Renewable Energy Policy Risk and Investor Behaviour
An Analysis of Investment Decisions and Investment Performance

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Abstract

For renewable energies to achieve their market potential and contribute to climate mitigation goals, cooperation between public and private actors needs to be strengthened. Policy plays a paramount role in increasing investors' confidence and decreasing uncertainty. However, the regulatory regime is also perceived by investors as an additional source of risk. A better understanding of the relationship between policy and market actors can lead to improved policy design and to a more balanced estimation of risk.

Distorted risk perceptions may lead in fact to suboptimal decisions and represent additional barriers to renewable energy market growth. Under a microeconomic perspective, biased perceptions vis-à-vis renewable energy technologies and policies can lead investors to overlook promising opportunities. At a macroeconomic level, policies failing to understand the behavioural context in which investors make decisions will not be able to leverage enough capital in the renewable energy market.

Existing literature has emphasised the need for more quantitative studies in this field. The present work represents one of the earliest attempts to fill this gap. Drawing upon a multidisciplinary literature review, a conceptual model has been developed, which investigates the role of a priori beliefs, policy preferences and risk attitudes in influencing the decision to invest in renewables, as well as the relationship between renewable energy share and portfolio performance.

Based on the results of a statistical analysis using multivariate techniques with a sample of 93 European investors, the doctoral work demonstrates that: *i)* cognitive factors have a measurable influence on the decision to invest in renewable energy technologies; and *ii)* there is a positive correlation between the share of renewables and the investment portfolio performance. The study shows which a priori beliefs mostly influence investors' decisions, and how investors perceive policy risk and benefits.

The main implications for scholars, policy makers and investors are discussed, and the main recommendations for future research are drawn.

Keywords: adaptive conjoint analysis, behavioural finance, investments, multivariate regression, renewable energy policy, risk.

Zusammenfassung

Damit erneuerbare Energien ihr Marktpotential ausschöpfen und einen Beitrag zum Erreichen der Klimaziele leisten, muss die Kooperation zwischen öffentlichen und privaten Akteuren verstärkt werden. Die politischen Rahmenbedingungen spielen sowohl für das Vertrauen der Investoren als auch für den Abbau von Unsicherheiten eine herausragende Rolle. Die Regulierung wird jedoch von den Investoren auch als eine zusätzliche Quelle von Risiken wahrgenommen. Ein größeres Verständnis des Zusammenhangs zwischen politischen Rahmenbedingungen und den Akteuren auf dem Markt kann jedoch zu einer verbesserten Politikgestaltung und zu einer verringerten Risikoerwartung beitragen.

Eine verzerrte Risikowahrnehmung kann zu suboptimalen Entscheidungen führen, die wiederum zusätzliche Barrieren für das Wachstum des Marktes für erneuerbare Energien darstellen. Aus mikroökonomischer Perspektive könnten Investoren vielversprechende Investitionsmöglichkeiten von erneuerbaren Energien auf Grund verzerrter Wahrnehmungen der Technologien und politischen Rahmenbedingungen übersehen. Auf makroökonomischer Ebene führen Rahmenbedingungen, die den Verhaltenskontext, in dem Investoren Entscheidungen treffen, nicht berücksichtigen, dazu, dass nicht genügend Kapital im Markt für erneuerbare Energien freigesetzt wird.

Die bestehende Literatur hat die Notwendigkeit für weitere quantitative Studien in diesem Bereich hervorgehoben. Die vorliegende Arbeit stellt einen der ersten Versuche dar, diese Lücke zu füllen. Aufbauend auf einer multidisziplinären Literaturrecherche wurde ein konzeptionelles Modell entwickelt. Dieses untersucht die Rolle von a priori Annahmen, politischen Präferenzen und Risikoverhalten bei der Entscheidung in erneuerbare Energien zu investieren, sowie die Beziehung zwischen dem Anteil erneuerbarer Energien und der Wertentwicklung des Portfolios.

Die Ergebnisse basieren auf einer statistischen Analyse mit multivariaten Verfahren mit einer Stichprobe von 93 europäischen Investoren. Damit belegt die Dissertation, dass: i) kognitive Faktoren einen messbaren Einfluss auf die Entscheidung haben, in regenerativen Energietechnologien zu investieren, und ii) dass eine positive Korrelation zwischen dem Anteil der erneuerbaren Energien und der Wertentwicklung des Investitionsportfolios existiert. Die Studie zeigt, welche vorgefaßten Überzeugungen den größten Einfluss auf Entscheidungen der Investoren ausüben, und wie Investoren politische Risiken und Nutzen wahrnehmen.

Die Hauptauswirkungen der Ergebnisse auf Wissenschaftler, Entscheidungsträger und Investoren werden diskutiert und die wichtigsten Empfehlungen für zukünftige Forschung zusammengefasst.

Stichworte: adaptive Conjoint-Analyse, verhaltensorientierte Finanzierungslehre, Investitionen, multivariate Regression, Erneuerbare Energien-Politik, Risiko.

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1 Introduction

In the World Energy Outlook 2009 (IEA, 2009a), the International Energy Agency delivers an extremely clear and compelling message: current energy policies cannot be maintained if we want to avoid severe consequences for the climate. An “energy technology revolution” is called for, in order to meet the challenging objective of halving CO_2 emissions by 2050 compared with 2005 levels (IEA, 2008a). “The task is urgent; we must ensure that investment decisions taken now do not leave us with inefficient, high-emitting technologies in the long term” (IEA 2009b, page 1). It seems that a new era is about to start, where renewable energy technologies are no longer considered a “Cinderella option” (Grubb, 1990) but are increasingly seen as “survival technologies” (Leggett, 2009).

Renewables have experienced a substantial growth over the last decade, both in developed and developing countries. Nevertheless, they are far from reaching their full potential and still account for a small fraction of the world’s energy industry.

Fostering the transition to a low carbon society requires a significant volume of investments in sustainable energy technologies (Meyer et al., 2009; OECD, 2008; Stern et al., 2006; UNFCCC, 2007). However, mobilizing private capital in this field is particularly challenging in the current economic context, as investors seem to display a certain risk aversion. As pointed out by Saponar (2010), analysts perceive an underweight in the sector as a result of disappointment and structural concerns.

To overcome the current challenges and help increase investors’ confidence more tailored policies are needed. A group of 181 investment institutions which collectively represent assets for 13 trillion US dollars has stated that clear and appropriate long-term policy signals are essential to help investors integrate climate change considerations into decision-making processes and reallocate capital to low-carbon technologies (UNEP FI, 2009). Policies therefore have a crucial role in creating more favourable conditions to increased investments in the renewable energy market, by lowering the risk associated to the investment and guaranteeing a stable framework. As expressed by an anonymous financial consultant “Policies must affect cashflow if businesses are expected to respond. Policy based on political ‘aims’ is in effect asking investors to speculate about political delivery and that speculation, in finance terms, will demand high or venture capital level returns, making these technologies even less attractive” (Hamilton, 2009, page 13).

This evidence seems to corroborate previous findings. For instance, at the Global Ministerial Environment Forum held in Monaco in 2008 policy representatives concluded that the main barrier to investments in greenhouse gas mitigation technologies is not the lack of capital, but rather the lack of appropriate policy packages to attract it (Usher, 2008a). Scaling up investments in the renewable energy requires therefore a deeper understanding of the relationship between policy and market actors, as more effective policies can be designed only if the main drivers of the investment decision making processes are thoroughly captured and assessed.

1.1 Study rationale

For renewable energies to achieve their market potential and contribute to climate mitigation goals, cooperation between public and private actors needs to be strengthened. Both groups play a key role. Policy makers should create incentives to ensure that the necessary investments are undertaken (IEA, 2007). In turn, the private sector must raise substantial financial resources to facilitate the transition towards a low-carbon economy. Policies can play a crucial role in reducing the risk associated to an investment decision, by providing a stable framework and decreasing market uncertainty. This is particularly true in such a relatively young business like the renewable energy market. The lack of familiarity in this specific domain might lead investors to overestimate risks and overlook promising business opportunities. In this respect, policies can correct market failures and help investors get a more balanced perspective. However, it is also true that in policy-driven markets the regulatory regime is often perceived by investors as an additional source of risk. Understanding the relationship between policy and investment by looking at investors' attitudes in the renewable energy investing domain represents therefore a very relevant research topic.

An increasing body of literature has started investigating how policies should be designed to mobilize investments in the renewable energy sector. In particular, several studies at EU level have provided a measure for policy effectiveness. They found that some policies are better than others in achieving the targets by ensuring lower production costs and providing a stable and predictable framework, thus stimulating increased investment flows. However, the majority of studies have focused only on the policy level, while neglecting the investors' perspective. The lack of emphasis on the investors' side is an important shortcoming in current research, as acknowledged in management and finance literature (Bürer and Wüstenhagen, 2008a and 2008b; Russo, 2003; Shleifer, 2000). As highlighted by the IEA (2007) the response of business to policy risk is important to determine the effectiveness of climate and energy policy, and therefore deserves further investigation.

The present doctoral work incorporates the investors' perspective as a relevant unit of analysis. Introducing a new angle of investigation will help to better understand the relationship between policy and investment. This relationship is traditionally seen as being rather unidirectional, with policy makers having the role to set the right framework for investments to flow. As reported in Sonntag-O'Brien and Usher (2004) "financial institutions view themselves more as instruments of change rather than initiators".

However, recent empirical works have provided evidence for a more complex picture. In particular, Bürer and Wüstenhagen (2008a) found that some investors are actively involved in policy development. The shift from the traditional perspective to a more balanced approach looking at the interaction between the two extremes of the relationship is reflected in the diagram below (Figure 1).

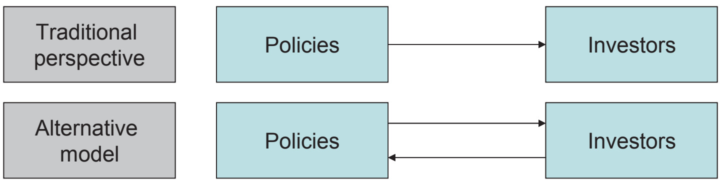


Figure 1: Shift from traditional research perspective to a bi-directional investigation approach

The present thesis intends to advance the knowledge on the link between policy risk and investment behaviour. Specifically, it looks at the impact of policy preferences, technological risk attitudes and a priori beliefs on the decision to invest in renewable energy technologies and its implications on investment performance.

1.2 Methodology and research scope

To help shed light on the investors' perspective, insights from the behavioural finance approach have been taken into account in the literature review. In fact, cognitive and behavioural factors might hinder market's acceptance of renewable energy technology innovation. This can consequently limit the size of investments in this sector and – ultimately – the success of policies. Evidence from scholars and practitioners alike seems to suggest that behavioural aspects deserve more attention in managerial research.

Based on the main research gaps identified in the literature review, the present dissertation incorporates the behavioural finance perspective in the analysis of the renewable energy investment decision making process, and proposes the following research questions:

- Do cognitive factors have a measurable influence on the decision to invest in renewable energy technologies?

The first research question brings along a series of more specific sub-questions, namely:

- How do cognitive factors related to policy perceptions influence the decision to invest in renewable energy technologies?, and
- How do cognitive factors related to technology perceptions influence the decision to invest in renewable energy technologies?

The second research question looks at the link between the share of renewable energy technologies in the investment portfolio and portfolio performance, and is articulated as follows:

- How does the share of renewables resulting from these investment decisions impact the portfolio performance?

To answer these research questions, a conceptual model has been developed, which looks at three main categories of behavioural factors: i) a priori beliefs, ii) policy preferences and, iii) attitudes toward technological risk.

The model has been tested using primary data collected during an online survey with a sample of European investors and analysed through multivariate statistical techniques. Europe was selected as an appropriate empirical context, both for its leading role on climate change and energy policies and because it is the world region that attracted the largest share of new renewable energy investments in 2008 (UNEP and Bloomberg NEF, 2009).

1.3 Expected contribution

The proposed research is expected to contribute to energy policy, management and behavioural finance literature, as well as to provide recommendations for managerial practice. Firstly, introducing cognitive elements in the analysis of policy effectiveness can be very enriching and lead to a more accurate description of the relationship between policy and investment. Thanks to a better understanding of investors' behaviours, the research will help policy makers to design more effective policy instruments to support the deployment of the sustainable energy market.

The analysis of the influence of behavioural factors represents an important contribution also to behavioural finance. As highlighted by Shleifer (2000) "the perception of risk is one of the most intriguing open areas in behavioral finance". By looking at how and to what extent investment behaviours in the renewable energy sector deviate from the expectations of traditional finance theories, the research will provide new empirical insights to support this stream of research.

Furthermore, the research is expected to advance the knowledge on the emerging field of sustainable management research. The existing literature has mostly focused on a restricted sample of investors, namely venture capitalists. By expanding the scope to a broader set of investors operating in the sustainable energy field, this work will contribute to extend previous findings to a broader and more general context.

The present dissertation intends to contribute also to the theory of social acceptance of renewable energy innovation. As observed by Wüstenhagen et al. (2007), while factors influencing socio-political and community acceptance are increasingly recognised as being important in the understanding of policy effectiveness, market acceptance has received less attention so far. By investigating investors' acceptance of climate and energy policies, the present research aims at addressing this gap.

Finally, this theme appears relevant also for practitioners, both incumbents and new operators in the renewable energy market. Cognitive biases in decision-making in fact create additional risk characteristics that restrain the likelihood to raise capital funding for clean energy investments. An analysis of cognitive biases as opposed to more rational elements of policy risks will help financiers to get a more balanced view of policy risks and opportunities in this promising business sector.

1.4 Structure of the work

The study is organized as follows:

- Chapter 2 sets the context for the empirical research, by giving an overview of the main renewable energy market, technology and policy trends, and their expected evolution;
- Chapter 3 reviews the most relevant literature under the framework of the present work;
- Chapter 4 develops the research questions and illustrates the conceptual model elaborated to guide the empirical analysis;

- Chapter 5 explains the research design and the research methods adopted;
- Chapter 6 reports the results of descriptive statistics for the sample analysed;
- Chapter 7 summarises the main results of adaptive conjoint analysis;
- Chapter 8 summarises the main results of the multivariate regression analysis;
- Chapter 9 draws the conclusions and summarizes the main recommendations for future research.

2 The context

The present chapter has the purpose to provide an overview of the main trends and the expected evolution of renewable energy technologies, as regards the following aspects: market growth, investment shares, technological improvements. An analysis of the main policies in place in several world regions is also provided.

2.1 Renewable energy market trends

Over the last years, renewable energy technologies have recorded progressive growth in both developed and developing countries. According to the WEO 2009 (IEA, 2009a) in 2007 non-hydro renewable energy sources contributed to 3% of global electricity generation (500 TWh). Between 1990 and 2007, the share of non-hydro renewables increased from 2% to 4% in OECD countries, and from 0% to 1% in non-OECD countries (mainly in Asia). It is interesting to note that the same WEO in 1994 projected the contribution of non-hydro renewables to reach 191 TWh in 2010, corresponding to 1% of total electricity generation. Although absolute numbers are small, this comparison suggests that renewable energy technologies have experienced an actual increase three times higher than predicted in a relatively short time span, also thanks to the policies implemented in an increasing number of countries.

All technologies have witnessed substantial progresses over the last decade, which have led also to a significant cost decrease. Growth has continued despite the financial and economic crisis which has impacted the market over the last two years. In the following, the main trends for single renewable energy technologies are reported.

2.1.1 Wind

Wind power generation capacity grew by over 30% in 2009 according to the Global Wind Energy Council (GWEC, 2010). This positive trend is triggered by the spectacular growth recorded in the European Union, USA and China. Asia was the world's largest regional market for wind energy in 2009, and China the world's largest market.

The historical trends in wind energy installed capacity in the top 10 countries are displayed in Figure 2.

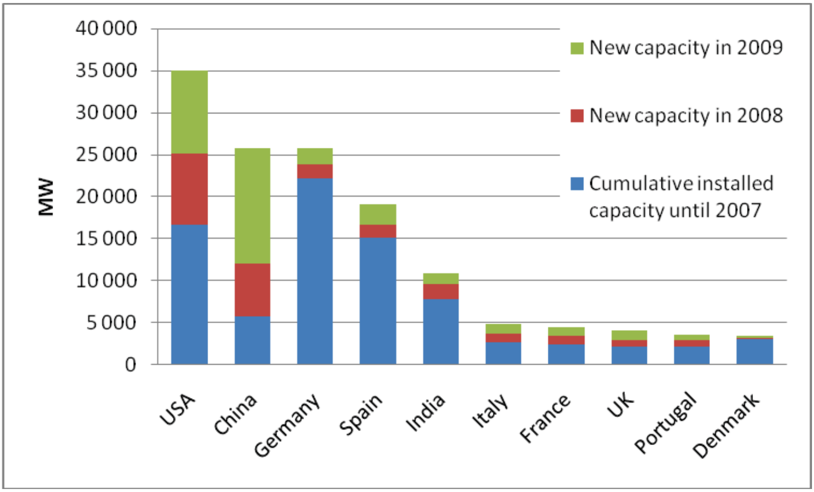


Figure 2: Wind capacity installed in the top 10 countries [Source: own elaboration based on GWEC (2009 and 2010)]

As far as the EU countries are concerned, new generation capacity in 2009 reached over 10 GW, with an annual average market growth of 23% over the last fifteen years (EWEA, 2010). Wind installations represented 39% of total generating capacity added in the EU in 2009, more than any other generating technologies.

As reported by the IEA (2009b), since the early 1980s the cost of onshore wind turbines has decreased by around a factor of three. This technology is expected to enjoy further cost reductions thanks to technological innovation. By 2050, onshore wind should face a total cost reduction of 23% compared to current levels, with learning rates of 7%[1].

2.1.2 Solar PV

Although smaller than wind in absolute values, solar PV capacity is experiencing a dramatic rise. PV is the fastest growing renewable energy technology, with a fourteen-time capacity increase in the last 10 years, and an annual average growth of 30% over the same period. In 2009, global cumulative capacity reached 20 GW, therefore even surpassing the optimistic "policy-driven scenario" target for 2010 elaborated by the European Photovoltaic Industry Association (EPIA, 2009). Indeed, in 2009 global

[1] A learning rate of 7% means that capital costs decrease by 7% for every doubling of cumulative installed capacity.

capacity additions exceeded 7 GW, the largest volume of solar PV ever added in one year (REN21, 2010).

In Europe, solar PV accounted for 16% of all new electric power capacity additions last year. The cumulated installed capacity of solar PV in the top 10 countries is reported in Figure 3.

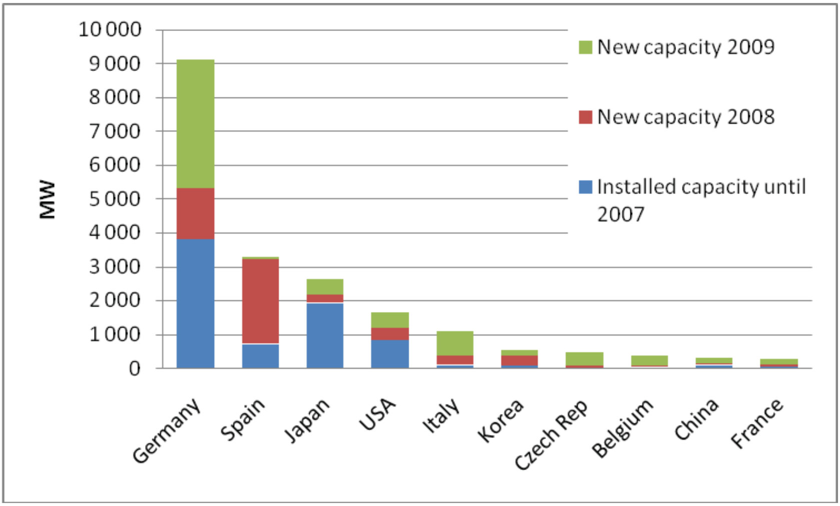


Figure 3: Photovoltaic capacity installed in top 10 countries [Source: own elaboration based on EPIA (2010)]

Analysts foresee even higher growth rates in the next four to five years. According to the latest outlook from EPIA, the world PV market could increase up to 30,000 MW per year by 2014 (EPIA, 2010). The IEA asserts that, with effective policies in place, solar PV could supply 5% of world electricity by 2030 and 11% by 2050 (IEA, 2010a). This means that by 2050 solar PV is expected to equal wind in terms of contribution to electricity generation (Frankl and Philibert, 2009).

