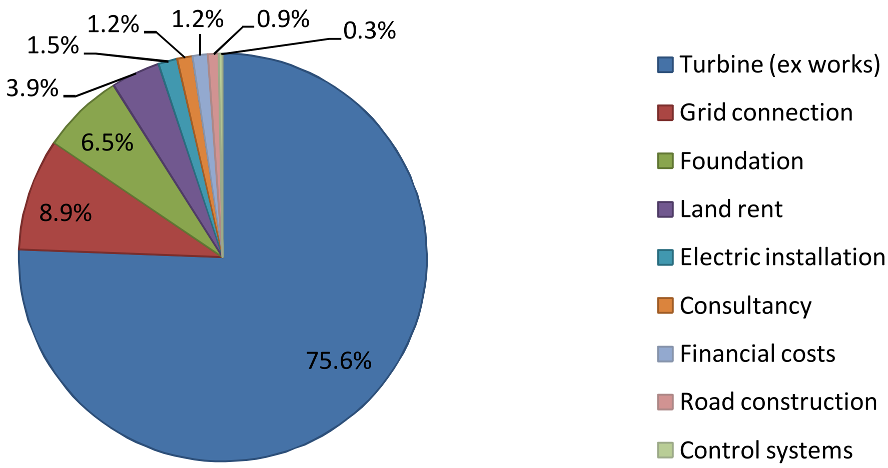
More than three quarters of the wind installation cost were estimated in an EU-wide survey to correspond to the price of the wind turbine itself (Figure 3.10). Among the remaining cost categories, the largest items concern grid connection (8.9%), foundation (6.5%) and land rent (3.9%), items that vary considerably across countries and across installations.

Figure 3.9: Installation cost of wind and other renewable energy sources



Source: RAE

Figure 3.10: Cost structure of a typical 2 MW wind turbine installed in Europe



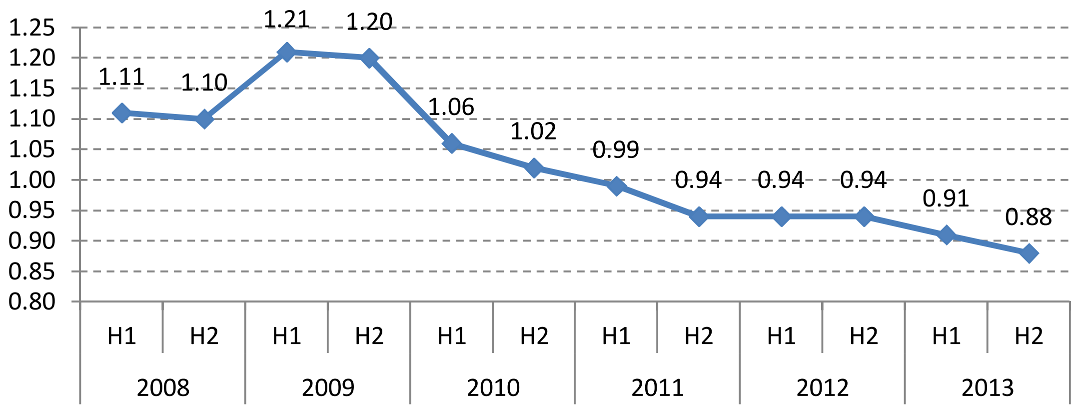
Source: EWEA

Over time, the investment cost has declined substantially, even in nominal terms. The commodities' prices (steel, copper etc.) had reached their peak in early 2008, just before the China Olympics, boosting proportionally the prices of wind turbines and relevant equipment.

The price of wind turbine, the largest cost component, has been declining substantially since 2009, following several years of price growth (Figure 3.11). According to Bloomberg estimates, the mean price of a wind turbine per MW delivered in the second half of 2013 has fallen by 27% since the first half of 2009. Meanwhile, as the energy productivity of the wind turbines per MW has also increased considerably in the same period due to technology innovation, the cost of energy produced (ie. per MWh) has fallen even further.

In summary, the decline since 2009 can be explained with (i) a lower than expected demand due to the global economic crisis, (ii) the rapid fall of commodity prices and (iii) the increase of nominal power and especially the efficiency of new wind turbines. As the fixed cost of a turbine is spread over larger capacity, the installation cost per unit of power falls. Design innovations and patent expirations further improve the cost performance of the major item of wind installation cost.

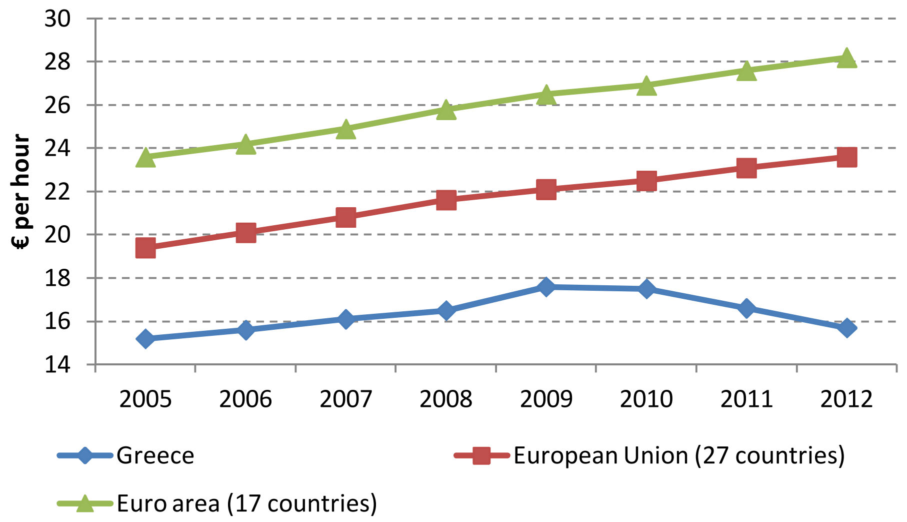
Figure 3.11: Wind turbine price (million € per MW), mean price by date of delivery



Source: Bloomberg.
Note: Due to the reasonable time gap between contracting and delivery, the above curve indicates contract prices with almost one year lag.

The remaining cost items depend stronger on the conditions that prevail in each country and in particular on the labour cost in construction and in the wider private sector. The total hourly labour cost (incl. employment contributions, taxes, etc.) in Greece in the business sector of the economy has declined significantly since 2009, despite the continuous upward trend in the Euro area and the EU overall (Figure 3.12). As a result, the unit labour cost in Greece has diverged significantly from the EU average (EUR 23.6 per hour) to reach EUR 15.7 per hour, considerably below the 2009 peak of EUR 17.6 per hour (-11% in nominal terms).

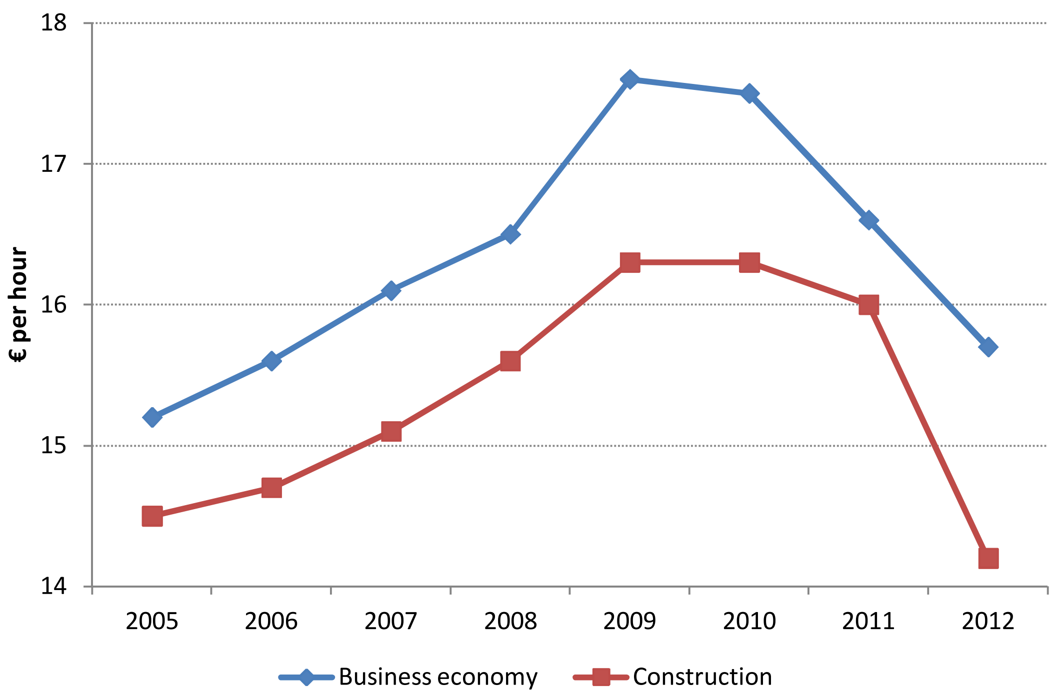
Figure 3.12: Total labour cost in the business economy in Greece and the EU



Source: Eurostat

The contraction of the unit labour cost was even sharper in the Construction industry (Figure 3.13). In 2012 the employers in the sector were paying EUR 14.2 per hour on average, lower even than the unit labour cost paid out in 2005 (EUR 14.5 per hour).