Such promising outlook is also related to a rapid cost decrease, with learning rates ranging between 15% and 22% (EPIA, 2009; Neji, 2007). System prices and electricity generation costs are expected to fall by more than two-thirds by 2030 (IEA, 2010a). These estimates suggest that even solar photovoltaics, which is currently one of the most expensive renewable energy technologies, should achieve market competitiveness in the next 10 to 20 years thanks to a series of technological improvements and economies of scale compared to traditional, fossil-fuel based technologies.

2.1.3 Concentrating Solar Thermal Power

After a gap of more than 15 years, the Concentrating Solar Thermal Power (CSP) market has begun to expand rapidly. Total current capacity in operation is only around 700 MW, but there are thousands MW of CSP under development worldwide, led by programmes in Spain and the US (IEA, 2009c). If appropriate policies are adopted and dedicated transmission lines are developed, CSP could become competitive for base-load electricity generation by 2030 and produce up to 4,600 TWh per year in 2050 (IEA, 2010b). Together, PV and CSP could represent up to 20% to 25% of global electricity production by 2050 (Tanaka, 2010).

2.1.4 Other renewable energy technologies

Other renewable energy technologies recorded more modest growth rates (3-6%), although in some countries more sustained trends were observed (REN21, 2010).

As for non waste biomass, approximately 56 GW of power capacity was in place at the end of 2009 (REN21, 2010). Europe's gross electricity production from solid biomass has tripled since 2001. Leading countries are the Scandinavian region, Austria and Germany. Significant growth in biomass power is also seen in a number of developing countries, including Brazil, India, Mexico, Thailand and Tanzania (REN21, 2010). According to the IEA (2009a), cumulative capacity of biomass and waste is expected to grow by at least 5% per year up to almost 150 GW in the coming two decades.

Geothermal capacity has increased by almost 2 GW since 2004, with an average annual growth rate of 4%. By the end of 2009, total capacity of geothermal power plants totaled approximately 11 GW, distributed in 24 countries. Almost 88% of that capacity is located in seven countries: the US, the Philippines, Indonesia, Mexico, Italy, New Zealand and Iceland. It is projected that other eleven countries – all located in Europe and the Americas – will add geothermal plants by 2015, with global capacity reaching 18.5 GW (REN21, 2010).

The IEA Energy Technology Perspectives (ETP) "BLUE Map Scenario", which aims at an energy-related CO_2 emissions decrease of 50% by 2050, envisages a world geothermal electricity generation of 1,000 TWh per year by that date (IEA 2008a), i.e. almost 15 times higher than the current production.

Hydro remains by far the largest source of renewable electricity, with around 3,100 TWh produced in 2007 from a 920 GW capacity, representing almost 16% of total world electricity supply (IEA 2009a). An estimated 35 GW capacity was added in 2008 and a further 31 GW during 2009, leading to more than 980 GW by the end of 2009, including 95 GW of small hydro and more than 127 GW of pumped storage capacity (REN21, 2010). The top-five countries in terms of installed capacity are China, the US, Brazil, Canada and Japan. Hydropower potential remains significant, but its exploitation is limited by environmental constraints, resettlement impacts and the availability of sites. The latter are expected to be concentrated in Brazil, China, India, Malaysia, Russia, Turkey and Vietnam (REN21, 2010). Despite constraints, the ETP "BLUE Map Scenario" projects a doubling of electricity production, up to almost 5,300 TWh per year by 2050 (IEA, 2008a).

Boosted by supporting policies in OECD countries, the global demand for liquid biofuels more than tripled between 2000 and 2007, reaching a share of around 1.5% of total transport fuel demand (IEA, 2009d). The leader in biofuels is Brazil, which introduced its first biofuels policy in the seventies, and where sugarcane ethanol represents more than 50% of fuel demand for light duty vehicles. Although having a much lower share on total domestic demand, the US became the largest world producer of ethanol (from corn) in 2006. On its turn, biodiesel accounted for the vast majority of biofuels consumed in Europe. EU countries, driven by Germany, are the world leaders in biodiesel production. Altogether, the share of biofuels on total energy demand for transport in IEA countries increased by almost a factor six from 0.4% in 2000 to almost 2.4% in 2007 (IEA, 2009e).

These very rapid growth trends have considerably slowed down over the last two years however, as a consequence of the emerging concerns on the sustainability profile of biofuels. Their future deployment will depend on the capability to rapidly develop the production of the so-called second generation biofuels from non-edible biomass feedstocks, in particular from wooden and agricultural residues. Considerable research efforts have been put in place in OECD countries and major emerging economies and the technological and economical potential is promising (IEA, 2009d).

Against these trends, global growth rates for fossil fuels have been of about 3-5% in recent years (REN21, 2010).

2.1.5 Expected evolution of the RE market

The crucial role of renewable energy technologies in future energy scenarios is confirmed by the long-term projections taking into account climate mitigation constraints. In such "alternative scenarios", assuming at least a 50% reduction of CO_2 emissions by the half of the century, renewables are expected to account for a significant share of total primary energy supply, to become the largest source of electricity production and to be the second largest contributor to CO_2 emissions abatement after energy efficiency.

According to the IEA ETP 2008 "BLUE MAP" Scenario projections (IEA, 2008a), the share of renewables in the power sector is expected to increase from the current 18% to almost 50% by 2050. Non-hydro technologies would show the highest growth rate, with a twenty times increase in the next forty years. Of these, solar is expected to grow over 400 times compared to current levels. The same scenario projects liquid biofuels (produced exclusively from sustainable sources) to supply 25% of total fuel demand in the transport sector by 2050.

The scenario elaborated by Greenpeace International and EREC (2008) is even more optimistic. Within the "energy [r]evolution scenario", also thanks to massive energy efficiency measures, renewables are projected to cover 60% of primary energy demand and contribute to 77% of electricity generation by 2050. Also in this case, the growth rate of non-hydro technologies would be the most sustained one. In particular, solar technologies would show a three-thousand time increase compared to 2005 electricity production levels.

Other studies focus exclusively on the European context, and argue that a full decarbonisation of our electricity production systems is possible with the technologies already available, provided that a series of policy and financial measures are implemented and that grid stability is enhanced. For example, the roadmap issued by the European Climate Foundation (ECF, 2010) shows the path to be followed in order to meet the G8 objective of cutting CO_2 emissions by at least 80% below 1990 levels by 2050. The document clearly highlights that achieving this target will require a profound transformation of the European electricity generation industry which should become nearly carbon-free.

The report points out that achieving this shift is technically feasible but will require fundamental changes in regulation, funding mechanisms and public support. The document also stresses that the transformation of the European power sector would yield economic and sustainability benefits, while securing and stabilizing Europe's energy supply.

However, the 2050 goals will be attained only if concrete actions are taken within the next five years. In particular, continued uncertainty about the business case for sustained investment in low-carbon assets will impede the mobilization of private sector capital. In order to stimulate a radical change, the roadmap includes a series of policy imperatives for the next five years.

Similarly, the recent 100% Renewable Electricity Roadmap for Europe and North Africa issued by Pricewaterhouse Coopers (PWC, 2010) underlines that no fundamental technology breakthroughs are required to achieve such a vision. Reaching a 100% renewable electricity goal in the two regions will rather require a sound evolutionary development of the economic, legal, and regulatory framework.

The roadmap depicts a 2050 vision in which the electricity supply system in Europe and North Africa is entirely based on a renewable energy source mix optimised per region, with mainly wind in Northern Europe, solar in North Africa, biomass in the Baltic and Eastern Europe and hydro in the Alps and Scandinavia. It also envisages a strongly reinforced and interconnected grid system, aligned and cooperative energy policies and a unified European electricity market united with the North African market.

The last EREC report "Re-thinking 2050" shows an even more aggressive scenario envisaging a fully renewable energy mix (and not just the electricity mix) for the European Union by 2050 (EREC, 2010). In this scenario the share of renewable electricity in final demand increases four times from current 10% up to 41% in 2050, mainly driven by wind and solar PV.

Furthermore, the scenario shows a massive increase of bioenergy, geothermal and solar for renewable heating and cooling supply, with the three sources accounting together for 45% of final energy demand in 2050. Another 10% would come from renewable transport fuels, totalling a 96% contribution to final energy demand in 2050.

The report highlights a large set of economic, environmental and social benefits stemming from a 100% renewable energy vision in the EU. These include security of supply and avoided fuel costs, avoided CO_2 emissions costs, cumulative investments and employment creation.

A synthesis of the expected trends reported in each scenario projection is provided in Table 1.

Table 1: Synthesis of the main scenarios depicting the projected growth of RES by 2050

Scenario	Scope	Target
IEA ETP 2008 "Blue Map"	Global	About 50% of RES in the electricity generation; 25% of biofuels in total fuel demand in the transport sector by 2050
EREC "Energy [r]evolution"	Global	60% of RES in the primary energy demand by 2050; 77% of RES in the electricity generation
ECF	Europe	Decarbonisation of the electricity industry by 2050
PWC	Europe and North Africa	100% electricity from RES by 2050
EREC "Re-thinking 2050"	European Union	96% of RES in final energy demand by 2050

Whatever exact shares of renewable energy will be actually reached by 2050, all these scenarios illustrate very clearly that renewable energy technologies have an enormous potential which is far from being fully exploited. Nevertheless, encouraging trends have been observed over the last years in terms of increased investment flows in the renewable energy market, as discussed below.

2.2 Investment trends

Investments in renewable energy technologies were still negligible until the early 2000s. As reported by UNEP and Bloomberg New Energy Finance (2009), in 2002 new investments in sustainable energy totalled 22 USD billion, of which non-governmental expenditures represented a minor share. Since then, sustainable energy investments have recorded a substantial growth, reaching almost 150 USD billion in 2007 (almost a seven-fold increase). It has been estimated that, from 2002 until the end of 2009, the green energy market has attracted more than USD 650 billion cumulatively (Bloomberg NEF 2009a; UNEP and Bloomberg NEF, 2009). The years 2006 and 2007 have experienced double-digit growth, whilst 2008 and 2009 have been affected by the consequences of the global financial crisis, which has impacted the clean energy market both directly (through a liquidity squeeze) and indirectly (via a general fall in global energy demand associated with lower oil and gas prices).

More specifically, total investments still slightly grew in 2008 (+5%), reaching an all-time record of 155 USD billions. After stalling in the first quarter of 2009, investment activity in clean energy rebounded in the rest of the year and survived the crisis, dropping only marginally to USD 145 billion at the end of 2009, as shown in Figure 4. Indeed, while some early announcements in 2009 were predicting a general fall in renewable energy investments by as much as 38% (IEA, 2009f), the consolidated results show that the drop was much more limited – about 7% - and that a sharp recovery was experienced in the second semester (Liebreich, 2010).

Even taking into account the slow-down in the last years, the overall period 2002-2009 showed an average annual growth rate of investments of more than 30% per year.

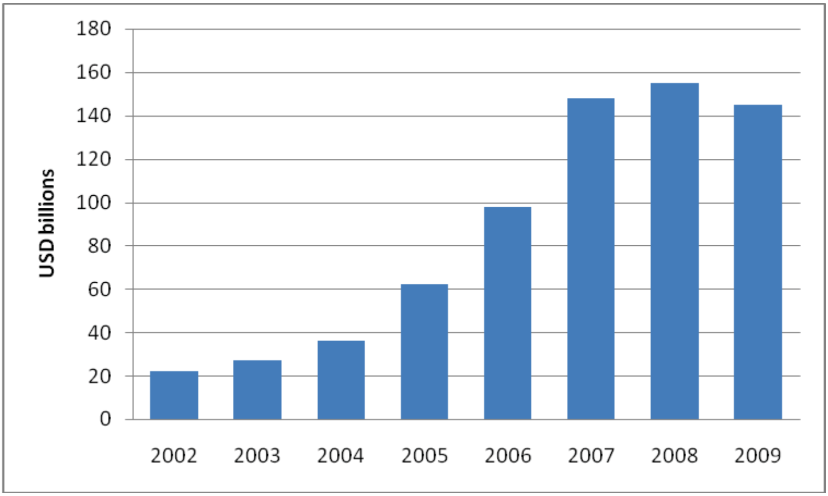


Figure 4: Global new investment in sustainable energy 2002-2009 [Source: own elaboration on data from WEF 2010 and UNEP/NEF 2009]

The outlook for 2010 is positive; the figures available for the first quarter indicate that investments were 31% higher compared to the same period of 2009, confirming the optimistic trend projected (Bloomberg NEF, 2010). The main reasons are the impressive growth of wind farms worldwide, and the dynamic renewable energy market development in Asia, mainly in China, that compensated also for investment decline in Europe and North America in

2009. In addition, many governments have launched green fiscal measures that have contributed to moderate the fall of investments in this industry and increase investors' confidence. Total budget available is estimated at around 180 USD billion, of which more than 50 USD billion is committed to renewables. As pointed out by Liebreich (2010), only a minor share (about 9%) of the total clean stimulus package was spent in 2009 while roughly two thirds of the total budget should be spent during 2010 and 2011, thus contributing to give a new impulse to renewable energy investments. Analysts forecast a record investment in clean energy for 2010, expected to reach USD 200 billion and possibly to continue growing beyond that level (Liebreich, 2010; WEF, 2010).

Apart from economic stimulus programmes and green fiscal measures established by governments, this growth trend is also spurred by technology improvements which have resulted in increased reliability and declining costs of most renewable energy options.

Looking more in detail at the investment trends per each technology some important differences can be observed.

2.2.1 Wind

Wind has continued to attract the highest share of new investments year after year, thus confirming its status of mature technology. Over the five year period 2004-08 wind absorbed around 160 USD billion, i.e. around 45% of total investment in clean energies (UNEP and Bloomberg NEF, 2009). Despite the economic downturn, investments in wind assets grew further to more than USD 603 billion in 2009, with a 13% increase compared to the previous year (REN21, 2010). This corresponds to more than 60% of total global investment in clean energy in 2009 (REN21, 2010). In the EU, for the second consecutive year, investment in wind was larger than in any other energy technology. Investment in wind farms in 2009 totalled €13 billion, of which €11.5 billion in the onshore wind and €1.5 billion in the offshore wind power sector (EWEA, 2010).

2.2.2 Solar

The second most important renewable technology was solar (mainly PV), attracting around 70 USD billion, i.e. 20% of the total over the period 2004-2008, with an increase of more than 50 times with respect to the investment level in 2004 (UNEP and Bloomberg NEF, 2009). In 2009, total investments dropped in absolute terms. This was the consequence of several factors, the main of which being the fact that offer of PV systems became larger than demand thanks to augmented manufacturing capacities and larger supply of purified silicon feedstock. Combined with the financial crisis, difficult access to debt finance, and the collapse of the solar PV market in Spain after a major change in its support policy, this led to fierce competition, reduction of margins and a very significant drop in average selling prices of PV modules and systems (up to 50%), i.e. of specific investment costs per watt. In fact, the PV market continued to expand in 2009 and is expected to grow further in the coming years (EPIA, 2010).

2.2.3 Other renewable energy technologies

The biofuels sector suffered the strongest drop, with decrease in spending of over 60% compared to the previous year and total investment returning to the level of 2005. This was due to a combination of factors, including lower oil prices and unfavourable market conditions for the US ethanol industry, the credit crunch and high sugar prices in Brazil. However, the outlook for ethanol remains positive in both countries (REN21, 2010). On the contrary, the European biodiesel continued to stagnate and its outlook is hampered by difficult economic conditions and new regulations, either already imposed or expected.

As far as other renewable energy sources are concerned, while biomass and waste experienced an increase in investments, small hydro, geothermal and marine energy faced difficulties in raising the necessary capital to secure projects.

2.2.4 Role of different financing sources

Private investments have become the largest source of capital for renewable energy projects. The bulk of investments in the private sector has come from four sectors: venture capital, private equity, public capital markets and investment banking.

Venture capital is a major source of funding for new technology-based firms and a decisive determinant of entrepreneurship and innovation (OECD, 2007). Venture capital financing for renewable energy boomed during 2006/2008, particularly for PV and biofuels, exceeding USD 3 billion worldwide in 2006 (REN21, 2008) and reaching almost USD 4.5 billion in 2008 (UNEP and Bloomberg NEF, 2009). North America leads in venture capital investment, with a share of around 55% of the world's venture capital in clean energy during the period 2006-2008.

Summing up the contribution of venture capital and private equity investors, the total flow of investments into clean energy reached USD 7.5 billion in 2007 and its record level of 11.8 USD billion in 2008. After the third quarter of 2008 however, venture capital and private equity investments fell dramatically down to their minimum in the second quarter of 2009, due to the financial crisis. Although they recovered in the second half of the year, they totalled USD 6.6 billion, i.e. down 44% on 2008, remaining below 2007 levels (WEF, 2010). The trend seems now upwards again, with a number of venture capital and private equity managers closing new funds ready for investment in 2010 (WEF, 2010).

The volume of clean energy investment on the public market grew dramatically from less than 1 USD billion in 2004 to its all-time peak of 25 USD billion in 2007. In 2008, public market new investment came back to roughly the same level of 2006, i.e. around 13 USD billion (WEF, 2010).

In early 2009 investments came to a complete standstill, due to peak of the financial crisis. However, the market rebounded in the rest of the year, finishing only slightly below the 2008 investment level. Decreases in public offerings in Europe and the US were compensated by a significant increase in fund raising in Asia, particularly in China and Taiwan (WEF, 2010).

In the whole period 2002-2009, the financing of renewable assets accounted for the bulk of new investment in clean energy. Asset financing ramped up globally from 6 USD billion in 2002 to 50 USD billion in 2006, doubling again up to 97 USD billion in 2008[2]. In that year, wind and solar accounted for almost three quarters of total investments (respectively 44% and 28%). In total, renewable power absorbed 83% of asset financing, biofuels 14%, with the rest being shared between energy efficiency and other low carbon technologies (UNEP and Bloomberg NEF, 2009).

Asset financing was hit by the financial crisis because of both lower conventional energy prices squeezing margins, and scarcer and more expensive capital. As for other investments, asset financing had a low-peak in the first quarter of 2009. It rebounded in the remaining months ending at a level of 92 USD billion at the end of the year, i.e. 5% lower than in 2008 (WEF, 2010). Again, investment decrease in Europe and Americas was offset by increasing volumes in Asia.

Green economic stimulus measures certainly helped the recovery, although this factor should be not overestimated, as only approximately 10% of committed money was actually spent in 2009 (Liebreich, 2010). However, the current level of investments remains well below the amount needed to effectively curb CO_2 emissions. Investments will need to increase up to 500 USD billion by 2030, according to WEF (2010).

[2] Excluding project refinancing and small/residential projects.

2.3 Main policies

Specific targets and dedicated policy measures have been set by several countries worldwide to support the deployment of renewable energy technologies. REN21 (2010) estimates that more than 80 countries have established renewable energy policies. There is a great variety of schemes and implementing measures, but two main broad categories can be identified (IEA, 2008b):

Investments support schemes, which include amongst others, capital grants and tax exemptions; and

Operating support schemes, like for example: price subsidies, quota obligations and green certificates, tender schemes and tax exemptions.

Operating support schemes can be further classified in price-based and quantity-based mechanisms. Feed-in tariffs (FIT) are the most widely used price-based support mechanism and are adopted by 50 countries and 23 States/Provinces all over the world (REN21, 2010). Under such schemes, renewable electricity fed into the grid is rewarded with a guaranteed tariff (total price per unit of electricity) for a determined period of time, which usually ranges between 10 and 20 years.

More recently, Feed-in premiums (FIP) have been introduced as a more market-oriented support instrument. In such a scheme, a premium price is paid to the electricity producer on top of the normal electricity market price. Both feed-in tariffs and feed-in premiums are usually technology-specific incentives, i.e. a different tariff is paid for each specific renewable electricity technology. In order to encourage renewable electricity technology cost reductions and reflect economies of scale and technology learning, a decreasing level of tariff/premium can be set.

Historically, feed-in tariff schemes have been the primary price-based policy instrument used to support the development of renewable in Europe (Papadopoulos et al., 1999). This type of renewable energy support scheme was adopted by Denmark in the 1980s and by Germany and Spain in the 1990s, and is now the most popular system being adopted by 21 EU Member States[3]. The United States enacted a national feed-in law already in 1978 (REN21, 2010).

[3] More specifically, three countries offer the choice between feed-in fixed prices and premiums, and one Member State uses a pure premium incentive (EC, 2008).