Figure 3.13: Total labour cost in Greece in Construction



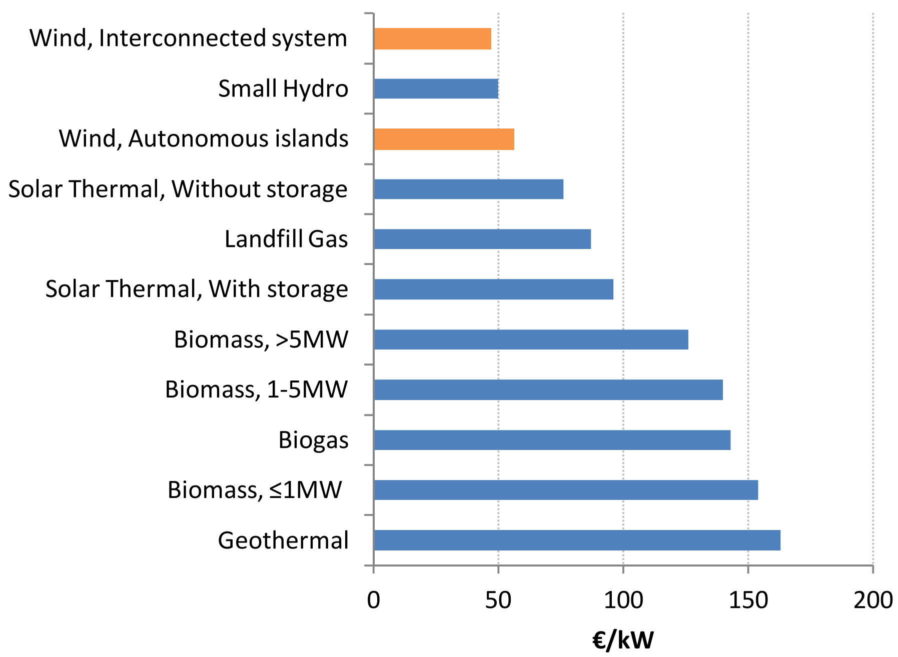
Source: Eurostat

3.2.4 Operation and maintenance cost

The annual cost of operation and maintenance are significantly lower compared with the initial installation cost. A significant part of the annual operating cost is taken up by warranty contracts, offered by manufacturers that also cover maintenance and service works. The fee of these contracts is usually drawn up in terms of percentage (2%-3%) of the installation cost. Other operating costs include insurance, rent, extraordinary expenses, wages and other overheads.

According to RAE estimates, the annual operation and maintenance cost for wind parks in Greece amounts to around EUR 47 per kW in the interconnected system and EUR 56 per kW in the autonomous islands. Compared with other renewable energy technologies, the annual operation and maintenance cost is indeed rather low (Figure 3.14).

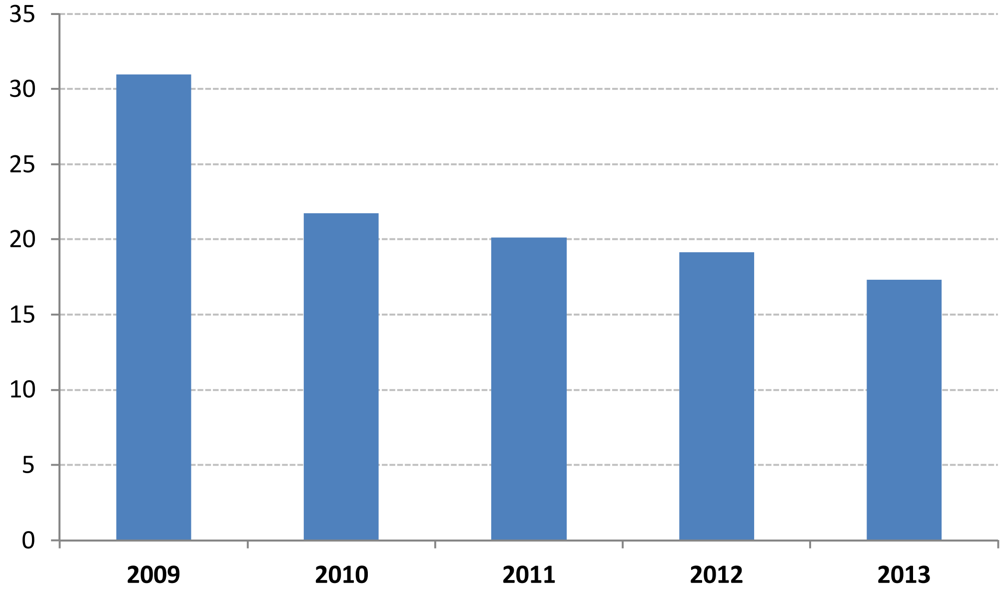
Figure 3.14: Annual operation and maintenance cost in Greece per technology



Note: The estimates on Biomass, Biogas and Landfill gas do not include fuel costs.
Source: RAE

Over time, the operating cost of wind parks has fallen significantly. According to estimates published in IEA (2013), since 2009 the operation and maintenance cost of wind parks has fallen globally on average by 44%, from EUR 31 to EUR 17/kW per year (Figure 3.15). To a large extent this decline comes from the fall in installation cost and hence the warranty contract fees, yet some of it might also be due to falling wages, a factor that is particularly relevant for Greece.

Figure 3.15: Annual operation and maintenance cost, 2009-2013



Source: IEA (2013), Wind Technology Roadmap

3.2.5 Access to finance: Credit rationing overall, yet credit expansion in the electricity sector

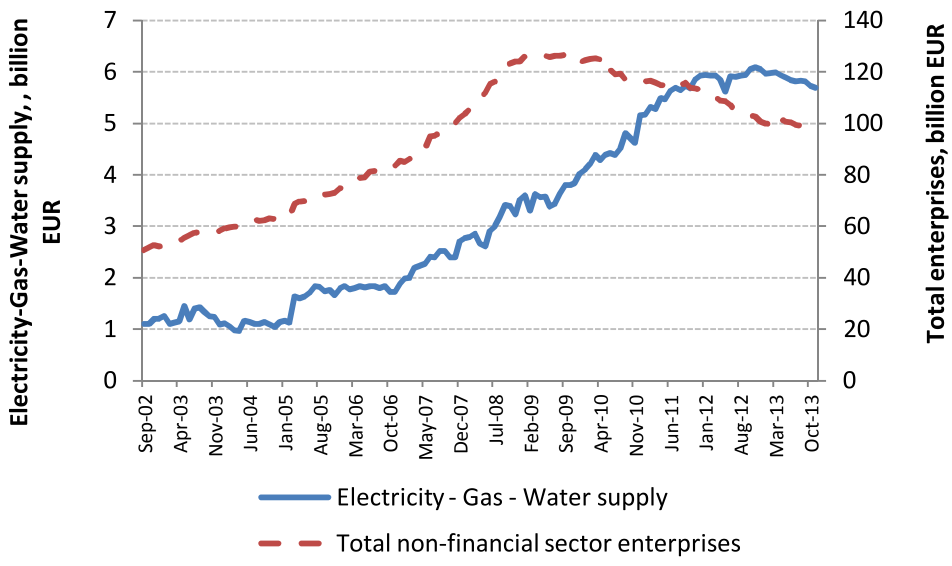
The economic crisis had affected the availability of capital through the Greek banking system. With the contraction of domestic income and the shaken confidence in the domestic banking system and capital markets, both credit and market capitalisation contracted. Meanwhile, the private sector involvement (PSI) in the significant reduction of the face value of outstanding debt in early 2012 weakened severely the capital base of the domestic banking system, whereas the ongoing recapitalisation is expected to mitigate these consequences in the medium term.

In particular, the ability to raise equity in the Athens Stock Exchange has deteriorated significantly since late 2007. Similarly, in 2011 and 2012, no enterprise from the non-financial sector issued any long-term bonds. A modest recovery was observed in the first 11 months of 2013, with the bond issues on the Greek market reaching EUR 278 million.

Evidently, the ability to finance investment projects with securities issued in the domestic capital markets has weakened substantially. A similar trend is also observed in obtaining credit through the banking system. The rapid credit expansion was stalled after the spring of 2008, when the extent of the harm done by the subprime mortgage market on the global financial system became evident (Figure 3.16). Since the start of the Economic Adjustment

Programme that came with the bailout agreement in May 2010, the outstanding balance of debt to Greek enterprises has been shrinking at a fairly steady pace.

Figure 3.16: Outstanding balance of debt issued by domestic banks to Greek enterprises



Source: Bank of Greece (2014)

Interestingly, the credit expansion to the Electricity sector in Greece continued strongly for years, even during the Economic Adjustment Programme's implementation. Given that most capacity additions in Greece during this period were made by renewable energy sources, and in particular by photovoltaic systems and wind parks, evidently the return on these investments was strong enough and the risk associated with them was low enough to offset the overall unfavourable credit conditions. However, the decision for a haircut of the Greek debt through private sector involvement (PSI), which was finalised in November 2011, affected to some extent also the credit expansion to the domestic Electricity sector. It is important to mention that Greek Banks have honoured their contracts towards local investors despite their scarcity of liquidity.

The outstanding balance of debt extended by domestic banks to enterprises in the Electricity-Gas-Water supply sector has been slightly falling since November 2012. This is largely due to the protracted recapitalisation process of the Greek banking sector. While the Greek banking sector has consolidated substantially, with the four remaining systemic banks receiving large capital injections in mid 2013, credit to enterprises has not picked up yet. This is largely due to the negotiations between the Greek authorities, the European Central Bank and the European Commission, regarding the capital requirements that need to be imposed on the Greek banks in the aftermath of the recent stress tests. The credit adequacy of the

Greek banking system is expected to return to normal rates with the completion of the recapitalisation process, which in turn should ease the credit conditions faced by the domestic enterprises.

That said, projects of big international investors in the Greek renewables market have enjoyed access to finance from foreign banks and financial institutions during the crisis period. The penetration of PVs was further supported strongly by export credit agencies of foreign manufacturers and mostly of China, being by far the biggest PV manufacturer worldwide.

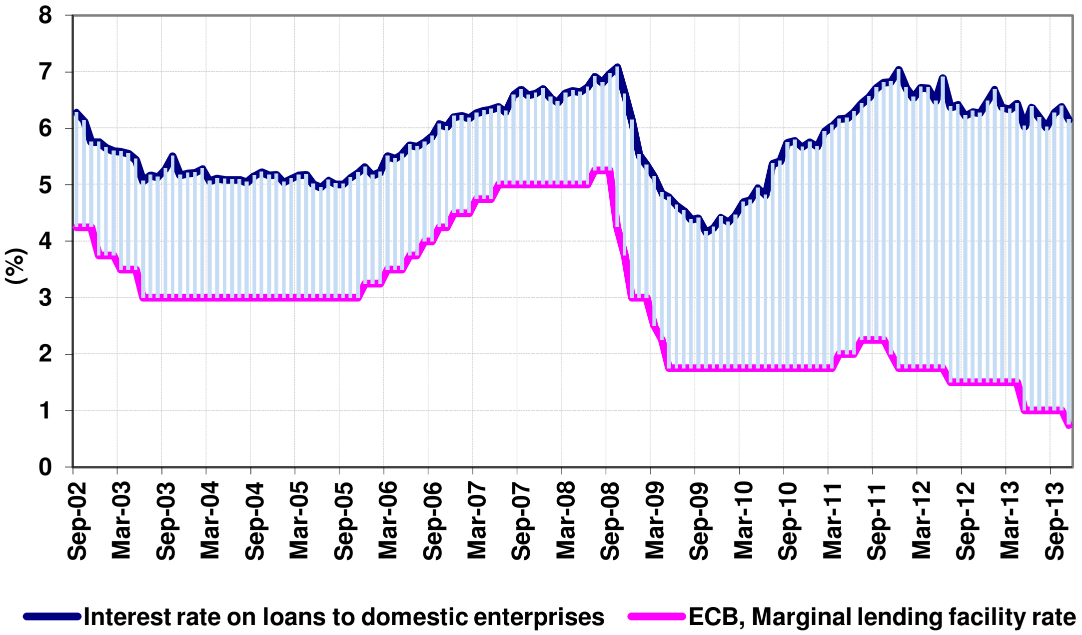
3.2.6 Interest rates

The limited liquidity that the Greek banks have experienced in the past few years, as they have been practically excluded from the European interbank lending market, has had an impact on the interest rates at which they lend to the domestic enterprises of the non-financial sector, which is a major investment driver. The interest rates of the domestic banks were tracking closely the reference rate of the European Central Bank until the Lehman Brothers collapse in September 2008 (Figure 3.17).

After the LB collapse and until late 2009, the domestic interest rates were falling as well, however the spread over the ECB rates was increasing, pricing in the loss of risk appetite by the investors. The interest rates increased substantially from the lowest point observed in October 2009 (4.16%), to return to the pre Lehman Brothers level of 7.03% in December 2011, immediately following the PSI decision, despite the fact that during the same period the ECB reference rate remained largely unchanged. Since then the interest rates on domestic loans have followed a downward trend, reflecting the fall of the ECB reference rate, with the interest rate spread fluctuating around 500 basis points. It must be stressed that, despite the increase of the interest rate spreads, the interest rates on loans to domestic enterprises have not exceed their pre-Lehman Brothers peak (Figure 3.17).

Given the course of the spreads of Greek government bonds over the same period, we can conclude that the increase of the interest rate spread after the Lehman Brothers collapse was largely due to risk associated with the ability of the state to serve its public debt. However, the fact that the interest rate spread has remained high, despite the significant drop in the spread on government bonds since the elections in June 2012, indicates that the cost of bank lending has remained high due to risk inherent to the banking sector. Over the medium term, with the finalisation of the capital shielding of the Greek banking sector, the spread over the ECB rate should subside, although the reduction of the overall interest rate might be offset to some extent by an increase of the ECB rate, as the growth of the European economy strengthens and inflation starts to pick up.

Figure 3.17: Average interest rate on new loans to enterprises in the non-financial sector



Source: Bank of Greece, ECB

3.2.7 Infrastructure

Living organisms shun from strong winds. As a result, locations with strong wind potential are usually not adjacent to large urban centres or other important electricity consumption nods. Hence, the harnessing of wind energy requires extensive work on strengthening and expanding the electricity grid to points at and beyond its edges, such as mountain ranges and, especially in the case of Greece, sea islands.

Indeed, the electricity grid is a serious constraint on wind energy development all over the world and Greece is not an exception. Areas with significant wind potential, such as Peloponnese and Evia, are characterised as congested. In these areas the installed renewable energy facilities, together with the binding grid connection offers, cover the current grid availability. Further production licences and grid connection offers in such areas are issued conditional on the completion of grid extension works.

In addition, most Aegean islands, an area with the strongest wind potential on Greek territory, are not connected to the mainland electricity grid. The autonomous systems of the islands, characterised with strong seasonality of demand, with peak during the summer tourist season, have a very limited capacity to absorb stochastic electricity generation. Hence, the full harnessing of the wind energy potential of the islands requires their interconnection with the mainland system. In the mean time, hybrid systems where wind parks operate in combination with pump hydro units, such as the 6.85 MW system developed in the island of Ikaria by PPC Renewables, could prove to be a viable alternative in the non-interconnected islands.

The system operator has drawn a long term plan for the development of the electricity network, which explicitly takes into account the need to strengthen the network in order to facilitate further additions of wind capacity. In particular, the plan includes the development of 400kV grid in areas with high wind potential (Thrace and Peloponnese), new interconnection between Evia and the mainland system at Nea Makri, high voltage dispatch centre in Aliveri and the interconnection of the Cycladic islands. In addition, the interconnection of the remaining Aegean Islands and Crete with the mainland system has been planned as well.

That said, the fiscal consolidation effort, the limited availability of financial liquidity, the bank recapitalisation and the restructuring of the System Operator seem to have had an impact on the progress of the network development works, increasing the competition among wind projects to secure grid access. Delays in the development of the grid may prevent the implementation of some projects which require massive grid expansion, nevertheless grid availability is primarily an important driver for the penetration of wind in the country's energy mix, with a lesser impact on the return on individual wind park investments per se. In the following chapter, the risk from grid availability is subsumed into the sensitivity analysis of IRR with respect to the initial investment cost.

3.2.8 Entrepreneurial and investment risks

The decision to make an investment depends not only on the expected rate of return, but also on the risk or the volatility of the return rate. Given that the majority of investors are risk averse, they would not invest in a project that has the same return as a lower risk alternative. Hence, risk comes with a price in terms of higher return.

A number of factors influence the certainty about generating a particular level of return on an investment in wind energy. These can be grouped into four risk categories – macroeconomic, financial, regulatory and other.

The inability of the Greek state to service its debt without institutional assistance and its impact on the stability of the banking sector influenced greatly the course of aggregate investment, over the past few years, but they do not have significantly affected RES investments, given their boom during the crisis. This is reasonable since the income of RES investments is not directly connected with the ability of the state to serve its debt obligations. Meanwhile, the country risk that comes with the doubt over debt service capabilities has subsided substantially, as evident by the significant reduction of the spreads since mid 2012, from 2 652 basis point for 10-year maturity bonds in June 2012 to 686 basis points in December 2013. The downward trend continued further in the first quarter of 2014, with the spread falling to approximately 490 basis points in March (year-on-year reduction by 88%).

Regarding the financial risks, fluctuation in the interest rates or the value of the collateral can influence the terms of the loans extended by the banks. Hence, it is advisable to perform a sensitivity analysis with respect to the interest rate to determine likely ranges of the return on investment when examining the expected return. That said, wind investments, like any long term investment, are relatively less sensitive to such risks. Furthermore, given that the bank recapitalisation process is nearing its completion, while large wind projects enjoy access to finance from foreign banks, further deterioration of the credit conditions is not very likely.

At the level of specific projects, problems with the grid connection and the licensing process could lead to delays, increasing the initial investment cost. This risk can be significantly mitigated with proper budgeting and planning.