A third typology of price-based mechanisms is represented by fiscal incentives, such as tax exemptions or reductions. A typical example is the exemption from carbon taxes.

As for quantity-based mechanisms, these are mainly represented by quota obligation systems (also called Renewable Portfolio Standards) and tendering schemes. In countries adopting quota obligation systems, producers and/or distributors are mandated to supply a certain share of their electricity – the target quota fixed by the government – from renewable energy sources. In many countries, so-called tradable green certificates (TGCs) are used to prove compliance with the obligation and to render the market more liquid: obligated parties can either invest directly in renewable assets or buy green certificates from other producers or suppliers. If they fail to do both, they must pay a penalty. TGCs are generally considered more market-oriented mechanisms, as their price is determined on the market. However, TGC prices strongly depend on policy-makers decisions related to quota targets, penalties, and the duration of the obligation.

Quota obligations and TGCs are technology-neutral support mechanisms and are meant to promote the most cost-efficient renewable energy technologies first. However, recognizing that less mature technologies also need support, several countries have recently introduced so-called “technology banding”, i.e. differentiated quota or incentives per technology. Quota system policies exist at the national level in 10 countries, and have been adopted by 52 among provinces, states and countries worldwide (REN21, 2010). In the EU, six Member States have implemented a quota obligation system with tradable green certificates (Ragwitz, 2010).

Finally, under tendering schemes a call for tender is issued by a national government or other institution for the provision of a certain amount of renewable electricity. The bidding determines competitively the price and winning parties are usually offered standard long-term purchase contracts.

Tenders usually specify the capacity and/or production to be achieved and can be technology- or even project/size specific (Ecofys, 2008). In the EU, this type of policy scheme was adopted by the United Kingdom, Ireland and France, but it was replaced by quota scheme in the United Kingdom in 2002, and by premium feed-in tariff in Ireland in 2000. It is now used only in France and to support offshore wind in Denmark (Weller, 2008).

There have been several changes in the renewable energy support schemes adopted by the EU countries over the years, with feed-in tariffs being replaced by quota systems or vice versa. For example, Belgium adopted a feed-in tariff scheme for renewables until 2002, when it was replaced by a quota system with tradable green certificates. The Netherlands introduced a quota system with tradable green certificates in the mid 1990s, which lasted until the year 2000 and was then replaced by feed-in tariffs in 2003. In other EU countries two or more technology-specific support schemes co-exist, as reported by Ragwitz (2010).

3 Theoretical background and literature review

The previous chapter has set the context for the present study, by providing an overview of the current status of renewables and their expected evolution, based on the main technology, market, investment trends and the policy support measures in place. In the present chapter, all these elements are discussed under a theoretical perspective. Three main bodies of literature which are relevant to the empirical work are presented: i) studies investigating the link between investments in renewables and financial performance; ii) studies analyzing the role of public regulators and the effectiveness degree of policy measures, and iii) studies applying the behavioural finance perspective to investigate the role of cognitive factors in influencing the investment decision making process.

3.1 Renewable energy investments and financial performance

As shown in the previous chapter, investments in renewable energy technologies have increased steadily over the last years, and have survived the economic downturn better than many had expected (UNEP and Bloomberg NEF, 2010). Some experts recognise that low carbon technologies can offer tremendous opportunities to overcome the current crisis thanks to the numerous environmental, economic and societal benefits they incorporate (Deutsche Bank, 2008; IEA, 2009f; Ragwitz et al., 2009). Fulton (Deutsche Bank, 2008) identifies a “safety net effect” for clean energy investments determined by government regulations, which ensure a built-in advantage over most other sectors in the long term. Furthermore, the IEA called for a “Clean Energy New Deal” to exploit the financial and economic crisis as an opportunity to induce a permanent shift in investments to low-carbon technologies (IEA, 2009f).

As scientific evidence on human-induced climate change becomes more robust, and consensus over the urgency and the necessity of taking action is reached, practitioners and policy makers are provided with a number of dedicated tools for financial analysis and decision making. Comparative studies on the performance of renewable energy investments versus traditional assets are also becoming common. These studies show that, in recent years, investments in renewable energy technologies have lead to superior performance compared to more traditional investments (Bloomberg NEF, 2009b; Deutsche Bank, 2009). Providing an explanation for this phenomenon, by clarifying the underlying relations between renewable energy investments and financial performance, would represent a useful theoretical contribution and would also help policy makers design more effective policies to attract further investments in this area. Unfortunately, management scholars have somewhat overlooked this topic so far.

Given the lack of studies specifically addressing the link between renewable energy investments and financial performance, some useful insights can be obtained from studies in related fields, such as those examining the relationship between environmental performance and financial performance. Scholars seem to suggest that there is a positive relationship between the companies' involvement in environmental and social activities and their financial performance (Cohen et al., 1995; Dowell et al., 2000; Hart and Ahuja, 1996; Porter and van der Linde, 1995; Reinhardt, 1999; Russo and Fouts, 1997). However as King and Lenox (2001) point out, correlative studies offer only a partial picture to corporate managers and policy makers, because they do not indicate the direction of causality. These authors therefore call for additional research in this area, to explore how underlying firm characteristics affect the relationship between environmental performance and financial performance. This view is shared by Weber et al. (2005) who state that while the positive correlation between environmental performance and financial performance is widely accepted, the strength of the correlation and its genesis are still often unclear.

A second shortcoming in the literature on renewable energy investments and financial performance is that the evaluation of the profitability of various renewable energy technology investment options is based on outdated and inappropriate models, which create additional economic and financial obstacles to the growth of renewables (Awerbuch, 1996; Dinica, 2006).

Some scholars argue that renewable energy technologies are already competitive vis-à-vis their fossil alternatives, and that their value is not correctly disclosed by levelised cost comparison techniques. This leads to a systematic overestimation of the costs of renewable-based electricity compared to the fossil alternatives (Awerbuch, 2003a and 2003b). Current valuation models do not correctly reflect the real value of alternative technologies, since they do not take into account a series of benefits of renewable energy technologies compared to fossil fuel sources (Wright, 2002). As a result, traditional accounting models tend to favor expense-intensive technologies over capital-intensive technologies. As highlighted by Kaplan (1986) accounting-based cost analysis often suggests that the incumbent technology is to be preferred over the innovation. This might lead investors to overlook promising technological solutions due to a lack of understanding of the real value of the innovation. In the case of renewables these benefits include reduced externalities, favourable risk profiles, flexibility in the production and distribution process, modularity and reversibility, amongst others. By ignoring these important attributes investors and energy planners systematically underestimate the real value of renewable energy technologies.

In order to provide a more balanced approach, a new stream of research has evolved which uses portfolio theory approaches (Markowitz, 1952) to evaluate technology alternatives. Awerbuch (2000) suggests that renewable energy technologies should not be compared based on stand-alone costs but should be rather evaluated on the basis of portfolio cost. This is defined as a technology's cost contribution relative to its risk contribution to a portfolio of generating resources. By applying this approach, the scholar finds out that a renewable energy technology as solar photovoltaics contributes to reduce overall portfolio risk even though it costs more on a stand-alone basis (Awerbuch, 2000). Therefore, investment and energy planning decisions should be taken on the basis of the evaluation of alternative resource portfolios rather than stand-alone costs.

The application of portfolio theory approaches in the energy field has led to insightful results. For example, Awerbuch and Berger (2003) have investigated how renewable energy sources can contribute to risk reduction in a mixed portfolio. The two authors suggest that adding wind, solar photovoltaics and other fixed-cost renewables to a portfolio of conventional generating assets leads to decreased overall portfolio cost and risk, even though the stand-alone generating costs of renewables may be higher. For example, in the analysis the authors report levelised annual busbar costs for wind used of 3.97 US cents/KWh, or 1% higher than nuclear, 26% higher than steam coal, 34% higher than oil and 44% higher than combined cycle gas turbines. However, when looking at single cost components, it can be seen that variable costs related to fuel and variable operation and maintenance account for 70% in the case of gas, whereas they are zero for wind, which is characterized by relatively high (and riskless) capital and no fuel and variable operation and maintenance costs. The analysis suggests that if risk-adjusted generating costs are used, renewables are most cost effective, thus resulting in efficient portfolios with lower fossil fuel shares.

This finding has very relevant implications both for investors and energy planners. As far as the former are concerned, renewable energy technologies can be used in a portfolio diversification strategy in order to hedge against fossil price fluctuations. Regarding the latter, renewables are found to be beneficial under a macroeconomic perspective. Lind (1982) describes renewable energy investments as a form of national insurance, since they help reduce the volatility of oil and gas. Along the same lines, Awerbuch and Sauter (2006) suggest that renewable energy technologies can help maintain macroeconomic growth by avoiding GDP losses due to oil price volatility.

Portfolio theory has been adopted more recently for energy planning purposes. For example, Roques et al. (2009), apply portfolio theory approaches to assess optimal wind power deployment in Europe, by identifying optimal wind power portfolios across a number of EU countries. Similarly, Muñoz et al. (2009) have developed a model for minimizing investment risk and maximizing the return of a renewable energy technology portfolio in Spain. An overview of the most recent research applying portfolio theory to energy planning is provided by Bazilian and Roques (2008).

All these literature contributions suggest that investment decisions should be evaluated not only with respect to their capacity to support one specific renewable energy technology, but, also, with respect to their ability to guarantee a sufficiently diversified technological environment, in which radical innovations can be developed, nurtured and, eventually, bloom. Furthermore, it is important to understand how different factors affect renewable energy investment decisions not only at an aggregated level, but, also, on a technology-by-technology base because factors or policies that may favour the deployment of one specific technology, may not necessarily be useful to support other renewable energy options.

From this literature review, several indications for research can be derived. Firstly, the relationship between renewable energy investments and financial performance remains still underexamined and the strength of the correlation is often unclear. Therefore more studies are needed in order to help clarify this point. Secondly, aggregate models based on traditional engineering economics do not capture the real value of renewables. This leads financiers to underestimate renewable energy projects because of the high upfront investments they require, despite the higher-long term potentials.

The present work intends to complement and extend this literature, by examining how cognitive elements and behavioural factors and attitude towards technological risk influence an actor's willingness to invest in renewable energy projects, by altering their perception of risk.

3.2 Effectiveness of policy instruments

Government intervention in the renewable energy market is essential to ensure that new technologies are given the possibility to compete with traditional energy sources in a more level playing field and to correct negative externalities associated to the use of fossil fuels.

Policies can play a crucial role in reducing the risk associated to an investment decision, by providing a stable framework and decreasing market uncertainty. As pointed out by Ecofys (2008) “commitment, stability, reliability and predictability are all elements that increase confidence of market actors, reduce regulatory risks, and hence significantly reduce the cost of capital”. Langniss (1999, pp.112) adds “in policy development, mitigating risk is certainly an alternative to raising the level of compensation”. Indeed, risk mitigation and risk reduction are important issues of concerns for investors; since lowering risk leads to a reduction in the cost of capital, risk reduction can make a larger number of projects attractive and lead to a more sustained growth of renewable energy technologies. Therefore the role of policy makers is to set a predictable and stable framework in order to send clear signals to market operators.

However, the relationship between policies and investment flows is not straightforward. Sometimes even ambitious policy targets are not able to catalyse investments. Even worse, the policy framework is sometimes perceived as a potential risk factor per se. In fact, policies and supporting measures can also change, thereby affecting the profitability of investments. As most markets for clean technologies are regulated under policy schemes, this risk is of particular importance for renewable energy technologies (Ecofys, 2008).

An increasingly relevant body of literature is investigating the role of public regulators, by looking at how policies should be designed to stimulate the growth of renewable energy innovations. Early disputes mostly focused on the effectiveness of different policy support systems in achieving policy objectives and on their overall cost-efficiency. The literature analysis carried out does not provide enough support to establish which support scheme is superior for promoting the diffusion of renewable energy technologies.

For instance, several authors (Lipp, 2007, Menanteau et al., 2003, Mitchell and Connor, 2004; Mitchell et al., 2006) have highlighted the positive role of feed-in tariffs in leading to an increase of the renewable energy share by lowering the risk associated with the investment decision. This positive effect of feed-in tariff encourages the financial participation of smaller and more risk-averse investors by creating lower-risk investment conditions (Hvelplund, 2005). Other studies provide support to the hypothesis that feed-in tariffs are a more effective policy scheme, compared to market-based approaches (Blok, 2006; Butler and Neuhoff, 2004; Contaldi et al., 2007; Couture and Gagnon, 2010; Madlener and Stagl, 2005; Meyer, 2003; Morthorst, 2000; Ragwitz and Huber, 2005; Rowlands, 2005 and 2007; Sawin, 2004; Sijm, 2002). In contrast, other analyses (e.g.: Lesser and Su, 2008) indicate that if not properly designed, feed-in tariffs can turn to be economically inefficient since they require policy makers to make significant guess-work as to future market conditions and rates of technological improvement. Therefore if feed-in tariffs are set too high or last too long, there will be inevitably a welfare loss for society (Lesser and Su, 2008). Liebreich (2009) points out that the hidden costs of feed-in tariffs may offset their benefits by determining liabilities in the long term. And indeed, some experts have criticized the German feed-in tariff scheme for being "unduly expensive" between 1990 and 1999 (Federal Economic Ministry's Advisory Council, 2004; in: Butler and Neuhoff, 2004).

Tradable green certificates have been introduced as an alternative to feed-in tariffs in some EU countries since they were considered to retain the potential to induce investments in the renewable energy sector in a more cost-efficient way in a liberalized energy market framework (Connor, 2003; Espey, 2001; Lauber, 2004; Morthorst, 2000 and 2001; Nielsen and Jeppesen, 2000 and 2003; Voogt et al., 2000; Wang, 2006). However, some research has highlighted a series of significant drawbacks characterizing quota-based models. For example, Fouquet and Johansson (2008) explain that the failure of the British Non-Fossil Fuel Obligation (NFFO) programme was not only due to lack of planning permissions as pointed out by the European Commission, but also to the fact the prices were too low compared to power generation costs. Additionally, tradable green certificate systems tend to favour the least costly renewable energy options, thus slowing down the innovation pace. They also increase investor risk since the income stream to be generated is highly uncertain and may change considerably over time. This issue is of particular importance, since the renewable energy market is mostly composed of small and medium size investors. Similarly, Mitchell and Connor (2004) conclude that the NFFO did not deliver deployment nor technology diversity and was mostly beneficial only to large companies.

Bergek and Jacobsson (2010) have analysed the Swedish experience in the implementation of a tradable green certificates system throughout the period 2003-2008. The main lessons learnt are that this market-based mechanism has proven to be effective and cost-efficient under a societal perspective. However, the system has not been efficient in terms of guaranteeing low consumer costs and has also led to overcompensation to power producers, unlike suggested by economic theory. Another drawback of the tradable green certificate scheme in Sweden is that it has favoured the more mature renewable energy technologies, which can better compete in a mass market.

As highlighted by Menanteau et al. (2003) incentive schemes for renewables have the purpose to allow them to progress on their learning curves and to be adopted beyond narrow niche markets. In this respect, the Sweden tradable green certificate scheme has not met expectations regarding its capability to stimulate technology development.

Lorenzoni (2003) made an ex ante evaluation of the Italian tradable green certificate system, by identifying a series of unclear aspects in the policy design which determine market uncertainty and increase the risk perceived by investors.

An analysis of the implementation of tradable green certificate systems in Sweden, the United Kingdom and Flanders made by Jacobsson et al. (2009) confirms that this type of scheme tend to favour incumbent companies, mature technologies and to generate high levels of excess profits.

The European Commission has adopted diverging attitudes as to the capability of price-based and market-based mechanisms to ensure renewable energy market deployment. In 1999, it issued a working paper (EC, 1999) which advocated the implementation of quota-based systems. As reported by several authors (Bergek and Jacobsson, 2010; Fouquet and Johansson, 2008; Lauber, 2004), the EC preferred tradable green certificates over feed-in tariffs as they were considered to be more competitive according to economic theory and to be more in line with the EU single electricity market objectives. Few years later, the EC issued a report on the support of renewable electricity (EC, 2005). This document concluded that so far feed-in tariffs have proven to be not only effective but also the most cost-efficient renewable energy support scheme.

To reconcile these contradictory results, scholars and researchers are increasingly proposing hybrid combinations of the two systems, in order to guarantee low investment risk and to attract a broad spectrum of investors while at the same time maintaining competition, avoiding windfall profits and stimulating technology innovation. This can be done, for example by introducing some elements of competition in the feed-in tariff model (Lesser and Su, 2008; Muñoz et al., 2007) through feed-in premiums – with or without electricity price index - or by applying technology banding to green certificates systems (Bergek and Jacobsson, 2010). Technology banding has been introduced already in some EU countries like Italy, Romania and the United Kingdom (Ragwitz, 2010).

As the literature review suggests, there is increasing evidence that policy effectiveness should be measured along a wider set of attributes than the type of renewable energy support scheme implemented. Indeed, as highlighted by Haas et al. (2004, page 838): “There is no single, universally applicable ‘best’ support mechanism or policy for the bundle of different technologies known as RES. A mix of policy instruments needs to be tailored to the particular RES and the specific national situation to promote the evolution of the RES from niche to mass markets. This policy mix needs to evolve with the technology”. The authors add: “More important than the choice of the system is the proper design and monitoring of the support system adopted; in this respect, the functionality, stability and continuity of a policy-support system are crucial features”. Del Río González (2008) points out that the success of the feed-in tariff in Spain is due to the broad political commitment which has provided a signal of stability and certainty to investors.

A study conducted by the IEA (IEA, 2008b) has found that feed-in tariffs and tradable green certificates can be equally effective in promoting the renewable energy market depending on the technology and on some country-specific conditions. It is rather the adherence to key policy design principles and the coherence of policy measures which determine the effectiveness and efficiency of renewable energy policies. This analysis confirms previous findings (Held et al., 2006), which have already highlighted the important role of long term policy frameworks to enable the successful deployment of renewable energy technologies, by providing clear signals to the market.

These analyses suggest that effective policies result from a comprehensive design, which takes into account several attributes including, not only the type of renewable energy support scheme in place, but also the level of the incentive provided, the duration of the support, the administrative framework, and social acceptance.

In this respect, Ragwitz (2010) highlights that non-economic barriers are relevant but the quantitative relation with the effectiveness has not been yet fully understood. This finding represents a very relevant rationale for the current work.

The IEA identifies five key principles for effective policies aiming at fostering the transition of renewable energy technologies towards mass market integration (Tanaka, 2008). The two highest priorities in the short term are to remove non-economic barriers to improve market functioning and establish predictable and transparent support frameworks in order to attract investments.

At the same time, it is important to ensure that incentives progressively decrease over time in order to foster and monitor technological innovation and move rapidly towards market competitiveness. Finally, in view of a massive large-scale diffusion of renewables due consideration must be given to their impact on overall energy systems in terms of system reliability and overall cost efficiency.

Another important outcome of the IEA study is that specific support measures should be developed in order to target renewable energy technologies with different degrees of maturity. This is in line with previous recommendations by scholars (e.g.: Christiansen, 2001).

While these studies have focused mostly on the policy level, other empirical works have started incorporating the investor's perspective into the picture, so as to understand the attitude of financial actors vis-à-vis the various policy instruments available. In particular, an investigation of the relationship between renewable energy policy design and financing has been made by Wiser and Pickle (1997). In their report, the authors conclude that well designed policies can reduce renewable energy costs dramatically by ensuring revenue certainty which, in turn, contributes to reduce financing risk premiums. More recently, Dinica (2006) has taken an investor-oriented perspective to analyse the diffusion potential of support systems for renewable energy technologies. In her paper, she claims that "classifications and analyses of support instruments' characteristics are mainly made from the perspective of policy makers". She also adds that "the way financial aspects of support systems are described is also not sufficiently suggestive with regard to attracting potential investors".

Bürer and Wüstenhagen (2008a, 2008b and 2009) have surveyed a sample of 60 venture capital and private equity funds to analyse investors' preferences for different types of support schemes. Along the same lines, Lüthi and Wüstenhagen (2009) have examined the influence of a set of policy attributes on the investment decisions of a sample of European PV project developers.

These empirical works provide further evidence that policy targets and the accompanying policy instruments deployed at the national, regional and global level have a strong influence on the investors' decision to allocate capital to renewable energy projects. The mentioned studies have the clear merit of shedding further light on the relationship between policies and investment decisions by incorporating the investors' perspective into the picture. In this respect, they represent an important step towards a better understanding of the relationship between policy instruments and investment decisions. The present work intends to complement and extend this literature, by examining how cognitive elements and behavioural factors influence an actor's willingness to invest in renewable energy projects. This is an important contribution, because incorporating these factors can provide a much more accurate description of the relationship between policies and investments, thus helping the design of better and more effective policy instruments.