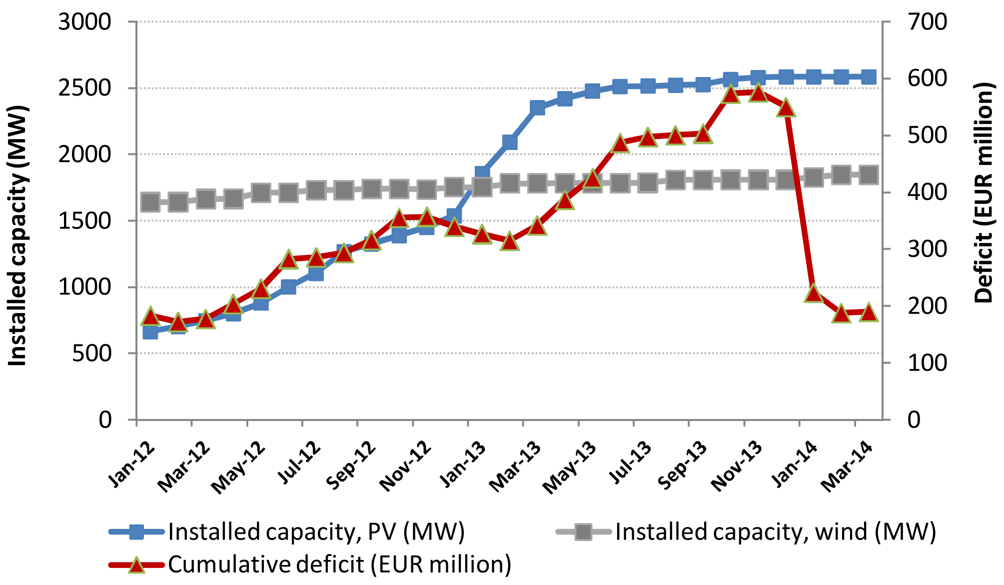
Problematic integration of wind power, due to energy “spillage”, i.e. generation cut-off from the grid due to inability to absorb the full scale of production, may also reduce the revenues of a project. It is important, however, to note that a compensation for such curtailments is foreseen by the law. Furthermore, the penetration levels are still too low to create such a problem. In any case, performing sensitivity analysis, with respect both to the investment cost and the wind generation capacity factor, is important.

Lastly, the regulatory risk regarding wind investment in Greece should also be taken into consideration. This risk is mainly related to the current deficit in the account, set up to fund the RES feed-in tariffs. This deficit has been driven mostly by the rapid penetration of PVs.

More specifically, the penetration of photovoltaic systems took place at a pace much more rapid than anticipated in the National Renewable Energy Action Plan (NREAP), submitted by the Greek government to the European Commission in 2010. The total installed PV capacity exceeded 2.5 GW in 2013, higher even than the 2020 target of 2.2 GW set in NREAP, which anticipated only 778 MW of installed PV capacity in 2013. Meanwhile, the PV systems entered the system at feed-in tariffs that had not fallen as fast as the PV installation costs.

As a result, the cost of supporting the PV systems has become much larger than anticipated. The account maintained by the market operator in order to finance the feed-in tariff system had a deficit of EUR 202 million even as early as November 2009, due to the lack of political will to pass the financing cost to the final consumers or to cure other market distortions. In the beginning of the PV boom during 2012-13, the account's deficit was close to EUR 180 million. However, by the end of 2013, with more than 2.5 GW of PV systems in operation, the account deficit reached EUR 550 million (Figure 3.18).

Figure 3.18: Cumulative deficit of the renewable energy account and installed capacity of wind and PV



Source: LAGIE

Indicative for the impact of the PV boom on the RES account deficit is the fact that in 2013 the net payment for PV energy took up 70% of the total outflows of the account (EUR 1.1 billion out of EUR 1.6 billion) at an average of EUR 279/MWh for ground PV systems and EUR 515/MWh for roof-top PVs. In comparison, wind energy received 21% of the account's net payments (EUR 347 million), at an average price of EUR 84/MWh.

In order to tackle the deficit of the account, the government imposed an extraordinary tax on RES revenues, while the Regulator increased the special levy paid by the consumers from EUR 5.43/MWh to EUR 14.96/MWh on average. In addition, in April 2013 the amount contributed to the account by the suppliers increased from EUR 32.80/MWh, being the average System Marginal Price at that month, to EUR 63/MWh (through law 4152/2013). Further, aiming not to put the burden entirely on final consumers, the account has been drawing revenues from a number of additional sources, such as auctioning of EU ETS allowances, TV licence fees and a lignite tax. These measures stabilised the deficit at around EUR 500 million during the second half of 2013. As a result of the deficit and the liquidity problems of the market operator, electricity producers are paid for the power they supplied to the grid with a delay of several months.

In an attempt to overcome the deficit, the Law No. 4254/2014 stipulates that RES and Cogeneration producers (except of roof-top PVs) must provide a discount on the total value of the sold energy for 2013,[4] in addition to the solidarity levy. For wind installations, in particular, the discount was set at 10%. To partly compensate the producers for the loss of revenue that came with these measures, the power purchase agreements were extended by 7 years for power stations that had been in operation for less than 12 years by 1 January 2014. In addition, the new law defined new feed-in tariffs for all renewable energy sources (see par. 3.2.1 for more details). Finally, with a decision of the Regulator, the special levy paid by the consumers was adjusted to EUR 19.73/MWh on average.

The above measures have had a considerable effect on the deficit of the renewable energy account, with the deficit now on a path to a swift, sustainable and permanent resolution. In particular, by the end March the deficit has contracted to EUR 189 million. Meanwhile, with these measures, according to the calculations of the market operator LAGIE, the cumulative deficit of the RES account is projected to narrow to EUR 128 million by the end of 2014, and in fact turn into a surplus of approximately EUR 100 million in the following year.

Over a longer term horizon and given the backlash against the rising energy costs, it is possible that the support scheme for wind energy changes from feed-in tariffs to feed-in premiums, quotas with green certificates or other market-based schemes. In parallel the

[4] This discount is set: (i) between 34% - 37.5% for PV stations above 100 kW, depending on the connection date (ii) 20% for PV stations up to and including 100kW, and (iii) 10% for remaining RES/Cogeneration stations.

progress of the harmonisation of the RES support mechanisms across the EU and the development of the integrated electricity market will minimise the risk through the diversification of the sources of income of the RES investments which will not be depended only on the national electricity consumption. The cost competiveness of wind energy against other renewable technologies will secure for it a key role in this new environment. In any case, the impact of such a change on the return on new wind investments is not attempted in this study - this would require further analysis, performed when the parameters of such a new system become known.

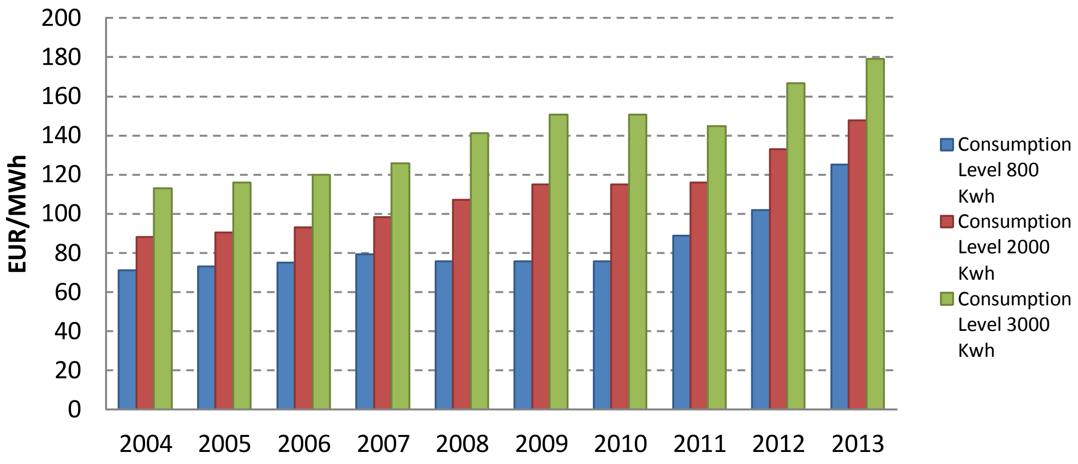
While the investment in wind cannot be considered risk-free, the business risk of wind investment in Greece is still considerably lower, compared with other alternatives. A more relevant comparison, however, for a global entity investing in renewable energy is for projects of the same type among the different broader geographical areas. For wind energy, the areas of interests are currently Europe, USA, Latin America and Far East Asia. Taking into account (i) the privileged characteristics of the development framework of wind energy in the EU, (ii) the lack of link of this framework with the fiscal policies and the public budgets and (iii) the long term commitment of EU towards RES promotion, Europe is by far the less risky location for a wind investment.

3.2.9 Energy prices

The retail prices of electricity have generally showed an increasing trend since the beginning of 2004 (Figure 3.19). It is instructive to note that there was no clear rising trend across consumption categories between 2009 and 2011, despite the addition of wind capacity to the grid. In 2011, the year when wind investment peaked, the rates for a household consuming 800 kWh per year (but not considered financially vulnerable) increased by 17%, however the rates for a household consuming 2000 kWh remained largely unchanged (0.8% growth), while the rates for 3000 kWh consumption actually declined, by 4.1%.

The sharp rising trend that we see across consumption categories was recorded in 2012 and 2013. During this period, the climate change levy that collects revenue for the RES account, maintained by the market operator, for residential consumers increased from 1.95 EUR/MWh in 2011 to 5.99 EUR/MWh in the first seven months of 2012, to 8.74 EUR/MWh in the remaining months of 2012 and to 9.53 EUR/MWh in 2013. Given that the final retail prices increased by about 13-23 EUR/MWh across the consumption categories in both 2012 and 2013, the increase of prices was not primarily driven by changes in the climate change levy. Nevertheless, retail prices would have risen faster, if the cost of the PV boom in 2012-13 was fully passed on to the consumers.