3.3 Behavioral factors affecting investment decisions

Mainstream finance approaches build upon the market efficiency principle. This concept was first introduced at the beginning of the XX century by Bachelier but was largely overlooked until it was taken up again by the neoclassical economist Paul Samuelson in the late 1950s. In its classic formulation provided by Fama (1970) the efficient market hypothesis states that in efficient financial markets prices fully reflect the available information at any given time. The fact that rational agents share the same amount of information at any given time makes it impossible for any investor to “beat the market”, ergo to out-profit the others. This also implies that prices are not predictable, but rather follow a “random walk” (Samuelson, 1965).

Three degrees of market efficiency are assumed (Fama, 1970). The weak form hypothesis posits that no excess returns can be achieved by using investment strategies based on historical price series. In a weak-form efficient market current share prices are the best, unbiased, estimate of the value of the security. The semi-weak form affirms that prices adjust to publicly available new information very rapidly and in an unbiased fashion, such that no excess returns can be earned by trading on that information. Finally, the strong form states that superior returns are not possible even in the case an investor knew inside information that is not yet available to the market. This is because the insiders’ information quickly leaks out and is incorporated in the prices.

Rationality of agents is at the heart of market efficiency theory, and is embodied in the two axioms of completeness and transitivity of preferences. Rational agents update their beliefs according to Bayes’ law.

It is worth highlighting that the theory admits occasional deviations from rationality but even in the case some investors do not behave fully rationally, the market as a whole is maintained in equilibrium thanks to arbitrage (Fama, 1965; Friedman, 1953).

Market efficiency and the two closely related theories of expected utility and subjective expected utility (Savage, 1954; von Neumann and Morgerstern, 1944) have become the paradigmatic approach to describe rational behaviour under uncertainty and have provided the foundation for prescriptive approaches to decision making (Raiffa, 1968 and Keeney and Raiffa, 1976; in

Einhorn and Hogarth, 1986). They constitute the building blocks for the development of the capital asset pricing model (Lintner, 1965; Markowitz, 1952; Mossin, 1966; Sharpe, 1964) and therefore for the theory of investor behaviour under uncertainty.

However, over the years an increasing body of literature has been questioning the capability of market efficiency and utility theory to provide logical answers to a series of phenomena which provide evidence for non perfect rationality of economic agents. One field of research which has emerged as an alternative to the traditional market efficiency approach is “behavioural finance”.

This discipline has developed out of the pioneering work of Herbert Simon (1957), who coined the term “bounded rationality”. The author proposed a behavioural model of rational choice, by pointing out some cognitive limitations of decision makers. The bounded rationality approach has been further refined in the 1970s by Amos Tversky and the Nobel Laureate Daniel Kahneman. The two authors applied a cognitive psychology perspective to analyse the most common misperceptions in many decision-making processes. Their work focused on the exploration of the systematic biases that separate the beliefs that people have and the choices they make from the optimal beliefs and choices assumed in rational-agent models (Kahneman, 2003). Based on a series of experiments and simulations, they found that people tend to rely on a series of heuristics when making judgements under uncertainty. Although these heuristics are quite useful in decision making, sometimes they can lead to severe and systematic errors in assessing the probability of events (Tversky and Kahneman, 1974).

In a famous work (Kahneman and Tversky, 1979), the two scholars identify a series of behaviours that are inconsistent with the axioms of expected utility theory. Firstly, people are found to underweight outcomes that are merely probable in comparison with outcomes that are obtained with certainty (certainty effect, or Allais paradox). This finding explicitly contradicts expected utility theory’s assumption that utilities of outcomes are weighted by their probabilities. Secondly, people are found to suffer from a reflection effect, which leads to risk seeking attitudes when choosing between negative prospects, and risk aversion when selecting between positive prospects. The preferences observed in both domains contradict expected utility theory principles as well. Thirdly, in order to simplify choices between alternatives, people often disregard components that are shared by all alternatives under consideration and focus on those components that differentiate them (isolation effect). This can lead to a reversal of preferences that violates again expected utility theory.

To better incorporate these deviations from full rationality, the two authors propose a prospect theory, in which value is assigned to gains and losses rather than to final assets and in which probabilities are replaced by decision weights. Another insightful finding of Tversky and Kahneman's observations is the influence of framing on decisions which represents an additional dilemma under a pure rational choice theory perspective (Tversky and Kahneman, 1981).

As opposed to efficient market theory, behavioural finance argues that individuals are not fully rational (Akerlof and Yellen, 1987; Barberis and Thaler, 2003; Miller, 1977). It also argues that they do not deviate from rationality randomly, but rather that most agents do so in similar ways. The main merit of behavioural finance is to add a human dimension to financial market analysis. Indeed, as highlighted by Shleifer (2000), the emphasis on investors is entirely foreign to traditional finance.

Once considered heretical, behavioural finance has now become mainstream. Both scholars and practitioners acknowledge the need to take into account the limits of rationality in decision making (Lovallo and Sibony, 2010). Behavioural finance approaches have been applied to underline a series of market "anomalies" including the limited effects of arbitrage (Froot and Dabora, 1999; Rosenthal and Young, 1990; Shleifer and Vishny, 1997), volatility of prices (Shiller, 1981), overreaction and underreaction phenomena (Barberis at al., 1998; Daniel et al., 1998; De Bondt and Thaler, 1985), the equity premium puzzle (Barberis et al., 1999; Bernantzi and Thaler, 1995; Jegadeesh and Titman, 1993; Mehra and Prescott, 1985), underperformance of mutual fund managers and pension fund managers relative to passive investment strategies (Malkiel, 1995), market's reaction to non-information (Cutler et al., 1991; Roll, 1984), amongst others.

The empirical evidence brought forward by these studies has challenged to various extents the weak, semi-strong and strong efficient market hypothesis illustrated above.

Defenders of traditional finance models reject these findings and attribute results to operationalisational problems and non-accurate methodological techniques. In particular, market overreaction and underreaction are plausible phenomena within certain conditions. In fact, the efficient market hypothesis does not exclude the possibility of short-term, occasional anomalies that might lead an investor to outperform the market. However, these anomalies occur randomly, so they should be attributed to chance rather than to market inefficiency. In other terms, such phenomena are to be reconducted within the framework of the probability law.

Over the years, an intense debate has been ongoing between representatives of the two schools of thought (a good overview is offered for example in Sewell, 2007). In particular, while Fama (1998) reiterates that market efficiency survives the challenges from behavioural finance and states that the alleged anomalies observed have perfectly rational explanations, Shleifer (2000) sees these anomalies as having rather behavioural explanations.

According to Einhorn and Hogarth (1986) both utility theory and its alternatives present some weaknesses in capturing three main elements which characterize risky decision making. These are: i) the nature of uncertainty in choice, ii) the effects of context, and iii) the dependence between probabilities and payoffs. Their main criticism is that gambling as the dominant metaphor used to conceptualize decision under risk is not a perfect proxy for real world contexts. In addition, people are highly sensitive to contextual variables, so that changes in context can strongly affect the evaluation of risk. Furthermore, payoffs can affect the weight given to uncertainty, particularly under ambiguity. This is defined as an intermediate stage between ignorance and risk. They argue that "uncertainty about uncertainties", or ambiguity, is a pervasive element of much real world decision making.

An opponent of the behavioural finance perspective is also Gigerenzer. In a series of publications he criticizes the approach of Kahneman and Tversky by raising objections at three levels: empirical, methodological and normative (see the review carried out by Vranas, 2000). One of his strongest arguments is that Kahneman and Tversky use atheoretical and rather vague terms to label the observed heuristics, and this impedes developing a convincing explanation on how these heuristics generate biases. He rather highlights the importance of investigating the cognitive processes that underlie judgement under uncertainty.

Contradictory findings are found also by behavioural finance scholars. For example, Osborn and Jackson (1988) and Thaler and Johnson (1990) found that past success leads to a willingness to take risks. Staw et al. (1981) observed that when individuals are threatened by likely losses they become more risk averse. These findings are in net contrast with the prospective theory of Kanheman and Tversky. In their turn, March and Shapira (1987) report a series of empirical studies which suggest that risk taking attitudes are not connected to adversity in the simple way described by Kanheman and Tversky.

Some scholars try to recompose the contradictions observed by combining the complementary views of both approaches. For example, Wiseman and

Gomez-Mejia (1998) integrate agency theory with prospect theory to analyse managerial risk taking attitudes. Sitkin and Pablo (1992) propose a conceptual model that is intended to form the basis of a future research agenda regarding the determinants of risk behaviour. Based on previous literature and additional research the authors propose six determinants of risk perceptions [4] and examine the likely effects of risk perceptions and risk propensity on individual risk behaviour in organisational settings.

Despite the mentioned shortcomings, behavioural finance seems to offer a valid framework to investigate how and to what extent perceptions and biases can influence decision making processes under uncertainty. The literature review on behavioural finance offered above shows that motivational factors can actually play a determinant role while weighting decision options, since they can significantly affect the perception of risk.

As stated by Shleifer (2000, p.181) “the perception of risk is one of the most intriguing open areas in behavioral finance”. He adds that “the emphasis on investors is entirely foreign to traditional finance, which has achieved its success by assuming precisely that investors do not matter except for the determination of the equilibrium discount rate...”. The author highlights the need to develop a conceptual model to fully capture the way investors assess risk, their rules of thumb and how they forecast expected scenarios. In turn, Thaler (1999) points out that adding a human element to financial market analysis can lead to a better understanding of the mechanisms underlying market behaviour.

The bounded rationality approach has gained recognition also in other disciplines including economics (Van Zandt, 1999), operations management (Bendoly, 2006; Gino and Pisano, 2008; Loch and Yaozhong, 2005), strategic management (Bromiley, 2005), sustainability marketing (Beretti et al., 2009). The venture capital literature (Gompers and Lerner, 2001; March, 1994; Zacharakis and Shepherd, 2001) has acknowledged the need to better clarify the role of cognitive factors in entrepreneurial decision making processes, as well as these agents’ understanding of risk and return. Yet, further empirical and theoretical work still needs to be done, particularly to study entrepreneurial firms in the domain of sustainable technologies (Jacobsson and Johnson, 2000; Russo, 2003).

Another recent application of behavioural finance is the analysis of the role and effect of public policy intervention in the market. The limited available

[4] The six determinants of risk perception identified by the authors are: problem framing, top-management team homogeneity, organizational control systems, social influences, problem domain familiarity and risk propensity.

literature in this new field seeks at understanding whether government intervention, even in inefficient markets, does more harm than good. Examples are the role of government as lender of last resort, as well as policies to increase investor protection or to stabilise security prices.

A pan-European study in the venture capital literature published in 2003 (Leleux and Surlemont, 2003) does not provide support neither for the seeding nor for the crowding-out effect, nor does it support the proposition that public investments are detrimental to the industry as a whole. This implies that further research is needed in this area, and behavioural finance can offer a valid perspective to address these issues.

A recent paper (Allcott and Mullainathan, 2010) has highlighted the need for more behavioural science studies in the Energy Policy field. Amongst others, the authors recommend governments to provide funding for behavioural programmes as part of their broader support for energy innovation. Indeed, the analysis of the impact of behavioural factors in the energy domain has been a largely overlooked topic. Some recent attempts to incorporate the cognitive psychology perspective in the energy field are those of Culhane (2008), Hasan (2006), Liang and Reiner (2009) and Piranfar (2009).

The scant literature available in renewable energy management literature offer limited insights. For example, Teppo (2006) makes a review of some of the most common cognitive biases identified in behavioural finance literature and adopts a model of risky decision-making behaviour in order to examine risk management strategies in the cleantech venture capital industry. Oschlies (2007) incorporates the behavioural finance perspective to investigate investment behaviours in the renewable energy market. Based on the analysis of literature and expert interviews she develops a behavioural model of financial decision making, which she uses to interpret the findings of a conjoint-based experiment with a sample of institutional investors. Finally, Wüstenhagen et al. (2009) explore the role of expectation dynamics in fuel cell venture capital investing under a behavioural finance perspective.

While the mentioned studies represent very valid attempts to stimulate a more thorough understanding of the influence of cognitive elements in the renewable energy investment domain, they are still based mostly on qualitative analysis and therefore do not help assess the nature and strength of the relationship between behavioural factors and renewable energy investments. To overcome this limitation and provide a contribution to this promising field of study, I develop and test a conceptual model that examines the behavioural factors affecting the investors' decisions. The model is described in detail in the next chapter.

4 The empirical study

The purpose of this chapter is to summarise the main knowledge gaps identified in literature, to develop the research questions and to elaborate a conceptual model capturing the main elements to be analysed and their relationships.

4.1 Research gaps

The analysis of the renewable energy context, the literature review and a series of interviews with investors and experts have allowed to identify a series of research gaps. One important research puzzle is that although renewable energy technologies display a very high potential for innovation and growth (as described in chapter 2), investments in this promising field are still below expectations.

The literature review has emphasized that bad policy design, the lack of appropriate accounting measures for renewables and cognitive biases – such as misperceptions, conservatorism or risk aversion - are all possible explanations for this situation. It has also underlined that the effectiveness of a policy is critically dependent upon its impact on investors' behaviours. Therefore, to maximize the impact of future energy policies, policy makers need to get a better understanding of how investors behave, and of how they take their decisions, particularly in regards to the key psychological factors that may influence their actions.

Yet, there is a surprising lack of rigorous empirical studies examining these aspects in the literature.

In the next paragraphs I try to address some of these issues, by developing two main research questions which help define the context for the empirical work. The research questions have the purpose to set the main boundaries of the research and to guide the development of the research hypotheses.

4.2 Research questions

The main research questions which guide the present doctoral work are:

- Do cognitive factors have a measurable influence on the decision to invest in renewable energy technologies?

The first research question brings along a series of more specific sub-questions, namely:

- How do cognitive factors related to policy perceptions influence the decision to invest in renewable energy technologies?, and
- How do cognitive factors related to technology perceptions influence the decision to invest in renewable energy technologies?

The second research question looks at the link between the share of renewable energy technologies in the investment portfolio and portfolio performance, and is articulated as follows:

- How does the share of renewables resulting from these investment decisions impact the portfolio performance?

In order to answer these research questions, a series of methodological steps need to be undertaken.

Firstly, the most important cognitive factors under the scope of the present research need to be identified.

Secondly, the nature and direction of the relationship between cognitive factors and renewable energy investment have to be stated.

Thirdly, the nature and direction of the relationship between cognitive factors, renewable energy investment and portfolio performance need to be described as well. These are necessary steps in order to translate the problem formulation into something testable during the field experiment.

Given the lack of a consolidated body of literature in this specific field, some methodological indications from the grounded theory approach (Glaser and Strauss, 1967) are followed in order to allow better interaction between theory and research practice, create clearer links between concepts and their indicators, and between claims and the evidence for these (Seale, 1999). Within this context, a conceptual model has been developed, which displays the main variables to be investigated and the relationships between them.

The main variables have been identified through primary and secondary research, namely through stakeholders' consultation during the preliminary stages of the research. In order to make the link between the various variables more explicit, a series of research hypotheses are formulated.

According to the definition provided by Kerlinger (1986, page 17) "a hypothesis is a conjectural statement of the relation between two or more variables". Compared to research questions, the hypotheses allow to make more specific predictions about the nature and direction of the relationship between the investigated variables.

4.3 Conceptual model and research hypotheses

The analysis of the above literature and a series of exploratory interviews with industry experts have provided the groundwork for the development of the conceptual model in Figure 5.

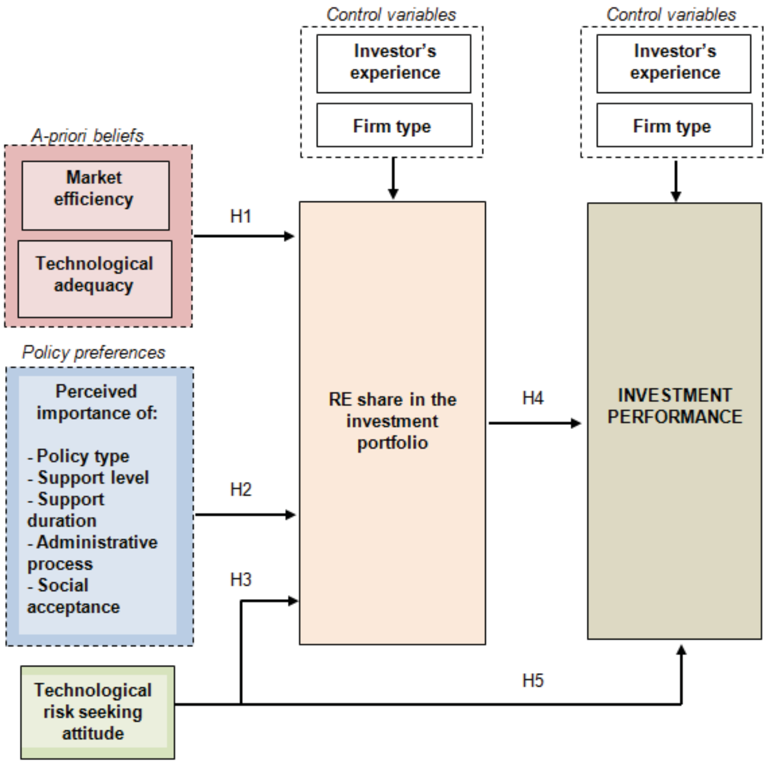


Figure 5: Conceptual model

The model, which includes two stages, examines whether behavioural factors have a measurable influence on the decision to invest in renewable energy projects, and whether, in turn, the share of renewable energy in the portfolio that results from these decisions is reflected into the portfolio performance.

The first stage examines the factors influencing an investor's willingness to invest in renewable energy technologies. Starting from the left-hand side of the diagram, three main general categories of behavioural factors have been included in the model: i) a priori-beliefs, ii) policy preferences, and iii) attitudes towards technological risk. Therefore the model assumes that an agent's willingness to invest in renewable energy technologies is affected to various extents by these types of cognitive elements.

As far as a priori beliefs are concerned, they are the result of the investors' personal history, educational backgrounds, and personal previous experience with renewable energy investments. As the success of a renewable energy project (and the consequent appeal of such a project for an investor) depends on the technological feasibility of the project and on the market's ability to value the project, the model argues that investors have a priori beliefs with respect to both aspects. Accordingly, it is expected that investors are influenced by two types of a priori beliefs. They reflect the investors' trust in the technologies considered for the investment, as well as their trust in the efficiency of the market mechanisms (in the following defined as "market efficiency").

The model argues that both types of a priori beliefs have a positive impact on the investors' willingness to allocate capital to renewable energy projects. The resulting hypotheses are the following:

Hypothesis 1a: The higher is the level of confidence in market efficiency the larger is the renewable energy share in the investment portfolio.

Hypothesis 1b: The higher is the level of confidence in the technological adequacy of renewable energy systems, the larger is the renewable energy share in the investment portfolio.

As discussed in chapter 3, in the current energy market policies play a paramount role in determining the success of a renewable energy project. Thus, it is expected that an agent's willingness to invest in a renewable energy project will be also strongly influenced by his/her preferences over different policy schemes. The analysis of the literature and a series of interviews with relevant stakeholders have suggested that the effectiveness of renewable energy policies depends on a large set of policy attributes, which include a combination of the right policy signals, incentive levels, program administration and predictability. By the same token, various elements of policy play a role in determining the decision to invest in renewable energy projects. Based on this review and the advice of industry experts, five different policy attributes have been included in the model: i) the type of support scheme, ii) the level of support, iii) the duration of the support, iv) the length of the administrative process and v) the degree of social acceptance. In the model it is assumed that the perceived importance of policy attributes strongly influences the willingness to invest in renewable energy projects. More specifically, the model argues that there is a positive correlation between the perceived importance of the various policy attributes and the decision to invest in renewables. The proposed hypotheses are therefore the following:

Hypothesis 2a: The renewable energy share in the investment portfolio is positively correlated with the perceived importance of the type of policy scheme.

Hypothesis 2b: The renewable energy share in the investment portfolio is positively correlated with the perceived importance of the level of support.

Hypothesis 2c: The renewable energy share in the investment portfolio is positively correlated with the perceived importance of the duration of support.

Hypothesis 2d: The renewable energy share in the investment portfolio is positively correlated with the perceived importance of the length of the administrative process.