Figure 3.19: Rates for residential electricity consumers in Greece excluding taxes



Source: ELETAEN

The fact that electricity prices did not increase in 2011, when wind investment peaked, but did grow with the PV boom supports the view that higher deployment levels of more mature technologies, such as wind, can actually drive down electricity prices (European Commission, 2014). The RES support schemes increase the cost for retail consumers, however the penetration of renewable sources pushes out of the electricity system expensive electricity generation units (merit order effect) and lowers the price for emission allowances (European Commission, 2014). So far, the level of deployment of RES and the prevalence of PVs in some countries have not allowed the merit order effect to dominate (European Commission, 2014), however higher deployment levels of wind, coupled with support schemes that pass the falling investment cost to prices, could actually have a deflationary impact on electricity prices. Despite the big hikes during the last 2 years, the Greek consumers continue to enjoy relatively cheap electricity, compared with their EU counterparts (Figure 3.20).[5]

Regarding the prices of the energy sources that are used as fuels for electricity generation, the weighted average import price of natural gas fluctuated between 13.69 EUR/MWh to

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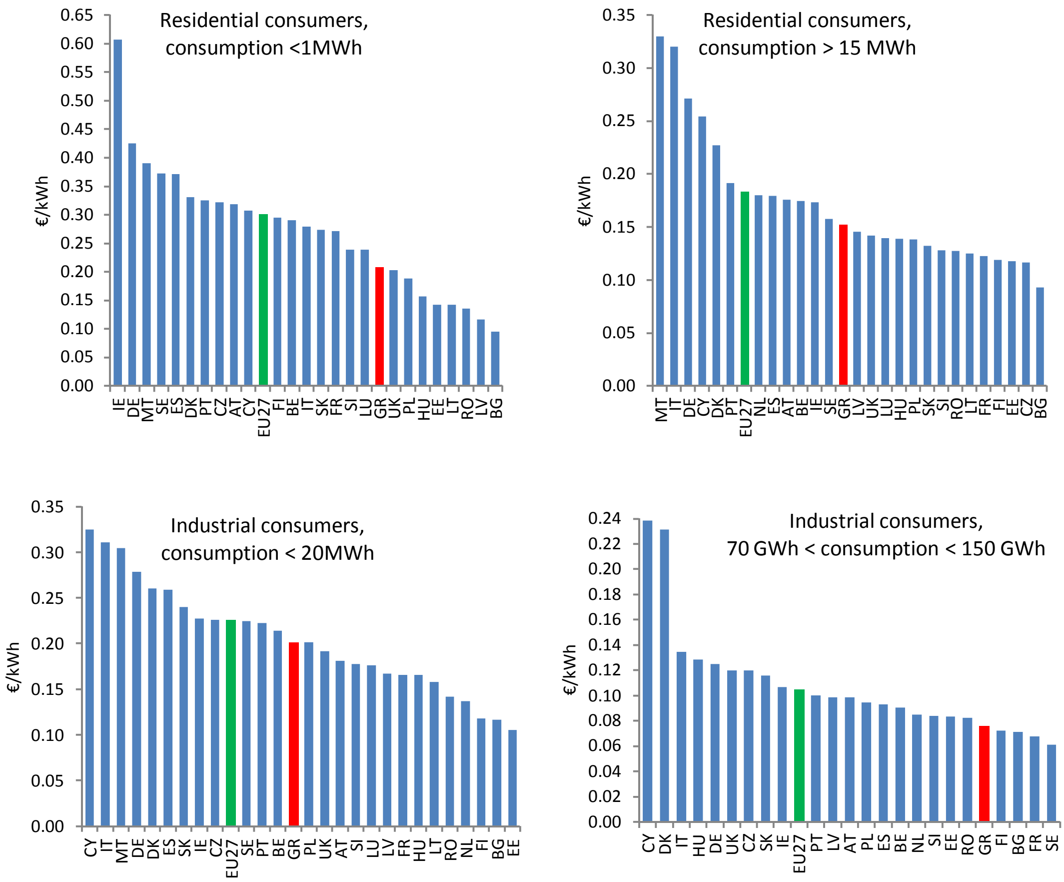
[5] It should be mentioned, however, that very large industrial facilities with continuous production enjoy significant discounts in electricity systems where the participation in the pool is not mandatory and the operation of base load plants at their technical minimum is not guaranteed by the system rules. These consumers can provide the base load electricity producers with guaranteed load, which lowers the risk that the base load plants will occur the heavy cost of switching off their plants during hours of low demand. It is not clear how these discounts are reflected in the average price of a category since it includes consumers with different load profiles (e.g. department stores), while commercial confidentiality and sampling issues may also distort the results.

37.63 EUR/MWh during the crisis years (2008-2013). Given the oil price indexation of gas prices in the long-term contracts through which Greece is primarily supplied, it is not surprising to see that the course of the import price of natural gas has largely followed the prices of oil.

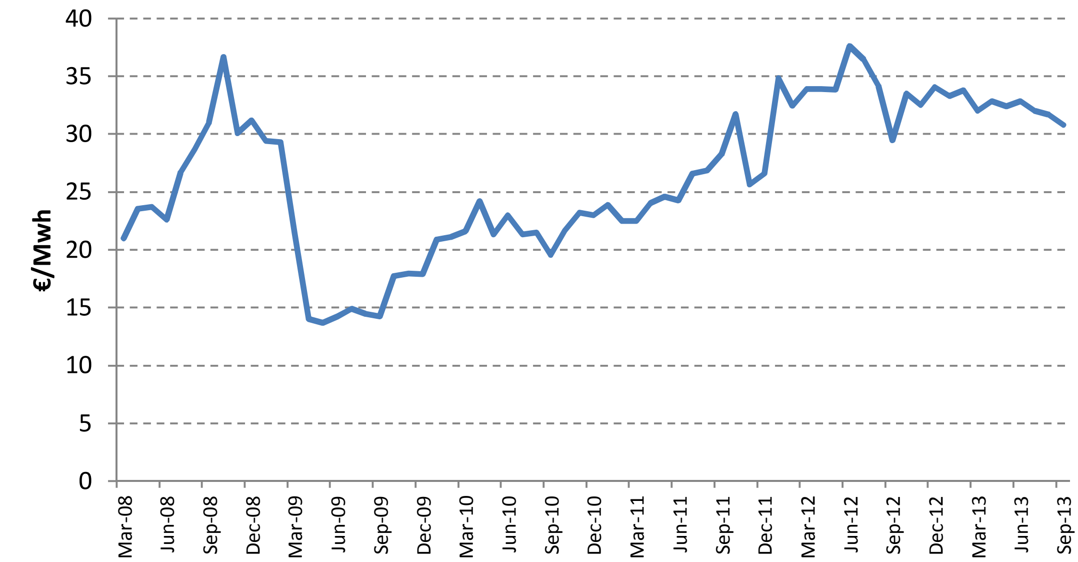
Figure 3.20: Electricity prices including taxes, first half of 2013



Source: Eurostat

In particular, the prices of natural gas fell sharply in early 2009, with a few months delay compared with the fall of crude oil prices when the impact of the global financial crisis on the real economy became evident (Figure 3.21). The price of natural gas has been rising since then, driven by the shaky recovery of the global economy and the turmoil in several important oil producers of Northern Africa and the Middle East (e.g. Libya), caused by the Arab spring events. In September 2013 the natural gas import price stood at 30.77 EUR/MWh, reaching approximately the same level with that observed in September 2008 (30.95 EUR/MWh).

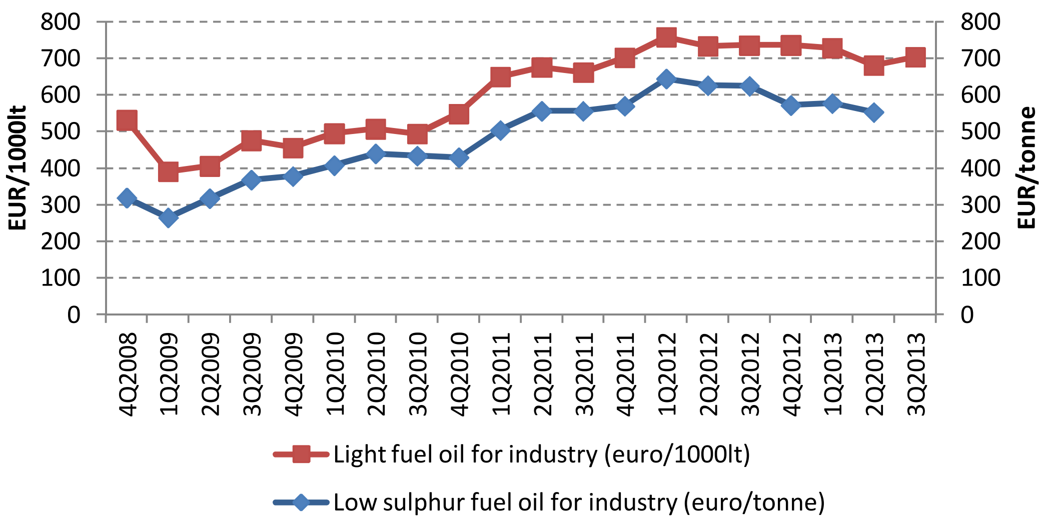
Figure 3.21: Weighted average import price of natural gas, 2008-2013



Source: RAE

The prices of low sulphur fuel oil and light fuel oil for industry, the primary electricity generating fuel source in the non-interconnected islands, have followed a similar upward trend since early 2009 (Figure 3.22).