Hypothesis 2e: The renewable energy share in the investment portfolio is positively correlated with the perceived importance of social acceptance.

Finally, as renewable energy technologies are sometimes perceived as unproven technologies with greater technological uncertainty but, also, with the possibility to grant higher potential returns in the future, the model argues that an investor's attitude vis-à-vis technological risk has also a strong influence on his/her willingness to invest. It is expected that those investors who are more averse to technological risk are less likely to invest in renewables compared to more risk-oriented actors. The following hypothesis is therefore derived:

Hypothesis 3: A higher propensity to invest in radically new technologies is associated with a higher renewable energy share in the investment portfolio.

In addition to the three main categories of behavioural factors just described, the model includes also two control variables: the investor's experience and the type of firm undertaking the investment[5].

The second stage of the model considers the factors influencing the investment performance. Controlling for the investor's experience and the type

[5] Overall, the questionnaire survey included five different parameters which could have been used as control variables in the model: years of experience, type of company, educational background, position in the organization and gender. All available control variables were initially used in the model. However, for parsimony purposes, only the ones that were significant or close to significance were eventually retained in the final version. More specifically, gender segmentation would have not lead to significant results, as almost all survey respondents are male. As for the other two variables, they did not prove to be statistically relevant and were therefore eliminated from the model.

of firm undertaking the investment, it is expected that the performance of the investment is dependent upon two variables: the renewable energy share in the portfolio and the investors' attitude towards technological risk.

As far as the first element is concerned, the literature review reported in paragraph 3.1 has identified a positive effect of renewable energy investments on financial performance, without however quantifying the strength of this relationship. It has also highlighted that increased growth of renewables is hampered by the use of traditional accounting methods which tend to favor incumbent technologies over more innovative alternatives. Demonstrating that a higher share of renewable energy is associated with a higher performance of the investment portfolio would be therefore a very relevant contribution. Based on these considerations, the following hypothesis is proposed:

Hypothesis 4: The higher is the share of renewables in the portfolio, the higher is the investment performance.

Finally, as renewable energy technologies have a higher degree of technological and market risks, but also the potential of guaranteeing higher future returns, provided that these risks are properly managed, the investment performance is expected to be positively correlated with the technological risk attitude. The following hypothesis is derived:

Hypothesis 5: The propensity to invest in radically new technologies has a strong impact on the investment performance.

It is worth highlighting that for sake of completeness, the existence of a reverse feedback relationship between investment performance and the renewable energy share in the portfolio should also be examined. In fact it can be expected that, over time, rational investors who have obtained above-average returns by including renewable in their portfolios, will also tend to increase the share of renewable in their portfolios in the following investment round. Therefore, it would be interesting to test the relationship between investment performance at time t and the renewable energy share in the investment portfolio at time t+1. Addressing this question requires an additional experimental design which is outside the scope of the present work. However, this limitation needs to be duly taken into account and can constitute a valid rationale for carrying out follow-up research with longitudinal data.

The next chapter illustrates the research design and how all the above-mentioned explanatory variables are operationalised, as well as the econometric techniques used to assess the influence of the explanatory variables on the dependent variables.

5 Research design and research methods

As highlighted by several scholars (e.g.: Black, 1999; Maxim, 1999; Yin, 2003), the research design is a fundamental step in the construction of a scientifically sound study. In fact, a well articulated research design helps minimize measurement errors, therefore enhancing the robustness of results (Maxim, 1999). The present chapter intends to illustrate the research design developed under the framework of the doctoral dissertation with the aim to address the research questions and to translate the conceptual model into empirical steps. The main research methods adopted are explained and the main phases of the analysis are discussed.

5.1 The research design

As defined by Yin (2003), a research design is “a logical plan for getting from here to there, where here may be defined as the initial set of questions to be answered and there is some set of conclusions about these questions”. In the case of the present research, the empirical investigation is guided by the two main questions formulated, which have in turn originated the conceptual model and the hypotheses described in chapter 4.

Given the complexity of the problem, and the many variables to be investigated, a research design including a combination of qualitative and quantitative methods (Black, 1999; Snow and Thomas, 1994) has been selected as the most suitable to best address the research questions.

As a first step, qualitative methods such as documentary analysis and observation and hearings were adopted in order to get a solid understanding of the main issues, priorities and problems related to renewable energy policy and investors’ behaviours and to set the context for the empirical research. Special attention was dedicated to the review of behavioural finance literature in order to identify the main cognitive variables to be analysed.

The second phase of the research included interviews with selected experts in order to test and refine the conceptual model and to assure content validity for the various constructs in the model. A preliminary version of the web-based questionnaire was developed and tested with a limited sample of investors and other stakeholders. The pre-test survey helped to reformulate unclear questions, and to refine the structure of the questionnaire by eliminating redundant or unnecessary questions. In parallel, a database of survey recipients was built up through extensive data collection.

This process allowed to finalize and launch the web-based survey questionnaire, which was administered to a sample of European investors during the third phase of the research. The data were then analyzed by means of adaptive conjoint analysis and multivariate regression. Both techniques are explained in detail below (see paragraph 5.3).

After the elaboration of the survey results, the first milestone was reached. This consisted in presenting and discussing the findings with the survey participants and other relevant stakeholders. In particular, a customized complimentary copy of the study was sent to all respondents. The document included also a feedback request module, which was used by some investors to provide additional comments to the study results. Furthermore, the doctoral work has been disseminated to a wide audience of scholars and practitioners, notably through the preparation of short and full length articles for academic conferences and peer-reviewed journals. Conferences and seminars provide unique possibilities to present the main research findings and get very useful feedbacks in order to improve the quality of the work.

The fourth step consisted in incorporating the various feedbacks received at the above-mentioned events in the present dissertation, and in a series of additional interviews with a selected number of questionnaire respondents. Further qualitative research was carried out in order to cross-check the findings against other empirical research in the same field. These additional efforts led to reaching the second milestone, which is the data validation phase, including further dissemination.

The subsequent steps of the research design are displayed in Figure 6.

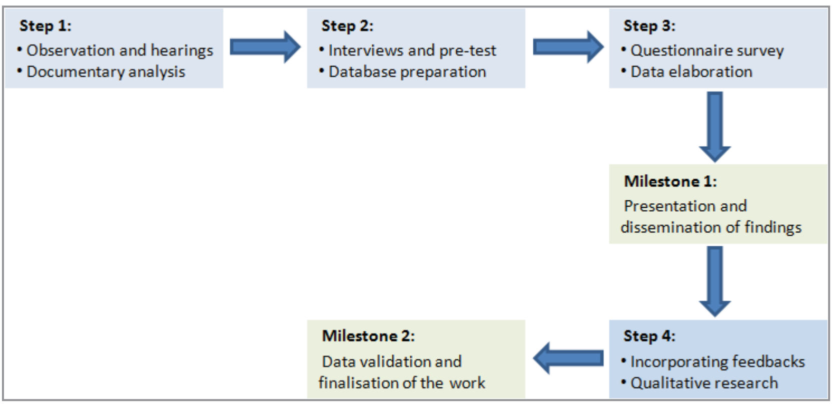


Figure 6: Main steps and milestones of the research design

A more in-depth description of the survey process and of the quantitative research methods used to elaborate the results is provided in the next paragraphs.

5.2 The survey instrument

A key step of the research process was the web-based survey. To this end, a questionnaire was developed using the Sawtooth Software SSI Web 6.6 licensed to the University of St. Gallen. The software enables the user to write questionnaires for computer-administered interviews and surveys.

The questionnaire was sent to a list of recipients identified through extensive data collection. In the next paragraphs, the structure of the questionnaire and the survey administration process are described in detail. The full version of the questionnaire is provided in Annex I.

5.2.1 The questionnaire structure

The questionnaire covered four main areas and included 35 specific questions. The purpose of the questionnaire was both to develop valid psychometric measurements based on Likert scales and to elicit policy preferences through adaptive conjoint analysis. In particular, the first section aimed at determining the diffusion of renewable energy investments. Respondents were asked to indicate the share of their investment portfolios allocated to renewables and the specific technologies included in their portfolios.

It is worth highlighting that a generic definition of the term “portfolio” was adopted. In fact, this research targeted a diversified group of investors, who have different profiles and are involved at different stages of the technology value chain. Therefore, given the different nature of the investments these agents undertake (e.g. stocks or bonds), it was neither possible nor appropriate to provide a common definition for the term portfolio. In order to avoid possible misunderstandings and to maximize the generalizability of results, in the questionnaire respondents were explicitly invited to consider the most representative investment undertaken by their company and to refer to this investment.

The purpose of the second section was to assess the investors’ knowledge and awareness of the technological and market potential of renewable energy sources, their a-priori beliefs about the role of market and policy in supporting the growth of renewables, as well as their attitude toward technological innovation. A specific question addressed the main sources of information used by respondents in order to guide their investment decision making process.

As far as the question investigating market and policy a-priori beliefs is concerned, respondents were asked to express their degree of agreement with some statements reflecting six common beliefs about renewables, using a 5-point Likert scale. This question was developed using a cognitive psychology approach, employing alternative formulations of the same problem to assess the influence of variations in framing on choice selection (Tversky and Kahneman, 1981).

The third section was dedicated to elicit preferences for renewable energy policies, using adaptive conjoint analysis (see paragraph 5.3.1). Respondents were asked to compare a number of alternative policy options to support an on-shore wind project, which differed in the type of policy scheme implemented, level of support, duration of the support, length of the administrative process and degree of social acceptance.

These policy attributes were selected since they fulfilled the criteria identified by Backhaus et al. (1996). In order to reduce the possible influence of unobserved factors and to allow for a fair comparison among attributes, some characteristics of the project, such as the availability of wind and the project size, were pre-defined and fully disclosed to respondents.

The fourth section of the questionnaire was dedicated to performance assessment: respondents were solicited to provide a self-assessment of the perceived past performance and of the expected future performance of their investments compared to their direct competitors, i.e. other investors operating in the same market.

Finally, the questionnaire also included a series of demographic questions covering the company profile, the investors' experience with renewable energy investments, as well as their age, their educational background and their position in the organizations.

5.2.2 Survey administration

As a first step of the data collection process, a database of target respondents was developed in the preliminary phases of the research project. Contact details of companies and their senior representatives were gathered from multiple sources including the websites of the European Venture Capital Association and its national affiliates, The Business Place website and other specialised directories. Additional sources of information used included the lists of participants in some of the most reputed international conferences on sustainable energy finance, such as the Wind Energy Conference for Equity Investors, the Renewable Energy Finance Forum, the New Energy Finance

Summit. Overall, a list of about 300 contacts in various European countries was collected. The distribution of contacts is shown in Figure 7.

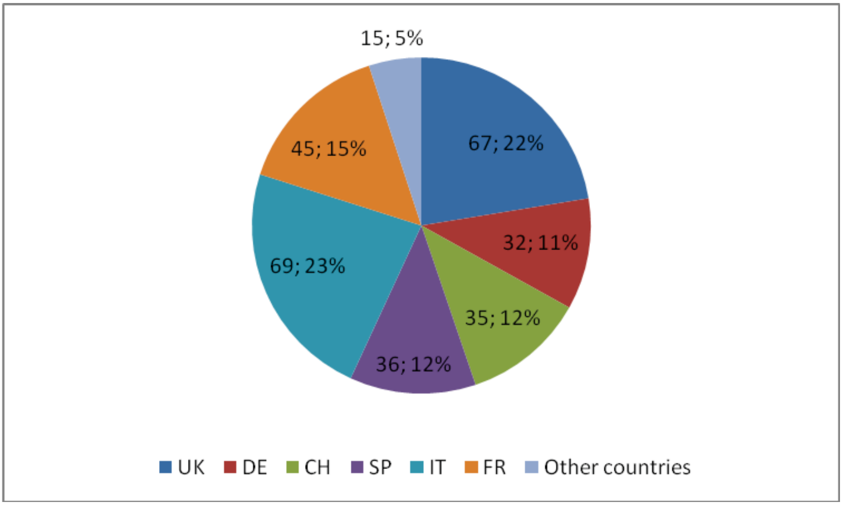


Figure 7: Distribution of the list of contacts by country

The database targeted mainly six European countries, which were selected under the framework of the present research because they represent particularly relevant case studies[6]. Most contacts were found in Italy and the United Kingdom (69 and 67, respectively) followed by France (45) while for the remaining countries an average of more than 30 contacts per country was reached. Fifteen additional contacts were included in the database from other countries like for example Belgium and Greece. Although these countries were not a primary target of the present research, selected banks and venture capital companies were included because of their reputation and active involvement in the renewable energy investing domain.

Investor profiles include Venture Capitalists, Private Equity Funds, Asset Managers, Investment Funds, Commercial Banks and Energy Companies.

The administration of the survey took place between June and September 2009. Before launching the survey, a pre-test with a limited number of investors from the sample and other relevant stakeholders was conducted in order to validate the measurement and refine the research instrument. The investors selected for the full scale survey received individual invitations via email. Reminders were also sent at regular intervals. Furthermore, a link to

[6] For a discussion of the country selection process, please refer to Menichetti (2008).

the survey was posted on the UNEP Sustainable Energy Finance Initiative website.

In order to limit the impact of self-assessment and maximize the accuracy of responses, Huber and Power's (1985) guidelines were followed, by guaranteeing that the information collected would remain completely confidential, agreeing to distribute a personalized feedback document and promising to share the final results of the study with respondents.

The online survey was accessed 136 times. However, 43 responses had to be discarded because they were either plainly unreliable[7] or greatly incomplete. As a result, 93 questionnaires were ultimately retained for the analysis, corresponding to an effective return rate of 31%, which is in line with studies of this nature. Of these, 49 questionnaires were fully completed, while 44 were almost fully answered. To compensate for missing data, the mean substitution method was used in order to provide all cases with complete information (Hair et al., 1998).

5.3 Quantitative research methods

Two quantitative research methods based on multivariate data analysis were used to elaborate the results: adaptive conjoint analysis and regression analysis. These techniques were selected as they seem to be particularly suited to fulfill the research objectives, according to the procedure suggested by Hair et al. (1998) and displayed in Figure 8.

Under the present research design, each technique served a specific research need. In particular, the conjoint analysis study had two main purposes: i) to provide intermediate results by analyzing investors' preferences for different renewable energy policies, and ii) to identify the most relevant policy attributes to be retained in the regression model. As for the multivariate regression, it had the goal to analyse the robustness of the statistical relationships between independent variables and the dependent variable, ergo to assess: i) the influence of behavioural factors on the renewable energy share of the investment portfolio and, ii) to assess the impact on the investment performance.

In addition to these two main statistical techniques, factor analysis was applied to investigate the interrelationships among variables and to filter a subset of representative variables in order to simplify the subsequent multivariate analysis and to better interpret the results.

[7] For example, some problems related to common scale formats and common scale anchors (Podsakoff et al., 2003), have been detected.

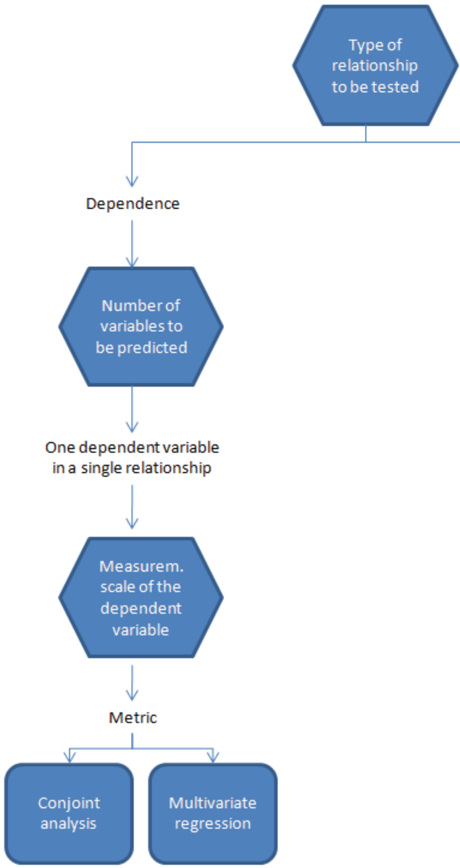


Figure 8: Multivariate technique selection process
[source: adapted from Hair et al. (1998, pages 20-21)]

Once identified the most suited statistical techniques for the type of relationship to be tested, the methods shown in the diagram above have been applied to process the variables illustrated in the conceptual model (page 51), as summarised in Table 2.

Table 2: Application of statistical techniques to the model variables

Variables	**Assessment method**
A priori-beliefs	Factor analysis
Policy preferences	Adaptive Conjoint Analysis
Technological risk attitude	Factor analysis
RE share in the portfolio	Multivariate regression analysis
Investment performance	Multivariate regression analysis

5.3.1 Adaptive Conjoint Analysis

5.3.1.1 Introduction

Conjoint analysis is a methodological tool that allows to study consumer preferences among multiattribute alternatives in a wide variety of product and service contexts (Green and Srinivasan, 1978). This technique has its origin in psychological research (Wittink and Cattin, 1989). The term "conjoint" derives from the idea that buyers evaluate an overall product or service based on its multiple conjoint attributes – also called features (Orme, 2009a). As opposed to traditional expectancy-value models, conjoint methodology is characterised by a decompositional approach (Green and Srinivasan, 1978 and 1990; Jaeger et al., 2000). In other terms, products or services are thought as possessing specific levels of defined attributes, and respondents' liking for a product is modelled as the sum of the part worths (utilities) for each of its attribute levels. Therefore the purpose of the research is to determine the contributed portion (part-worth utility) of each attribute level to the dependent variable (Moore, 1980).

Conjoint analysis assumes that a consumer assigns a utility value to each level of each attribute and makes his or her final decision based on the total utility values across attributes for a given choice set (Green and Srinivasan, 1978 and 1990; Jaeger et al., 2000; Marshall and Bradlow, 2002; Randolph and Ndung'u, 2000). Assuming that a product can be defined as a vector in a multidimensional attribute space, and that the evaluation of the product is based on its attribute levels, it becomes theoretically possible to relate preference to attributes (Janssen et al., 1991).

In contrast to direct questioning methods that simply ask how important each attribute is or the desirability of each level, conjoint analysis forces respondents to make tradeoffs like the ones they encounter in the real world.

It would be time consuming and difficult for respondents to evaluate all possible product combinations in order to provide information on their values for the various product features. Conjoint analysis offers the researcher a more efficient way to obtain such information: only a careful chosen set of hypothetical product concepts is presented to respondents for evaluation. It is the job of the analysts to find a set of parth worths for the individual attributes that, given some type of composition rule, are most consistent with the respondent's overall preferences. By analysing the answers conjoint analysis can estimate the weights and preferences respondents may have placed on the various features in order to result in the observed product preferences.

Conjoint analysis has been extensively used in applied psychology, as well as in marketing research. Over the years, the methodology has acquired popularity also in other academic disciplines and among practitioners, as described in the next paragraph.

5.3.1.2 Origin and evolution of the methodology

Conjoint measurement traces its root back to 1920s, but the 1964 seminal paper of Luce and Tukey appeared in the first issue of the Journal of Mathematical Psychology (Luce and Tukey, 1964) is generally acknowledged to be the cornerstone of the methodology development. Following this contribution, a number of theoretical works were released (Krantz, 1964; Tversky, 1967), dealing either with algorithmic developments (Carroll, 1969; Kruskal, 1965; Young, 1969) or methodological applications (for a comprehensive review see Green and Srinivasan, 1978 and 1990). There are several methodological papers available, which provide a comprehensive description of the methodology and the mathematical algorithms behind the tool (see for example: Green and Rao, 1969; Green and Wind, 1973 and 1975; Rao, 1977).

Conjoint analysis has been extensively used in applied psychology, as well as in marketing research where it was first introduced by Green and Rao (1971) and further developed by Batsell and Lodish (1981) and Louviere and Woodworth (1983). Over the years, the methodology has acquired popularity not just in the academia but also among practitioners and has extended its application boundaries to several other fields thanks to its possibility to simulate the decision making process in real life situations.

Jaeger et al. (2000) report examples of application in several sectors, including transportation, tourism and recreation, environmental valuation and shopping behaviour. In the sustainability marketing and consumer behaviour domain, conjoint analysis has been applied quite extensively. For example it has been used to study the importance of green packaging (Rokka and Uusitalo, 2008), to evaluate the influence of ecolabelling on purchase decisions (Heinzle and Wüstenhagen, 2009; Sammer, 2007) or to determine household preferences and willingness to pay for energy-saving measures (Banfi et al., 2008; Farsi, 2010; Poortinga et al., 2003).