Figure 3.22: Prices of low sulphur and light fuel oil for industry

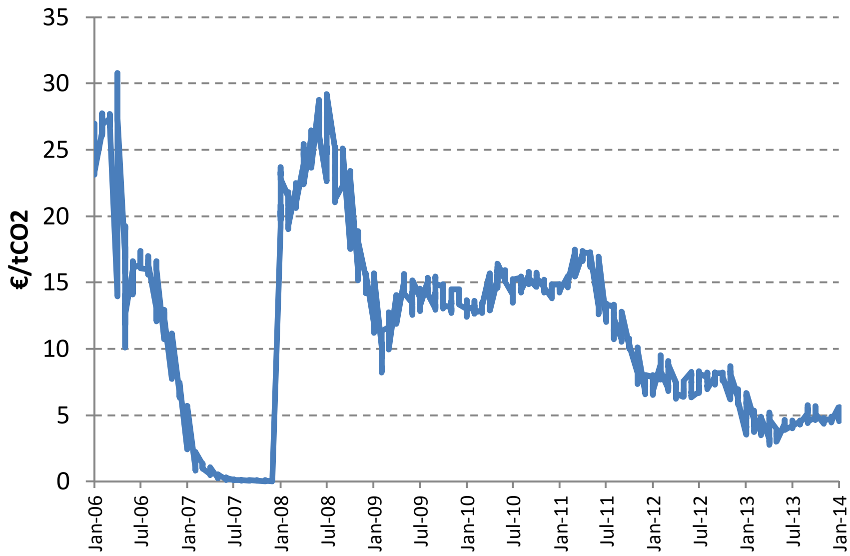


Source: IEA, Energy Prices and Taxes

Finally, although there is no universal answer on how the EU ETS has affected electricity prices, research indicates that 60-100% of the CO_2 price is passed through to electricity consumers.[6] In Greece, since the beginning of 2013, when no longer allowances are handed out for free to electricity generation installations, the main electricity provider is passing fully the cost of obtaining allowances to the retail prices of electricity.

The price of emission allowances has declined from 25 EUR/tCO_2 in September of 2008 to 5 EUR/tCO_2 in January of 2014, mainly due to the impact of the economic crisis in Europe. As the current carbon price is not sufficient to stimulate investment in low-carbon technologies, a number of initiatives were either recently adopted or are currently under preparation to prop up the price of EU ETS allowances. It is worth noting that with carbon prices of around 30 EUR/tCO_2, observed in the recent past, it is estimated that commercially mature renewable energy technologies would not need further subsidies, covering their cost with revenues from selling energy to the wholesale market.

Figure 3.23: Prices of emission allowances ending in December of each year, 2006-2014

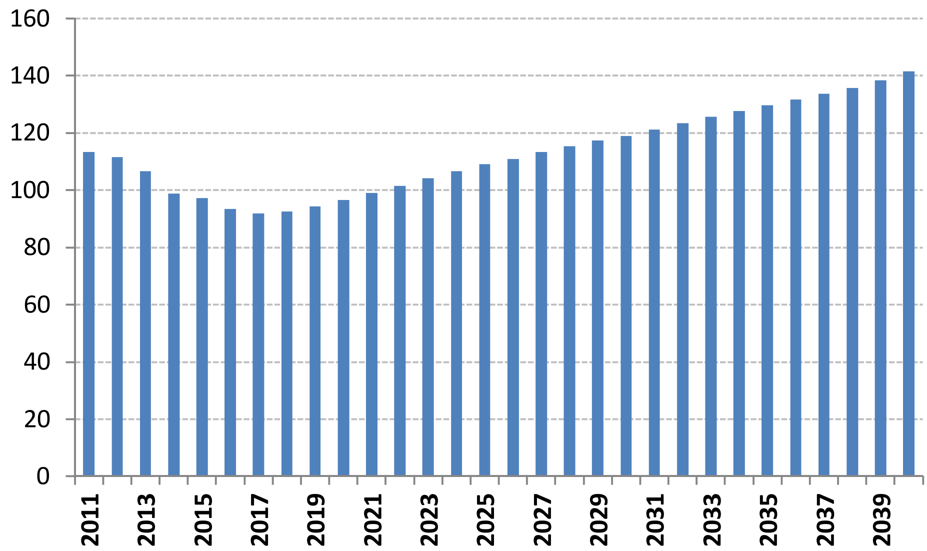


Source: Intercontinental Exchange.

Regarding the future, the energy prices are expected to continue the downward trend in the medium term, picking up again their growth by the end of the current decade (Figure 3.24). In the long-term, over the period 2011-2040, the Brent Spot Price is expected to increase by 0.8% on average (EIA Reference Scenario). Given the learning curve of wind technology, which reduces the levelised cost of wind energy, the tightening cap on greenhouse gas emissions and the forecast for growth of the global oil prices over the long-term, the continuous competitiveness growth of wind technologies is quite likely.

[6] Fabra & Reguant (2013), Sijm et. al. (2006)

Figure 3.24: Brent spot price projection, 2012 USD per barrel



Source: Energy Information Administration, Annual Energy Outlook 2014 Early Release

3.3 Conclusions

During 2010-2013 approximately EUR 6.3 billion were invested in renewable energy technologies in Greece, almost five times as high compared with the investments made during 2006-2009. PV technologies and wind power absorbed the largest share (93% share of total investments in RES over the period 2006-2013), responsible respectively for EUR 5.4 billion and EUR 1.7 billion of investment respectively.

Thus, the investment in wind energy experienced notable resilience in Greece, despite the deep economic crisis. Even though the GDP contraction in Greece began in 2008, wind energy investment continued to increase throughout the first four years of the crisis, exceeding 300 MW new capacity in 2011. In 2012 and 2013, however, new wind capacity fell back to around 115 MW per year. Nevertheless, since the second half of 2012 wind energy investments has shown a return to a growth path.

Within the same period, wind energy financials remained robust. Indeed, the solidarity tax imposed on turnover from July 2012 in effect reduced the feed-in tariff close to its 2008 level. However, the investment cost has fallen substantially since then, with the price of wind turbines per MW of nominal power falling by 27%, with the efficiency/productivity of wind turbines per MW of nominal power increasing significantly in the same period and labour cost decreasing by 11% since their peak in 2009.

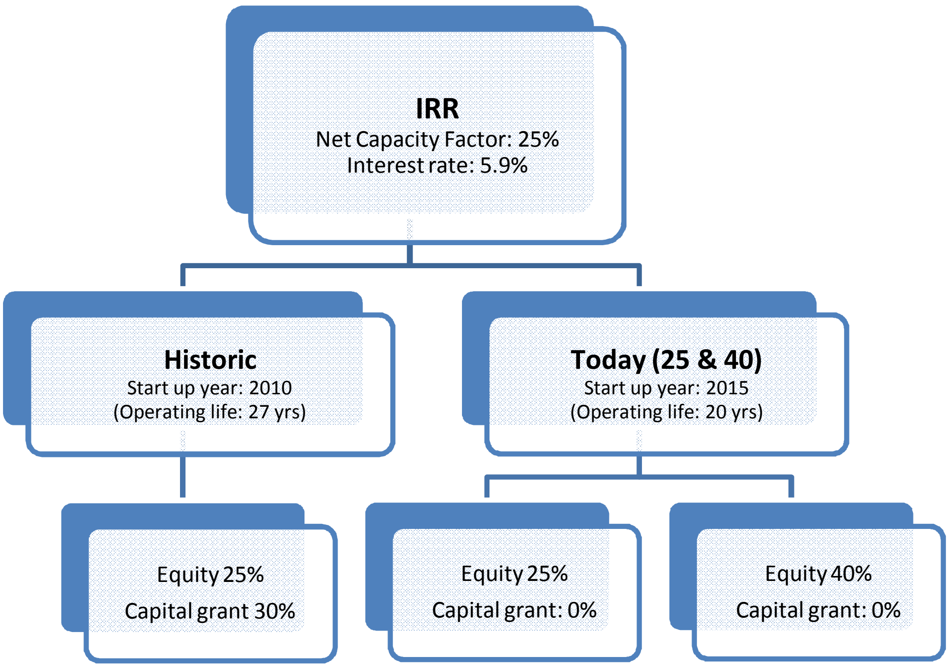
Evidently, the fall of investment in wind energy in 2012 was mostly due to the switch of investor interest to PVs. Bank credit extended to the electricity sector showed exceptional buoyancy until late 2012, despite the overall credit constraints. The prolonged recapitalisation process on the Greek banking system after the PSI limited the ability of the Greek banks to extend credit, which affected the electricity sector as well. Given the boom of PV systems in 2012 and 2013, most of the credit extended to the electricity sector in those years must have been directed to photovoltaics, which enjoyed exceptional returns then due to sharply reduced investment cost and high, but falling, feed-in tariffs. That left little credit available for wind energy investment by domestic financial institutions; however foreign banks continued financing RES projects in the country, sponsored by large international firms.

Furthermore, the deficit of the renewable account due to the PV boom, which was imposing regulatory risks, has now been tackled in a sustainable way and will be eliminated by the beginning of 2015. The relevant risks should in principle concern primarily the photovoltaic producers; however, potential wind energy investors should also be aware that their investment is not absolutely risk-free. Nevertheless, as the return on wind investment today is significantly higher than the very low rates of safe haven assets (the yield on 10-year German bunds stood at 1.8% in December 2013), the premium that they enjoy over the risk-free assets as an award for taking up this risk may well be very rewarding.

4. Investment returns in a typical wind farm

To examine the impact of the economic crisis on the attractiveness of investing in wind energy, we compared the equity internal rate of return for a wind project that enters the grid on January 1st 2010 with a comparable project which enters the grid on January 1st 2015. Given the project lead times from design to production of a wind park, we are essentially comparing projects for which the investment decision has been made in 2008 and 2013 respectively. Two alternatives are considered for the project that enters the grid in 2015. The first assumes that equity accounts for 25% of the investment's cost (Today25), while the second assumes equity use of 40% (Today40), to take into account the difficulty of obtaining debt finance in Greece today (Figure 4.1).

Figure 4.1: Main assumptions



The Historic scenario assumes 25% equity financing and 30% grant, whereas in the Today25 and Today40 scenarios the RES producers, instead of a grant, enjoy a 20% premium on the feed-in tariff. We used the actual historic values of parameters, such as the feed-in tariff, the interest rate and the inflation rate for the period 2010-2013 (Table 7.2 in the Appendix), while for 2014 onwards the assumptions on these parameters are common across the scenarios.

In particular,. we assume fixed interest rate at 5.9% for loans drawn today, along with operating and insurance costs of 13 €/MWh each year and other costs equal to 3% of turnover (Table 7.1 in the Appendix).

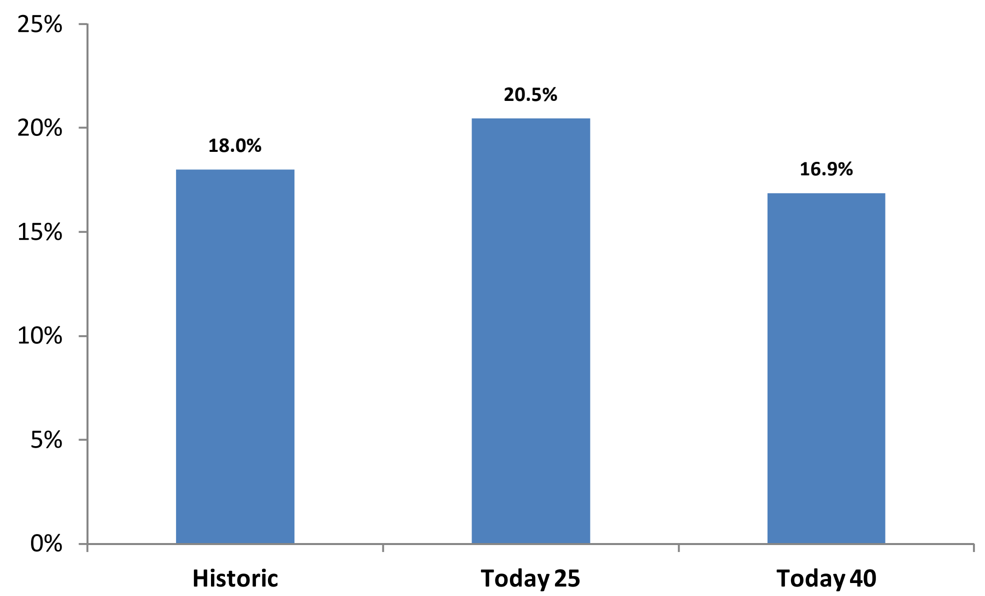
Finally, the net capacity factor of the wind project is assumed at 25%, which is equivalent to a net yield of 2,190 MWh annually. The depreciation rate is set equal to 10% for equipment and 4% for buildings. The total capital expenditure equals EUR 1.4 million in the Historic scenario and EUR 1.2 million in the Today scenarios, to take into account the fall of wind turbine prices.

Finally, the calculations are performed for a period of operation of 20 years for the Today25 and Today40 scenarios, while in the Historic scenario a 27 years project life-time is assumed, following the provision of Law 4254/2014 for a seven-year PPA extension for wind farms in operation for less than 12 years by the end of 2013. According to the new law, existing wind farms in the interconnected system with installed capacity above 5 MW will be paid 86 EUR/MWh, in case they have received a capital grant. Similar wind parks that will join the interconnected system after the entry in force of the new law will receive 105 EUR/MWh in case of no capital grant, for the entire life-time of the project.

4.1 Main results

A project with 25% equity participation today has an equity IRR of 20.5%, which is higher by 2.5 percentage points, compared with a similar project undertaken in the beginning of the crisis (18% in the Historic scenario, Figure 4.2). The difficulty in obtaining capital grants today, which is met by raising more debt capital, boosting consequently the financial outflow, is counterbalanced by higher FiT and lower investment cost.

Figure 4.2: Equity IRR, Historic and Today scenarios



Even in the case where debt finance cannot exceed 60% due to the credit scarcity brought by the crisis, implying that the project requires 40% equity capital, the internal rate of return is slightly lower compared with the Historic scenario (1.1 percentage points). Despite the economic crisis and the lack of capital grants, as long as the wind park investors can secure sufficient leverage with debt finance (at least half of the capital grant of 30%, or at least 60% overall), the financial return on their equity for a project with comparable productivity is at least as good.

4.2 Sensitivity analysis

To take into account the risks faced by a wind energy project, a sensitivity analysis is conducted with regard to changes in major variables (i.e., feed-in tariff, capital expenditure, operating expenses, interest rate and capacity factor) over the range of -20% to +20%.

With respect to the feed-in tariff, further cuts in the foreseeable future are highly unlikely, given that the measures of Law No. 4254/2014 have resolved the issue with the RES account deficit. Nevertheless, for the sake of completeness, we performed a sensitivity analysis with respect to tariffs. In particular, the IRR in the Historic scenario drops by 2.2 percentage points to 15.8% in case of a 10% reduction in the feed-in tariff (Table 4.1).

Table 4.1: Equity IRR, sensitivity analysis

	Low	Intermediate	Base	Intermediate	High
	-20%	**-10%**	**0%**	**+10%**	**+20%**
			Historic		
FiT	13.3 %	15.8%	18%	19.7%	21.1%
CAPEX	25.8 %	21.8%		14.9%	12.4%
Interest Rate	19.6%	18.8%		17.2%	16.4%
OPEX	19.1%	18.5%		17.5%	17.0%
Capacity Factor	11.3%	14.6%		21.4%	24.3%
			Today25		
FiT	11.4%	16.1%	20.5%	25.0%	29.6%
CAPEX	30.3%	24.8%		17.1%	14.2%
Interest Rate	21.7%	21.1%		19.8%	19.2%
OPEX	21.5%	21.0%		19.9%	19.4%
Capacity Factor	12.8%	16.7%		24.3%	28.3%
			Today40		
FiT	10.5%	13.8%	16.9%	20.0%	23.0%
CAPEX	23.5%	19.8%		14.4%	12.4%
Interest Rate	17.7%	17.3%		16.4%	16.0%
OPEX	17.4%	17.2%		16.6%	16.3%
Capacity Factor	11.5%	14.2%		19.5%	22.2%

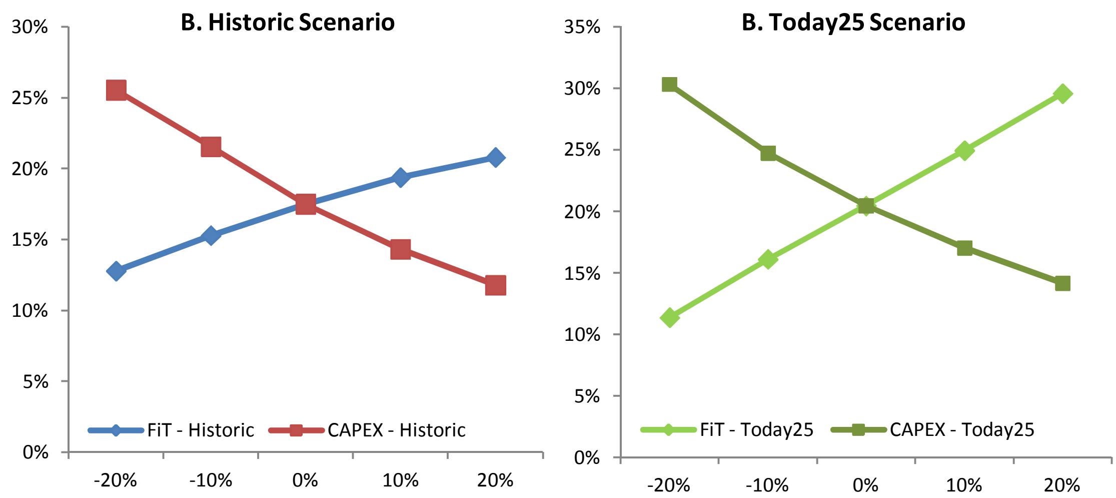
The drop is higher in the Today 25 scenario, where a 10% tariff cut reduces the IRR from 20.5% to 16.1%,. Similarly, the IRR in the Today 40 scenario drops to 13.8% from 16.9%. The larger drop in terms of percentage points in the Today scenarios is explained by the fact that the projects enjoy higher revenues from electricity generation, to compensate for the lack of capital grants compared with the Historic scenario.