A review of the literature on the application of conjoint analysis in the environmental field made by Alriksson and Öberg (2008) identified a total number of 84 studies related to agriculture, ecosystem management, energy, environmental evaluation, forestry, land management, pollution, products, recreation, environmental risk analysis and waste management. The authors conclude that compared to more traditional areas of application like marketing and transportation, the number of environmental conjoint studies is rather small but increasing, and that the method seems to work effectively in eliciting preferences on environmental issues.

Conjoint analysis has been widely applied also to measure public acceptance of policies. For example, since the early 1970's, it has been applied for health care planning (McClain and Rao, 1974; Whitmore and Cavadias, 1974; Wind and Spitz, 1976; Hopkins et al., 1977).

In the energy policy context, it has been used to assess public preferences over nuclear power (Sung Choi and Whi Lee, 1995) or wind (Álvarez-Farizo and Hanley, 2002).

In strategic management literature, this technique has been used to analyse investment decision making processes of entrepreneurs like venture capitalists (Franke et al., 2006; Muzyka et al., 1996; Riquelme and Rickards, 1992; Shepherd and Zacharakis, 1999), informal investors (Landström, 1998), management buyout investors (Birley et al., 1999), to help design rural credit market (Dufhues et al., 2004) as well as to investigate strategic thinking of top managers (Hitt and Tyler, 1991; Priem, 1992; Priem and Harrison, 1994).

To the author's knowledge the present dissertation represents one of the earliest attempts to apply this technique to assess investors' preferences over renewable energy policy characteristics (a similar experiment was conducted by Lüthi and Wüstenhagen, 2009).

5.3.1.3 Brief description of main steps

A conjoint analysis study includes the following key steps:

- Attribute List Formulation

A business problem is defined and an attribute (features) list is developed to study the problem.

- Data collection

Respondents are asked to express the trade-offs they are willing to make among product features by rating, sorting or choosing among hypothetical product concepts.

- Utility calculation

A set of preference values (also called part worth utilities) is derived from the interview data; they reflect the trade-offs each respondent made.

- Market Simulation

The utility values are used to predict how buyers will choose among competing products and how their choices are expected to change as product features and/or price are varied.

Among the various conjoint measurement techniques available[8] Adaptive Conjoint Analysis - ACA (Johnson, 1987) was selected as the most suitable approach under the scope of the present study since it retains the following main features: a) it collects preference data in a computer-interactive mode, therefore increasing the respondent's interest and involvement with the task, and b) it allows to customize the interview so that respondents are asked in detail only about those attributes of greatest relevance.

The term adaptive refers to the fact that the computer-administered interview is customized for each respondent. At each step previous answers are used to decide which question to ask next, to obtain the most information about the respondent's preferences (Sawtooth, 2007). The respondent's part worths are continually re-estimated as the interview progresses, and each question is chosen to provide the most additional information, given what is already known about the respondent's values. Compared to the other conjoint methods described, ACA has the advantage to provide statistically significant results also with a limited sample and to allow for the inclusion of a relatively high number of attributes and levels.

The ACA interview is usually composed of several sections, each one having a specific purpose. As described in Orme (2009a) and Sawtooth (2007), the main steps are the following:

- Preference for Levels (the "ACA Rating" question type)

As a first step, respondents are asked to rate the levels in terms of relative preference. This question is usually omitted for attributes for which the respondents' preferences are obvious, like for example price or quality. In such cases, the researcher can set a predefined order of preference for levels, from "best to worst" or "worst to best", and the rating question is automatically skipped.

[8] There are several conjoint measurement techniques, ranging from traditional full-profile methods to two-factor methods to hybrid methods (Gustafsson et al., 2007; Huber et al; 2007). In the present research, a review of the most popular has been carried out, which included conjoint value analysis (CVA), choice-based conjoint analysis (CBC), adaptive conjoint analysis (ACA). For a comprehensive description of the various methodological tools see the Sawtooth Technical Papers library, available at: http://www.sawtoothsoftware.com/education/techpap.shtml, and in particular the paper of Orme (2009b).

- Attribute Importance (the “ACA Importance” question type)

This step has the purpose to learn the relative importance of each attribute to respondents. This provides information upon which to base initial estimates of respondents’ utilities. The questioning is based on differences between those levels the respondent would like the most and the least.

Similarly to the rating question, also the importance question can be omitted. However, an ample size is needed in this case, as some information at the individual level is lost (King et al., 2004).

- Paired-Comparison Trade-Off questions (the “ACA Pairs” question type)

In this phase of the analysis, a series of customized paired-comparison trade-off questions is presented. The respondent is shown two product concepts at a time, and is solicited to indicate which one is preferred, and the strength of preference.

The computer starts with a crude set of estimates for the respondent’s utilities, and updates them following each pairs question. The crude estimates are constructed from the respondent’s preference ranking or rating for levels, and the importance ratings of attributes. Every time the respondent completes a pair question, the estimate of the respondent’s utility is updated, thus improving the quality of the subsequent pairs questions.

- Calibrating Concepts (the “ACA Calibration” question type)

As a last step, a series of calibrating concepts are presented, using those attributes determined to be most important. These concepts are chosen to occupy the entire range from very unattractive to very attractive for the respondent. The respondent is asked to indicate the likelihood of buying each of them.

The purpose of this section is to scale the utilities non-arbitrarily, so that sums of utilities for these concepts are approximately equal to logit transforms of the respondent’s likelihood percentage.

Calibrating concepts are not required in case of share of preference simulations, and in particular if using the ACA/HB system for hierarchical Bayes estimation, as in the case of the present research.

5.3.1.4 Application to the present study

The conjoint analysis design was elaborated following the procedure suggested by Backhaus et al. (1996) and already applied by Oschlies (2007). Conjoint analysis is based on the assumption that each "product" is composed of an almost infinite number of attributes. However, not all attributes are relevant to different customers. Therefore an important step in conjoint measurement is to define which attributes and levels do influence the most customers' preferences.

This screening process requires a participatory process with the respondents to be carried out in the preliminary stages of the research. To do so, an orthogonal matrix has been developed, which allowed to screen and reduce the number of attributes and levels in order to keep the number of product concepts to a manageable size.

According to the approach defined by Backaus et al. (1996), attributes shall fulfill the following criteria:

- Relevance (they need to be relevant in the investor's decision making)
- Influence (they can be influenced by investors)
- Independence (attributes and levels should not interact)
- Compensatory (can be substituted one with the other in investor's perceptions)
- Understandable (not misleading)

By applying the above-mentioned criteria to the list of attributes identified in the preliminary stages of the research process (Menichetti, 2008), only five attributes were ultimately retained. They were fine-tuned after the pre-test survey, which helped better specify attributes and levels in order to avoid misinterpretation.

The final list of attributes and attribute levels is displayed in Table 3.

The combination of attributes and levels led to a total number of 14 paired-comparison trade-off choices to be answered by investors[9].

[9] The number of trade-off questions is determined according to the following formula: 3*(N-n-1)-N where N=total number of levels taken into the pairs section, n=total number of attributes taken into the pairs section (Orme 2009a, p.324).

Table 3: Attributes and attribute levels of renewable energy policies selected under the present research

Attributes	Levels
1. Type of renewable energy support scheme	1. Tax incentives / Investment grants
	2. Tender schemes
	3. Feed-in tariffs
	4. Tradable Green Certificates / Renewable Portfolio Standard
2. Level of the incentive (the premium paid per unit of electricity produced and sold)	1. 100 €/MWh incentive
	2. 75 €/MWh incentive
	3. 50 €/MWh incentive
	4. 25 €/MWh incentive
3. Duration of the support (number of years for which the incentive is paid)	1. incentive unchanged for less than 10 years
	2. incentive unchanged from 10 to 20 years
	3. incentive unchanged for more than 20 years
4. Length of the administrative process	1. Less than 6 months
	2. From 6 to 12 months
	3. More than 12 months
5. Social acceptance	1. Low (anti-wind activism, negative press, anti-wind demonstrations)
	2. High (pro-wind activism of NGOs, favourable press, pro-wind citizens' coalitions)

The survey proceeded as follows: first, a series of "importance questions" were asked by the software, where the highest and the lowest levels of each attribute were compared. Then, a series of "pairs questions" were automatically generated by the software, where trade-off investment decisions were proposed. Two attributes at a time were shown. Although concepts described on several attributes have the advantage of seeming more realistic, the feedbacks received during the pre-test phase indicated that respondents were tired and tended to be confused if presented with more than two attributes, as they had to process more information. Preliminary evidence in conjoint research suggests indeed that beyond three attributes gains in efficiency are offset by respondent confusion due to task difficulty (Sawtooth, 2007). In order to avoid non-accurate responses, it was then decided to present only two attributes at a time.

Finally, following the methodological suggestions provided by Sawtooth (2007) and already presented in paragraph 5.3.1.3, both rating and calibration questions were omitted. In fact, since respondents' preferences for attribute levels were rather obvious[10], pre-defined orders of preferences for levels were set. In addition, since the hierarchical Bayes estimation method was used to process the data it was not necessary to add the calibration questions.

As already anticipated, the conjoint analysis study had two main purposes: i) to provide intermediate results by analyzing investors' preferences for different renewable energy policies, and ii) to identify the most relevant policy attributes to be retained in the regression model, as discussed in the next paragraph.

5.3.2 Multivariate regression

5.3.2.1 Introduction

Regression analysis is by far the most widely used and versatile dependence technique, applicable in every facet of business decision making (Hair et al., 1998).

Multiple regression analysis is a general statistical technique used to analyse the relationship between a single dependent (criterion) variable and several independent (predictor) variables.

The objective of regression analysis is to predict a single dependent variable from the knowledge of one or more independent variables.

Its basic formulation is: $Y_1 = X_1 + X_2 + ... + X_n$

In principle, this statistical technique should be used only when both the dependent and independent variables are metric. However under certain circumstances nonmetric data can be included as well, either as independent variables (as dichotomous variables, known as dummy variables) or the dependent variable. As explained more in detail below, three nominal variables were included in the model through dummy-variable coding (see next paragraph).

As other multivariate techniques, regression analysis is a very valuable tool to conduct theoretically significant research, and to evaluate the effects of naturally occurring parametric variations in the context in which they normally occur (Hardyck and Petrinovich, 1976). Thanks to its flexibility, it can be used both for predictive and explanatory purposes. It allows to objectively

[10] For example, it can be expected that a premium incentive level of 100 €/MWh is always preferred to a level of € 75/MWh or lower.

determine the degree and character of the relationship between the dependent variable and the independent variables. Firstly, it helps assess the relative importance of each independent variable in the prediction of the dependent variables. Secondly it identifies the magnitude and the direction (positive or negative) of each independent variable's relationship. Furthermore, it helps assess the nature of the relationship between the independent variables and the dependent variable. Finally, it provides insights into the relationships among independent variables in their prediction of the dependent measure.

5.3.2.2 Operationalisation of variables

The multiple regression technique was applied in the present study to investigate the role of behavioural factors in affecting investment decisions and to analyse the relationship between the magnitude of the investment in renewables and the overall portfolio performance. As reported in chapter 4, the conceptual model included three main classes of behavioural factors: a priori-beliefs, policy preferences and technological risk attitude.

These variables were operationalised in the questionnaire using a combination of quantitative indicators and psychometric scales (see paragraph 5.2.1). In particular, a priori beliefs were operationalised by means of multi-item psychometric scales. In order to increase interpretability, the variables were then factor analyzed using orthogonal rotation. After eliminating two items with high levels of cross loadings, the procedure yielded a two-factor solution representing, respectively, the degree of confidence in renewable energy technological adequacy and the degree of confidence in market efficiency. The two variables were finally operationalised by aggregating the items tapping into each construct. The degree of *confidence in renewable energy technological adequacy* was assessed by means of the following two items: a) energy supply from new renewable electricity sources (e.g. wind and solar) will grow by more than 10% per year worldwide over the next 20 years; b) solar energy is a low-density resource, requiring a lot of land: therefore it will never achieve a significant share of the world's energy mix (reversed). The degree of *confidence in market efficiency* was assessed by means of the following two items: c) market forces alone will never lead to a significant exploitation of renewable (reversed); d) government intervention does more harm than good, let governments stay out of the way.

The attitude for technological risk was assessed by means of a two-step procedure. Respondents were first asked to allocate a hypothetical investment budget of USD 10 Million to three different solar technologies with increasing degrees of technological uncertainty: crystalline silicon cells, thin film cells, and third-generation solar cells based on nanostructures. *Technological risk seeking attitude* was then measured as the ratio of the amount allocated to the radically innovative technologies (nanostructures) to the amount allocated to the less innovative technologies (crystalline silicon and thin films).

The policy variables were measured using the results of the conjoint analysis. In particular, the average importance of the attributes calculated for each respondent was used to operationalise the policy variables retained in the regression model. In this respect, it is worth highlighting that average importances are calculated from part worth utilities and are expressed as the ratio between the average utility differences between the best and worst level of each attribute and the sum of average utilities. Since part worth utilities are interval data which are scaled to sum to zero within each attribute, it is not possible to directly compare values between attributes, and therefore part worth utilities are not suited to be used as such in the regression model. As the purpose of the regression model is to characterise the relative importance of each policy attribute for the surveyed investors, individual-level average importances have been used.

In order to incorporate the results of the conjoint analysis in the regression model, a series of methodological choices had to be taken. First of all, since the conjoint importances are expressed as percentages that add to 100, it was not possible to include all five policy variables in the regression model, as the latter would otherwise be undetermined. To overcome this problem, instead of excluding one variable a priori, it was preferred to use of all policy variables by normalizing all other utility values to the utility value of the least preferred policy attribute, i.e. social acceptance (see chapter 7).

As mentioned, the model also included two main control variables: the *investor's experience* was measured as the number of years of experience that each respondent had in the renewable energy sector. To control for *firm's type*, three dummy variables were created: dummy_VC included venture capitalists and private equity firms; dummy_funds included pension funds, hedge funds, banks and insurance companies; finally, dummy_others included all other investors not belonging to the former two broad categories, i.e.: project developers, utilities, infrastructure funds and engineering companies.

The *share of renewable energy in the investment portfolio* was measured through a 5-point scale, where each point corresponded to increasing percentages of renewable energy technologies in the investment portfolio (from 1 = less than 5% to 5 = 100%).

Finally, the performance of the investment was measured through a 3-point Likert scale that assessed the extent to which the portfolio's performance was considered by the respondent above, equal to, or below the direct competitor's performance. It is worth highlighting that, although the questionnaire included questions regarding both the past and the future expected performance, only past performance was retained in the model as dependent variable.

Given the confidential nature of the information collected, all the dependent variables had to be measured through the questionnaire. This is indeed a shortcoming of the present research. In an ideal experimental setting, objective data should have been used to measure the investment performance. Unfortunately, given the reluctance of the surveyed companies to disclose information on their investment funds, more qualitative and perceptual measures had to be adopted in the final version of the questionnaire.

In order to exclude the risk of self reported biases and therefore confirm the validity of results, a Harman's single-factor test was conducted (Andersson and Bateman, 1997; Podsakoff et al., 2003). The Harman's single factor test is widely used in social sciences in order to control for common method variance (i.e. self reported bias). This refers to the amount of spurious covariance shared among variables because of the common method used in collecting data (Buckley et al., 1990). The test requires the researcher to load all the variables in the study into an exploratory factor analysis and examine the unrotated factor solution to determine the number of factors that are necessary to account for the variance in the variables. The basic assumption of this technique is that the presence of common method variance is indicated by the emergence of either a single factor or a general factor accounting for the majority of covariance among measures (Podsakoff et al., 2003). The results of this test are reported in Table 4 and Table 5.

Table 4: Harman's single factor test: Eigenvalues

	Eigenvalue	Difference	Proportion of variance explained	Cumulative variance explained
1	2.95	1.22	0.33	0.33
2	1.72	0.46	0.19	0.52
3	1.26	0.26	0.14	0.66
4	1.00	0.20	0.11	0.77

As shown in Table 4, the unrotated factor solution resulting from the exploratory factor analysis indicates a 4-factor structure with eigenvalues greater than or equal to one and shows that none of the factors accounts for the majority of the covariance among the measures[11]. If the data were affected by common method variance the data would have revealed a structure largely dominated by a single factor, which should have accounted for most of the variance in the sample.

Table 5 displays the details for the four factors identified.

Table 5: Harman's single factor test: Unrotated factor patterns

Variables	Factor 1	Factor 2	Factor 3	Factor 4
Confidence in market efficiency	-0.29	0.43	0.16	0.65
Confidence in technology adequacy	-0.34	0.57	0.49	0.26
Technological risk seeking attitude	-0.09	0.45	-0.74	-0.04
Perceived importance of the policy type	0.91	0.20	-0.03	0.12
Perceived importance of support level	0.94	0.19	0.11	0.00
Perceived importance of support duration	0.95	0.13	0.06	0.06
Perceived importance of the length of the administrative process	0.89	0.24	0.00	-0.03
Investor's experience	0.12	-0.54	-0.18	0.61
RE share in the investment portfolio	0.27	-0.65	-0.19	0.32
Investment performance	0.18	-0.56	0.48	-0.18

In the unrotated factor matrix, the columns define the factors and the rows refer to variables. The number of factors (columns) is the number of substantively meaningful independent (uncorrelated) patterns of relationship among the variables (four in this case). The intersection of row and column indicates the loading for the row variable on the column factor. The loadings measure which variables are involved in which factor pattern and to what degree. By comparing the factor loadings for all factors and variables, those

[11] For example, factor 1 explains only 33% of the covariance among measures, factor two is responsible for 19%, factor 3 for 14% and factor 4 explains only 11% of the variance.

particular variables involved in an independent pattern can be defined, and those variables most highly related to a pattern can also be seen. While looking at the first factor (column), it can be seen for example that it seems to exist a high positive correlation between the perceived importance of policy type, support level, support duration and length of the administrative process under factor 1 (with values of 0.91, 0.94, 0.95 and 0.89, respectively). However, all remaining loadings under the same factor are low. Additionally, the same variables which display high loadings under factor 1 have different and very low values under all remaining factors. This is an additional confirmation that the model is not affected by common method variance problem.

5.3.2.3 Application to the present study

The conceptual model described in Figure 5 (page 51) was tested by estimating the linear models (1) and (2) below:

$$\mathrm{Y}_{1,\mathrm{i}} = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \beta_3 x_{3i} + \beta_4 x_{4i} + \beta_5 x_{5i} + \beta_6 x_{6i} + \beta_7 x_{7i} + \sum_j \beta_j control_{ij} + \varepsilon_i \quad (1)$$

$$\mathrm{Y}_{2,\mathrm{i}} = \gamma_0 + \gamma_1 \mathrm{Y}_{1,\mathrm{i}} + \gamma_2 x_{3i} + \sum_j \gamma_j control_{ij} + \eta_i \quad (2)$$

Where:

Y1: RE share in the investment portfolio

Y2: Investment performance

x1 : Confidence in market efficiency

x2 : Confidence in technological adequacy

x3 : Technological risk seeking attitude

x4 : Perceived importance of policy type

x5 : Perceived importance of support level

x6 : Perceived importance of support duration

x7 : Perceived importance of the length of the administrative process

Controlj: Investor’s experience, dummy VC, dummy funds, dummy ‘other investors’

The two equations were first estimated as independent regressions by means of Ordinary Least Squares (OLS). However, as the dependent variable of the first equation (Y1) is one of the explanatory variables in the second equation, OLS estimators could be biased and inconsistent. The model was therefore re-estimated using three different methods: 2-stage Least Square (2SLS), 3-stage Least Square (3SLS), and Seemingly Unrelated Regression (SUR) as well. SAS Proc Model was used to estimate both the OLS and the system equation models.

The results of a Hausman specification test (Hausman, 1978), which is used to check for the endogeneity of a variable, suggested that the data structure was not affected by endogeneity and that the system estimation methods were not necessarily preferred over OLS. For consistency purposes, and to take into account the econometric characteristics of the dependent variable, the performance equation was also re-estimated using a multinomial logit model. In fact, as the analysis revealed no endogeneity problems, it was possible to estimate equations 1 and 2 separately.

The results of all the four estimation methods, as well as the additional estimation of the performance model through multinomial logit are reported in chapter 8.

6 Descriptive statistics

This section introduces the results of the questionnaire survey, by providing some descriptive statistics for the sample analysed. More specifically, after presenting the respondents' profile the chapter illustrates the responses given by the sample to the questions raised in the survey, as regards their market and technology beliefs, the main sources informing their investment decisions, their risk taking attitude and their self-assessment of investment performance. This first set of results serves also a basis for the more in-depth elaborations provided in the following chapters.

6.1 Profile of respondents

Table 6, which displays descriptive statistics, suggests that the sample is fairly well diversified, with respect to the degree of renewable energy penetration in the investment portfolios, the types of technologies included in the portfolios, as well as the profile of investors.

Table 6: Descriptive statistics for the sample

	Research sample	
Firm's exposure to the RE investing domain	**N**	**%**
- yes	62	67%
- no	31	33%
Total	93	100%
Investment by technology	**N**	**%**
- Solar photovoltaic	36	58%
- Wind onshore	29	47%
- Biomass	21	34%
- Solar thermal	15	24%
- CSP	14	23%
- Hydropower	13	21%
- Wind offshore	12	19%
- Geothermal	11	18%
- Biofuels	4	6%
- Tidal/Wave	3	5%

Table 6: Descriptive statistics for the sample (cont.)

Share of renewables in the investment portfolio	N	%
- Less than 5%	12	19%
- From 5 to 9%	6	10%
- From 10 to 49%	16	26%
- From 50 to 99%	11	18%
- I only invest in renewables	17	27%
Total	62	100%
Personal experience in the RE investing domain	**N**	**%**
- No experience	10	16%
- Less than 5 years	29	47%
- From 5 to 10 years	17	27%
- More than 10 years	6	10%
Total	62	100%
Company profiles	**N**	**%**
- Venture Capital, Private Equity or hybrid	34	37%
- Banks, Hedge Funds, Pension Funds and Insurance Companies	10	11%
- Project developers and utilities	5	5%
- Infrastructure Funds	4	4%
- Private companies	8	9%
- Engineering/other	6	6%
- No response	26	28%
Total	93	100%
Age of respondents	**N**	**%**
- Under 30 years	10	11%
- From 31 to 40 years	35	37%
- From 41 to 50 years	11	12%
- More than 50 years	6	7%
- No response	31	33%
Total	93	100%
Educational background	**N**	**%**
- Economics and business administration	24	26%
- Finance	16	17%
- Legal	2	2%
- Engineering	24	26%
- Multidisciplinary	27	29%
Total	93	100%

The data indicate that about two thirds of the respondents currently invest in renewables. It is worth highlighting that the database of contacts included both companies already investing in the renewable energy market and companies not investing in this domain. Such distribution suggests that companies involved in the renewable energy investing domain had a stronger interest in taking the questionnaire compared to non-renewable energy investors.

Renewables represent at least 10% of the portfolio for over 70% of respondents, while 27% of respondents invest only in renewables. Solar photovoltaics and wind onshore are the two most represented technologies, being in the investment portfolios of 57% and 47% of the respondents, respectively. Biomass, solar thermal and concentrated solar power follow, while tidal and wave are the least represented technologies (accounting for only 5% of the portfolio).

With respect to the investors' profiles, the sample is also well diversified. Although more than half of respondents who have answered the question declare to work for a Venture Capitalist (VC) and Private Equity (PE) Funds or hybrid combinations of both, other investors are well represented too. Private companies and investment funds constitute 8% of the sample. Banks, insurance companies, pension funds and hedge funds total 10% of the sample, project developers and utilities cover 6% of the sample, and Infrastructure Funds account for 4%.

The average investor's experience in the renewable energy sector is not particularly high. Only 27% of respondents have more than 5 years of experience with renewables, and only 10% have more than 10 years experience. The majority (47%) declared having less than 5 years of experience, and the remainder has not experience at all. This is not surprising, if we consider that the renewable energy market has started experiencing a considerable growth only quite recently and still represents a limited fraction of the global energy market (Usher, 2008b).

It also worth adding that, although respondents seem to have rather limited experience with the renewable energy industry, on average they have considerable overall working experience. By looking at their age groups, it can be noted that 84% of those who have answered this question are at least 30 years old or older, 27% are over 40 years old and 10% are older than 50 years. This suggests that investors have acquired relevant experience in other sectors before switching to the renewable energy business. Such finding is further confirmed by the position held within the organization. Respondents are senior representatives of their companies, their profiles ranging from Vice-Presidents and CEOs to Directors, Managing Partners, Associates and Senior

Analysts. The high-level profile of investors ensures a certain level of accuracy in the responses, thus supporting the reliability of data.

Finally, in terms of education almost one third of respondents have a multidisciplinary background; 25% have studied Engineering and 25% Economics and Business Administration.

6.2 Awareness and beliefs

As mentioned in chapter 5, the purpose of the second section of the questionnaire is to assess the investors' knowledge and awareness of the technological and market potential of renewable energy sources, their a-priori beliefs about the role of market and policy in supporting the growth of renewables, as well as their attitude toward technological innovation.

The first question aims at investigating the degree of awareness regarding the cumulative amount of investments needed in the energy sector in order to invert the current trend of increasing greenhouse gas emissions and avoid catastrophic consequences for the climate.

The background data used to formulate the question are taken from the already cited IEA publication "Energy Technology Perspectives" (ETP), 2008 edition. The ETP represents a reference book for energy practitioners, and is widely known also to most renewable energy investors and commercial organisations. Data refer to two different CO_2 mitigation scenarios: the "ACT scenario", resulting in a stabilization of CO_2 emissions to current levels by 2050, and the "BLUE MAP scenario", which would lead to a halving of CO_2 emissions by the same target year.

The question addressed to the survey respondents was: "If CO_2 emissions are to be significantly reduced by 2050 compared to current levels, huge investments in new and innovative technologies are required. How would you assess the following estimates of investment needs provided by various researchers".

The responses given by the investors in the first case are displayed in Figure 9.

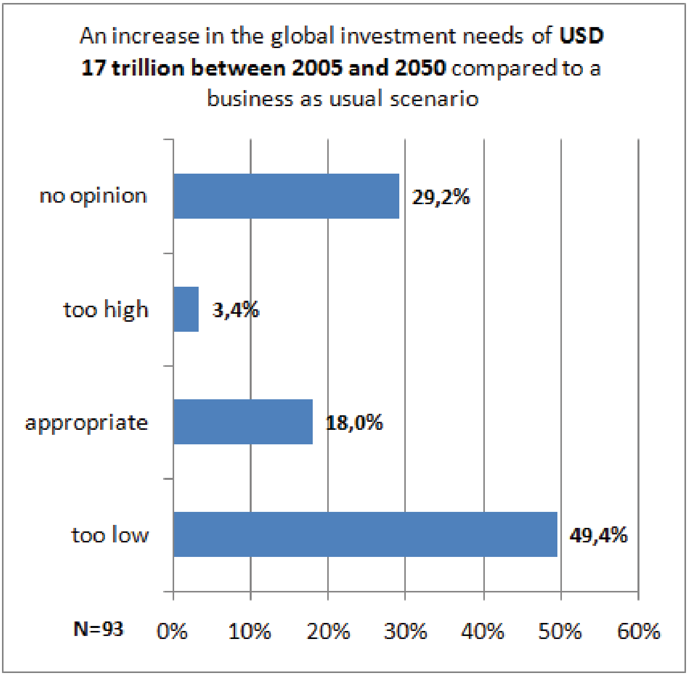


Figure 9: Respondents' opinions on the appropriateness of the investment effort proposed by the ACT scenario of the ETP 2008 publication

For almost half of respondents, an additional investment effort of 17 trillion over the period 2005-2050 is not enough to avoid serious consequences for the climate. This suggests that on average investors seem to be quite aware of the magnitude of the problem. Another 18% of the sample believes that the proposed amount is appropriate, while only 3% of investors think this effort is too high.

Figure 10 shows the responses provided by the investors regarding the more ambitious emission reduction scenario. An increase in the global investment needs of USD 45 trillion between 2005 and 2050 compared to a business as usual scenario is considered appropriate by over 37% of respondents. Almost one fourth of the sample considers this estimate too high, and more than 12% of respondents believe it is too low.

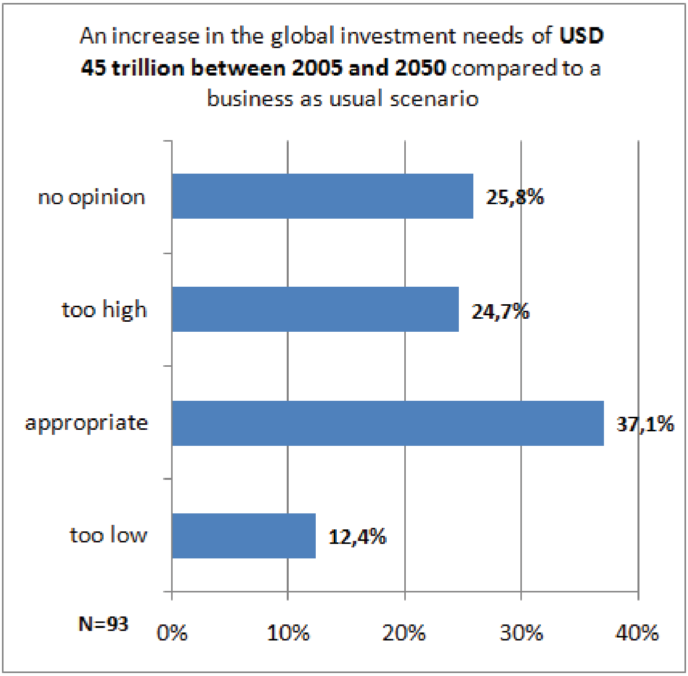


Figure 10: Respondents' opinions on the appropriateness of the investment effort proposed by the BLUE MAP scenario of the ETP 2008 publication

In the following question investors are asked to identify the likely share that renewables could reach in Europe by 2050.

As displayed in Figure 11, a penetration rate of 20% of renewables by 2050 is feasible for almost 80% of respondents. In addition, over 40% of the sample believes that renewable energy sources could reach a rate of 50% by 2050. A higher share of renewables in the future European energy mix is not likely to be reached, according to the investigated sample. In particular, only 9% of respondents believe that reaching up to 80% of renewable energy in the European mix by 2050 is feasible, while 62% think that this target is unfeasible. Furthermore, 74% of respondents think that reaching a fully renewable-based energy system is completely unfeasible.

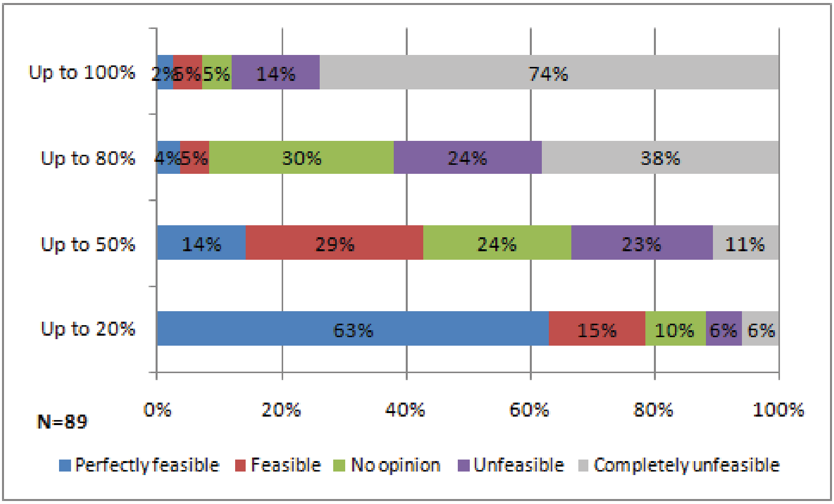


Figure 11: Respondents' opinions on the feasible share that renewables could reach in Europe by 2050

The third question consists in a table displaying seven common beliefs about renewable energy sources. Respondents are asked to indicate to what extent they would agree with each of the statements proposed.

These a priori beliefs can be grouped in two main categories: technology beliefs, which reflect the investors' trust in the potential of the technologies considered for the investment, and market and policy beliefs, which are related to the investors' degree of confidence in the efficiency of market and policy mechanisms. As already mentioned, following a cognitive psychology approach some statements are positively phrased while some others are negatively phrased.

As shown in Figure 12, two thirds of respondents believe that the energy supply from new renewable energy technologies like solar and wind will grow by more than 10% per year worldwide over the next 20 years. This is in line with the projections made available by the most authoritative sources in the sector (IEA, 2008a) and corroborates the impression that, on average, respondents display a high degree of awareness and a good knowledge of the technology potentials.

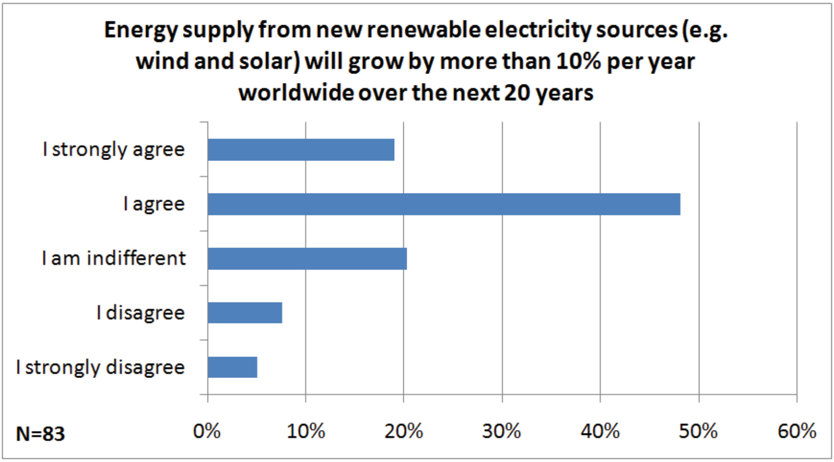


Figure 12: Respondents' opinions on the growth potential of new renewable energy technologies

Figure 13 reports one common belief about solar energy, i.e. the fact that it will never achieve a significant share of the world's energy supply given the huge amount of land that it requires.

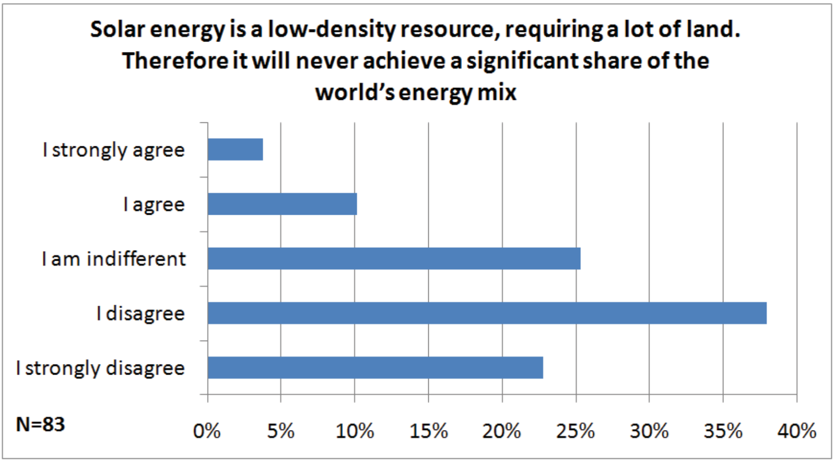


Figure 13: Respondents' opinions on the potential for solar energy to reach a significant share of the world's energy mix

This common misperception does not take into account the significant progresses achieved by solar technology, which makes it suitable for building-integrated applications, thus not requiring any land occupation. Respondents seem to be aware of these technological improvements; in fact over 60% of them do not agree with this statement. However, it is worth highlighting that 14% of investors either agree or strongly agree.

Another common opinion about renewable energies is that their intermittent availability raises a lot of additional problems to grid management since it alters grid stability. It is believed that huge investments are needed in order to ensure storage systems and back-up capacities to compensate for the variability of renewable energy sources. In reality, the amount of renewables that can be safely integrated in grids depends on the flexibility of the whole system. The latter depends on four aspects: flexible supply (for instance based on gas and hydro), flexible demand (e.g.: smart grids), storage and interconnections. In particular, a highly interconnected system needs much less storage and back-up. Since huge investments in transmission and distribution are needed in a scenario of highly growing electricity demand, this is a unique opportunity to modernise and make electricity systems more flexible, which will allow for an easier integration of renewables.

Although significant improvements have been reached in terms of flexibility of power systems and of renewable energy output forecasts, many stakeholders are still skeptical on the actual potential of renewables for large scale deployment because of the mentioned shortcomings. As far as the surveyed investors are concerned, Figure 14 indicates that almost half of respondents do not agree with this statement, while 28% either agree or strongly agree.

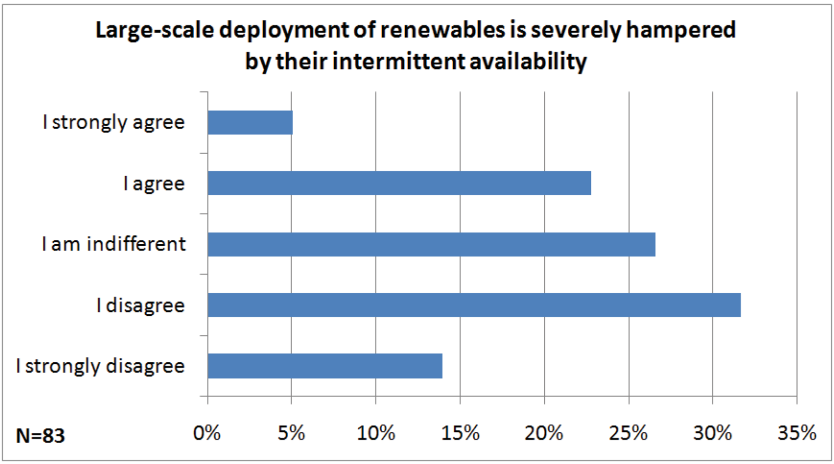


Figure 14: Respondents' opinions on the large-scale growth potential of renewable energy technologies given their intermittent availability

As already described in chapter 2, experts indicate that with current trends solar PV will reach the so called grid-parity within the next 10 to 20 years.

Therefore, in order to measure the degree of optimism of investors regarding the potential of solar PV, a specific question has been elaborated on this topic.

As Figure 15 reveals, this is a quite controversial issue among the investment community; in fact the number of investors who do not believe this will happen almost equals the number of those who believe that solar PV will reach the same cost of conventional retail electricity within the next decade (41% versus 46%).

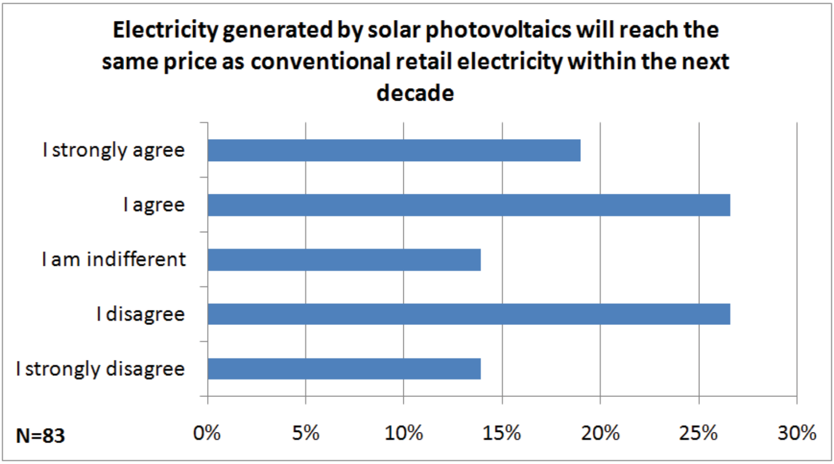


Figure 15: Respondents' opinions on the potential of PV to reach grid parity

As far as policy and market beliefs are concerned, three specific questions were addressed in the survey, which have the purpose to understand whether respondents see policies and regulations as beneficial or harmful to the effective deployment of a market for renewables.

According to Figure 16, 44% of respondents think that government regulation is important to enable a favourable framework for the growth of renewable energies, and that market forces alone will never be able to boost the sector.

However, 35% of the sample has the opposite view, i.e. that governments should not interfere with market dynamics, and that market forces will ensure the significant exploitation of renewable energy sources.

The statement presented in Figure 17 presents a completely opposite view compared to the previous one, since it incorporates an anti-government perspective expressed by one venture capitalist during a previous survey (Teppo, 2006).

The results indicate that for over 70% of respondents, government intervention in the renewable energy sector is not harmful; only 8% of the sample concurs with the proposed statement.