An even deeper cut of the feed-in tariff by 20% results in IRR of 13.3% (-4.7 p.p. from the base case) in the Historic scenario. In the Today25 scenario, IRR decreases also by 4.7 percentage points to 11.4%, while in Today40 it drops to 10.5%..

With regard to capital expenditure (CAPEX), the sensitivity analysis indicates a similar impact with the FiT, yet of inverse magnitude (Figure 4.3). In the Historic scenario higher investment cost by 20% implies a fall in the IRR to 12.4%. In contrast, CAPEX savings can have a significant boost in the return of the project since lower costs by 10% yield an IRR of 21.8% (and 25.8% assuming 20% lower investment costs).

Similarly, in the Today 25 case higher investment costs by 10-20% are associated with lower IRR by 3.4-6.3 percentage points compared with the base scenario. In the downside case the analysis indicates an equity IRR of 24.8% and 30.3% respectively for CAPEX reduction by 10% and 20%. The corresponding IRR range for the Today 40 scenario is 12.4-23.5%.

Figure 4.3: Effect of CAPEX and FiT on equity IRR



Meanwhile, the equity IRR is much less sensitive to fluctuations in the interest rate and the operating expenses. With regard to the debt financing cost, in the three cases employed the IRR shows small deviations, up to 1.1 percentage points from the base case. Similarly, higher operating & maintenance costs reduces IRR slightly compared to the base case, with the increase in operating expenditure by 20% generating lower IRR by 0.9-1.6 percentage points.

It is worth noting that IRR is less sensitive to change in the parameters in the Today40 scenario, compared with the other two scenarios. This is due to the fact that in this scenario, the equity IRR is calculated over a larger equity capital outlay. As the equity capital remains fixed at a larger share, fluctuations in annual cash flow have a comparatively lower impact on the equity IRR, compared with the scenarios with lower equity share.

Finally, given the varying productivity of wind farms across different sites, we also performed sensitivity analysis with respect to the capacity factor of a wind farm. In the Historic scenario, the development of a wind project that yields a 10% higher capacity factor increases the equity IRR to 21.4% from 18%, while an increase in the net capacity factor by 20% improves the IRR to 24.3%. In contrast, the selection of a site with lower energy yield by 10% reduces the IRR to 14.6%, while a decrease of the energy yield by 20% (which corresponds to a net wind yield of 2,628 MWh per year) reduces IRR further to 11.3%.

In the Today25 scenario, the project generates an IRR of 24.3% with a 10% higher net capacity factor, while a 20% higher net capacity factor improves IRR further to 28.3%. Correspondingly, the IRR drops to 16.7% and 12.8% in case of lower capacity factor by 10% and 20% respectively. The equity IRR in the Today 45 scenario ranges between 11.5% and 22.2% with respect to variation in the net capacity factor by -20% to +20%.

4.3 Conclusions

The analysis shows that a wind project with 25% equity finance which is expected to enter the grid in 2015 has a higher equity IRR compared with a comparable wind project, which has been conceived in the beginning of the economic crisis. This implies that the higher feed-in tariffs and lower capital expenditure more than compensates the lack of capital grants, provided that sufficient debt finance is available. Even in the case of a higher reliance on equity to 40% due to credit scarcity, the internal rate of return is not lower than the 25% equity project that entered the grid in 2010.

The sensitivity analysis indicates that, even in the case where the feed-in tariff declines further, the IRR remains significantly above the risk-free rate. A CAPEX run-off would have a similar impact with FiT decline, whereas IRR is much less sensitive to fluctuations in the interest rate and the operating expenses. The careful selection of the wind project’s site, with respect to its energy yield, remains the most potent factor, in terms of impact on IRR, among those examined in the sensitivity analysis.

5. Conclusions

The Greek economy is stabilising, in the aftermath of a deep and prolonged contraction. Despite the severity of the crisis, which had a profound impact on investment in the country, the penetration of renewable energy sources accelerated during the years of economic contraction. Wind energy, in particular, experienced an investment boom in 2011, at a time when the sovereign bond spreads were considerably higher than today. Investment in wind fell in the second half of 2012 and has returned to growth since then.

The main reason for having lower investment in wind in 2012 and 2013, compared with the all-time record year 2011, appears to be the boom experienced in photovoltaic technology during these two years. In practice, there is a significant overlap between investors who consider wind and PV investment, as part of a strategy of building a portfolio of renewable energy installations. Hence, the higher return observed for PV in the past two years, driven by the sharp fall in PV panel prices, and the prospect of lower PV feed-in tariffs in the future were the main reasons for the switch from wind to PV. The policy measures to stop the PV boom and limit its impact on energy cost portend stronger interest in wind investment, which perhaps explains the half-on-half growth of wind investment since the second half of 2012, despite the continuous difficulties in the domestic banking system.

Evidently, the economics of wind are to a significant extent isolated from the overall course of the economy. In fact, the return on investment for a project with comparable wind energy characteristics and capital structure today is considerably higher than at the beginning of the crisis. Even if the entrepreneurs cover as much as half of the capital grant that was available before the crisis with equity capital instead of debt, the internal rate of return on equity is still about the same despite the unfavourable change of the capital structure. The reasons for this are the lower capital expenditure, the gains in productivity and the higher feed-in tariffs. Even in the case of lower feed-in tariffs, the sensitivity analysis shows that the premium over placements in safe-haven assets remains high enough and return is slightly higher than the rate expected back in 2008.

The prospects for wind energy in Greece are brightening up. Its main rival as destination of investment funds for renewable energy – PV – has already covered the targets for 2020 and is not expected to attract major funds until it reaches grid parity. The perception of risk for investment in Greece is also subsiding, as evident by the course of the sovereign bond spreads and the general index of the Athens Stock Exchange. The fundamentals have also improved, as the sustained twin deficits that essentially pushed the Greek economy over the edge has turned into small twin surpluses, with the balance of both the primary fiscal account and the current account turning positive in 2013. Meanwhile, the large debt overhang is not creating a serious threat of a payment moratorium, given its exceptionally long average maturity and low average interest rate.

Greece emerges from the crisis with a stronger economy, where many of the significant imbalances of the recent past, especially on the fiscal front and on the front of cost competitiveness, have been corrected. The economy is currently in the look-out for a new model of sustainable growth, centred on investment and exports. Given the imperative to tackle the global warming phenomena, the commercial maturity of wind technology and the healthy return to investors, wind energy could form a significant part of the new growth paradigm of Greece.

6. References

European Commission, 2014. *Energy Economic Developments in Europe*. Brussels.

Fabra, N. and Reguant, M., 2013. *Pass-through of emission costs in electricity markets*. NBER Working Paper No. 19613.

Sijm, J. P. M., K. Neuhoff and Y. Chen (2006), 'CO2 cost pass through and windfall profits in the power sector'. *Climate Policy* 6, pp. 49-72.

7. Appendix

Table 7.1: Assumptions for estimating IRR

	Historic	Today 25	Today 40
State grant	30%	0%	0%
Equity	25%	25%	40%
Long-term loan	75%	75%	60%
Depreciation Rate			
Equipment	*(from 2014)* 10%	10%	10%
Buildings	*(from 2014)* 4%	4%	4%
Duration	27 years	20 years	20 years
FIT (€ / MWh)	*(from 2014)* 86	105	105
Bank loan period	10 years	10 years	10 years
Loan Interest Rate	*(from 2014)* 5.9%	5.9%	5.9%
Investment Cost (€/ MW)	€1,404,830	€1,179,830	€1,179,830
Operating cost (€/ MWh)	€13	€13	€13
Administrative cost (% of annual revenues)	3%	3%	3%

Historic: *A wind project that enters the grid on January 1st 2010 (investment decision made in 2008). We used the actual historic values of parameters, such as the feed-in tariff, the interest rate and the inflation rate for the period 2010-2013 (Table 7.2 below).*

Today25: *A wind project that enters the grid on January 1st 2015 (investment decision made in 2013). Equity accounts for 25% of the investment's cost.*

Today40: *Same as Today25 with Equity accounting for 40% of the investment's cost.*

Table 7.2: Assumptions for estimating IRR in the Historic Scenario for 2008-2013

	2008	2009	2010	2011	2012	2013
Inflation	4.2%	1.2%	4.7%	3.3%	1.5%	-0.7%
Feed-in Tariff	80.14	87.85	87.85	87.85	84.84	80.97*
Interest Rate	5.71%	3.52%	4.27%	5.74%	5.92%	5.87%
Equipment depreciation rate	7%	7%	7%	7%	7%	7%

* In addition, in the estimations the revenue of wind parks for 2013 was reduced by 10% (equivalent to setting the feed-in tariff to 72.87 EUR/MWh), to take into account the recent decision to impose a compulsory discount on the revenue of that year (see par. 3.2.8 for more details).