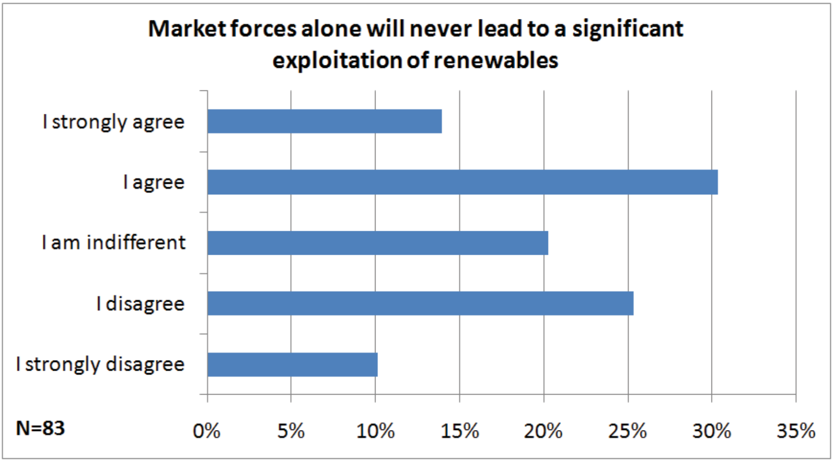


Figure 16: Respondents' opinions on the possibility for market forces to lead to a significant exploitation of renewables

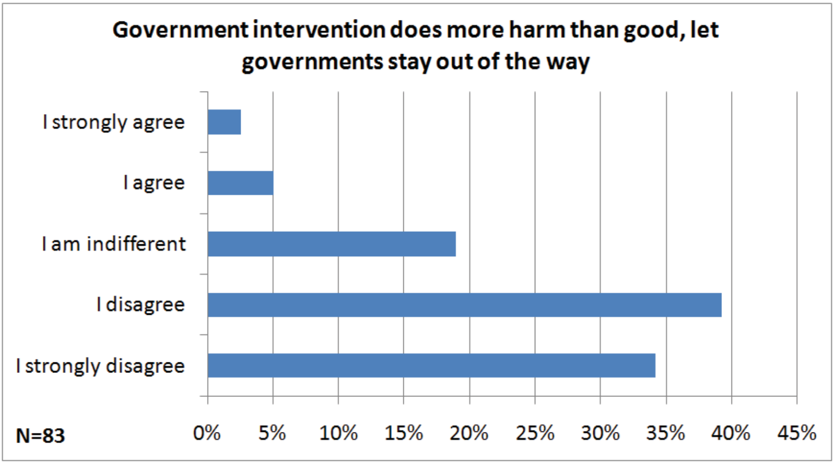


Figure 17: Respondents' opinions on the appropriateness for government to intervene in the renewable energy sector

The last statement intends to provide support to one of the previous two, by looking at investors' attitudes vis-à-vis renewable energy subsidies. This topic is very controversial and has been extensively disputed by both scholars and practitioners. Opponents point out that renewable energy subsidies distort the market therefore leading to unfair competition, while supporters highlight that subsidies to renewable energies are just a way to create a more level playing field. In fact, fossil energy sources are also heavily subsidized by governments, with estimated annual expenditures of approximately 550 billion USD (Birol, 2010).

According to fifty percent of the investigated sample, renewable energy subsidies do not represent a potential source of risk for their investments. Another 23% of respondents on the contrary share the view that subsidies represent a source of risk, as shown in Figure 18.

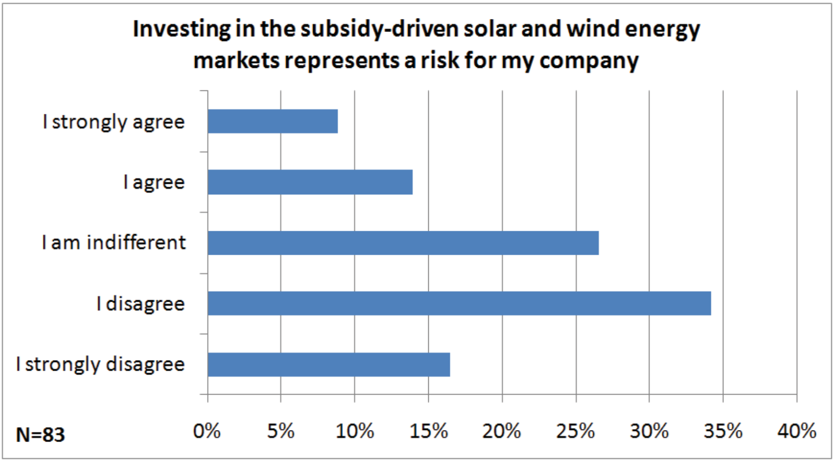


Figure 18: Respondents' opinions on the appropriateness of renewable energy subsidies

6.2.1 Correlations among a priori beliefs

Once described qualitatively the main investors' technological and market a priori beliefs, an additional analysis has been carried out, which consisted in looking for some correlation amongst these beliefs. The contingency table reported below (Table 7) reveals a strong correlation (significance at the 99% level) between some of them. In particular:

- Those who think that electricity generated by solar PV will reach grid parity within the next decade do not support the view that solar energy will never achieve a significant share of the world's energy mix, thus displaying a strong confidence in the potential of solar technology

- Those who think that electricity generated by solar PV will reach grid parity within the next decade believe also that energy from new renewable energy sources will grow by over 10% per year worldwide over the next 20 years, thus confirming their positive attitude vis-à-vis the potential of more innovative technologies

- Those who think that solar energy will never achieve a significant share of the world's energy mix believe also that large scale deployment of renewables is severely hampered by their intermittent variability, thus implying that these investors still perceive high technological barriers; for them achieving a satisfactory level of technological reliability is an important condition to commit more capital in the renewable energy business sector.

Table 7: Significant correlations between a priori beliefs

		Energy supply from new renewable electricity sources (e.g. wind and solar) will grow by more than 10% per year worldwide over the next 20 years	Solar energy is a low-density resource, requiring a lot of land. Therefore it will never achieve a significant share of the world's energy mix	Large-scale deployment of renewables is severely hampered by their intermittent availability	Market forces alone will never lead to a significant exploitation of renewables	Government intervention does more harm than good, let governments stay out of the way	Investing in the subsidy-driven solar and wind energy markets represents a risk for my company	Electricity generated by solar photovoltaics will reach the same price as conventional retail electricity within the next decade
Energy supply from new renewable electricity sources (e.g. wind and solar) will grow by more than 10% per year worldwide over the next 20 years	Pearson correlation	1	-,156	-,040	,075	-,197	-,131	,383**
	Sig. (bilateral)		,175	,727	,519	,085	,258	,001
	N	77	77	77	77	77	77	77
Solar energy is a low-density resource, requiring a lot of land. Therefore it will never achieve a significant share of the world's energy mix	Pearson correlation	-,156	1	,301**	,122	,209	,130	-,416**
	Sig. (bilateral)	,175		,008	,290	,068	,261	,000
	N	77	77	77	77	77	77	77
Large-scale deployment of renewables is severely hampered by their intermittent availability	Pearson correlation	-,040	,301**	1	,291*	,230*	,111	,087
	Sig. (bilateral)	,727	,008		,010	,044	,338	,454
	N	77	77	77	77	77	77	77
Market forces alone will never lead to a significant exploitation of renewables	Pearson correlation	,075	,122	,291*	1	-,019	-,091	,023
	Sig. (bilateral)	,519	,290	,010		,868	,431	,842
	N	77	77	77	77	77	77	77
Government intervention does more harm than good, let governments stay out of the way	Pearson correlation	-,197	,209	,230*	-,019	1	,014	-,086
	Sig. (bilateral)	,085	,068	,044	,868		,902	,457
	N	77	77	77	77	77	77	77
Investing in the subsidy-driven solar and wind energy markets represents a risk for my company	Pearson correlation	-,131	,130	,111	-,091	,014	1	-,205
	Sig. (bilateral)	,258	,261	,338	,431	,902		,073
	N	77	77	77	77	77	77	77
Electricity generated by solar photovoltaics will reach the same price as conventional retail electricity within the next decade	Pearson correlation	,383**	-,416**	,087	,023	-,086	-,205	1
	Sig. (bilateral)	,001	,000	,454	,842	,457	,073	
	N	77	77	77	77	77	77	77

**.The correlation is significant at the 0.01 level (bilateral).

*.The correlation is significant at the 0.05 level (bilateral).

6.2.2 Technology beliefs and share of investments in renewables

The purpose of this analysis was to understand whether a higher degree of confidence in the technological potential of renewable energy sources is reflected into a higher share of renewables in the investment portfolio. In the present paragraph the main findings are reported, according to the specific types of technological a priori beliefs analysed.

From the analysis of contingency tables reported below (Table 8- Table 10) it can be seen that:

- The stronger is the belief that new renewable energy technologies will grow by 10% per year worldwide over the next 20 years, the higher is the share of renewables in the investment portfolio

- The stronger is the belief that solar will never achieve a significant share of the world's energy mix, the lower is the share of renewables in the investment portfolio

- The stronger is the belief that large scale deployment of renewables is severely hampered by their intermittent availability, the lower is the share of renewables in the investment portfolio

Table 8: Analysis of the contingency table comparing the opinions on the growth potential of new renewable energy technologies with the actual share of RES in the investment portfolio

N=77		Energy supply from new renewable electricity sources (e.g. wind and solar) will grow by more than 10% per year worldwide over the next 20 years					
		I strongly disagree	I disagree	I am indifferent	I agree	I strongly agree	Total
What percentage of your portfolio is in renewable energy technologies?	Less than 5%	10.0%	10.0%	20.0%	40.0%	20.0%	100.0%
	From 5 to 9%	0.0%	0.0%	50.0%	50.0%	0.0%	100.0%
	From 10 to 49%	0.0%	8.3%	8.3%	66.7%	16.7%	100.0%
	From 50 to 99%	0.0%	0.0%	12.5%	25.0%	62.5%	100.0%
	I only invest in RES	0.0%	7.1%	0.0%	71.4%	21.4%	100.0%
Total		2.1%	6.3%	12.5%	54.2%	25.0%	100.0%

Table 9: Analysis of the contingency table comparing the opinions on the growth potential of solar energy technologies with the actual share of RES in the investment portfolio

N=77		Solar energy is a low-density resource, requiring a lot of land. Therefore it will never achieve a significant share of the world's energy mix					
		I strongly disagree	**I disagree**	**I am indifferent**	**I agree**	**I strongly agree**	**Total**
What percentage of your portfolio is in renewable energy technologies?	**Less than 5%**	10.0%	30.0%	50.0%	0.0%	10.0%	100.0%
	From 5 to 9%	0.0%	25.0%	50.0%	25.0%	0.0%	100.0%
	From 10 to 49%	33.3%	50.0%	0.0%	16.7%	0.0%	100.0%
	From 50 to 99%	50.0%	25.0%	25.0%	0.0%	0.0%	100.0%
	I only invest in RES	28.6%	57.1%	7.1%	7.1%	0.0%	100.0%
Total		27.1%	41.7%	20.8%	8.3%	2.1%	100.0%

Table 10: Analysis of the contingency table comparing the opinions on the large-scale growth potential of renewable energy technologies with the actual share of RES in the investment portfolio

N=77		Large-scale deployment of renewables is severely hampered by their intermittent availability					
		I strongly disagree	I disagree	I am indifferent	I agree	I strongly agree	Total
What percentage of your portfolio is in renewable energy technologies?	Less than 5%	0.0%	20.0%	30.0%	40.0%	10.0%	100.0%
	From 5 to 9%	0.0%	0.0%	50.0%	50.0%	0.0%	100.0%
	From 10 to 49%	16.7%	33.3%	33.3%	8.3%	8.3%	100.0%
	From 50 to 99%	25.0%	50.0%	12.5%	12.5%	0.0%	100.0%
	I only invest in RES	14.3%	57.1%	14.3%	14.3%	0.0%	100.0%
Total		12.5%	37.5%	25.0%	20.8%	4.2%	100.0%

6.3 Main sources for informing investment decisions

The questionnaire also intended to provide some useful indications regarding the most relevant sources to inform investment decisions in the renewable energy market. To this end respondents were asked to rank the following five sources based on the extent to which they influence their investment decisions: i) investments by well-known/high-profile investors in the sector; ii) technical reports; iii) personal intuition; iv) in-house due diligence; v) consultants' opinion.

These options were presented by means of a pull-down list and measured along a one-to-five scale, where 1 corresponds to the most important source and 5 to the least important source.

Figure 19 shows that in-house due diligence scores highest amongst the proposed options, being mentioned as the most important source of information by 35% of respondents. Financiers seem to rely also on the investment decisions taken by sector leaders (25% of responses), and on technical reports (22%). Personal intuition is mentioned by 11% of respondents, while consultants' opinion is the least relevant information source according to respondents.

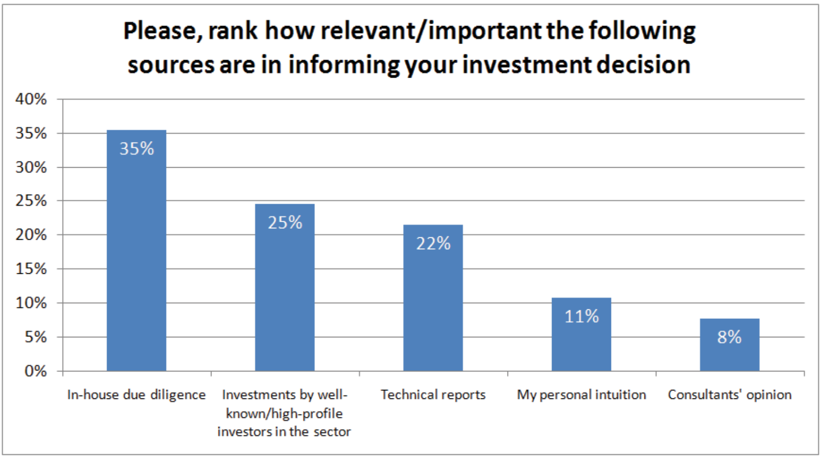


Figure 19: Most important sources for informing investment decisions (items having received a 1 ranking in the survey; N=65)

In order to gain even deeper insights, some demographic segmentation has been conducted.

Table 11 reveals that young professionals seem to display a certain overconfident attitude, which is progressively softening with the increase of experience. For example, while personal intuition is mentioned as the most important driver for an investment decision by 50% of young financiers, very experienced professionals (more than 50 years old) declare to rely mainly on in-house due diligence.

Intermediate groups (31-40 and 41-50 years old investors) have a more diversified attitude. Among the various categories, they tend to follow more what well known and highly reputed investors are doing, while taking their investment decisions.

Table 11: Most important sources for informing investment decisions split by age groups

Information sources (N=65)	**Age group**			
	< 30	**31-40**	**41-50**	**> 50**
In-house due diligence	38%	43%	22%	60%
Investments by well known/high profile investors	0%	21%	44%	20%
Technical reports	13%	14%	33%	20%
My personal intuition	50%	11%	0%	0%
Consultants' opinion	0%	11%	0%	0%
Total	**100%**	**100%**	**100%**	**100%**

Results split by type of company are more nuanced. As shown in Table 12, there is no specific behaviour that characterises strongly a certain company type compared to others. Similar patterns can be identified in pension funds and hedge funds. However, the sample of these two categories is too small to enable any strong conclusion. The other interesting aspect is that VC and PE funds assign the highest rankings to personal intuition across the whole sample.

Table 12: Most important sources for informing investment decisions split by company type

Information sources (N=65)	Company type						
	1	2	3	4	5	6	7
In-house due diligence	100%	0%	20%	100%	0%	21%	30%
Investments by well known/high profile investors	0%	8%	20%	0%	100%	14%	30%
Technical reports	0%	17%	20%	0%	0%	21%	5%
My personal intuition	0%	58%	20%	0%	0%	36%	35%
Consultants' opinion	0%	17%	20%	0%	0%	7%	0%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

1= Pension Fund
2= Venture Capital
3= Bank
4= Hedge Fund
5= Insurance
6= Private Equity
7= Other

Figure 20 regroups the results for all scores and for the whole sample.

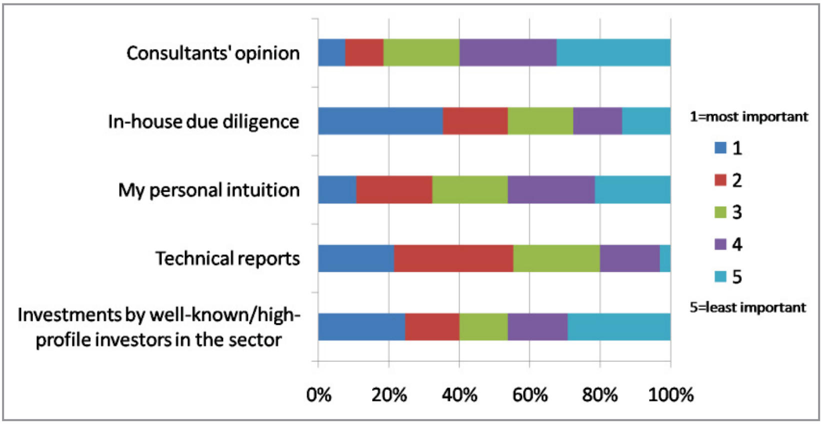


Figure 20: Main sources for informing investment decisions (from 1=most important to 5=least important)

By summing up the scores received by each information source as first and second preferred option respectively, technical reports outstrip in-house due diligence as an important source for informing the investment decision making process. It is also worth highlighting that investments performed by well-known market actors are mentioned as an important source of information by 40% of the sample, thus confirming the existence of herd behaviours in this market. Personal intuition is an important source of information for over one third of investors, while consultants' opinions remain by far the least considered source by the investigated sample. Finally, when looking at weighted average scores the following ranking order is obtained: 1) in-house due diligence and technical reports, 2) investments by well known/high profile investors in the sector, 3) my personal intuition, and 4) consultants' opinion.

6.4 Risk taking attitude of investors

In order to evaluate the investors' attitude for technological risk, a question was formulated, which asked respondents to allocate a hypothetical investment budget of USD 10 Million to three different solar technologies with increasing degrees of technological uncertainty (and therefore with increasing degrees of risk): crystalline silicon cells, thin film cells, and third-generation solar cells based on nanostructures. The results are presented in Figure 21, which shows the average allocation for the sample: 3.7 million Euros would be hypothetically invested in crystalline silicon solar cells, 3.7 million Euros in thin-films solar cells, and 2.6 million Euros in third generation solar cells.

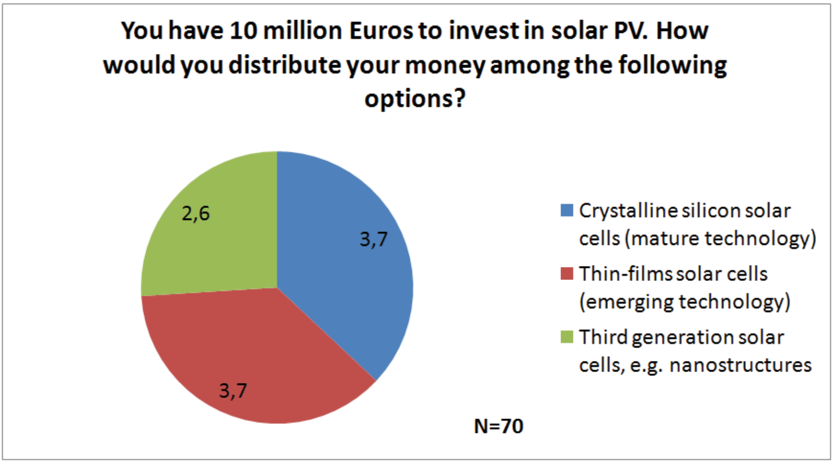


Figure 21: Distribution of the portfolio amongst PV solar technologies

This average distribution appears quite rational, since it takes accurately into account the current market share of the various solar technologies and their expected evolution. Indeed, as reported by EPIA (2010) while the PV market is still dominated by crystalline silicon technologies, more innovative technologies like for example thin films are expected to gain a higher share in the next few years, thanks to the more accelerated compound annual growth rate they are currently displaying.

However, by looking more in detail at single responses, quite significant differences can be identified among respondents. In particular, 20% of the sample would not invest any Euro on crystalline silicon solar cells, 12% would not invest on thin-films at all and 18.5% would not put any money on third generation solar cells. At the other extreme, 6% of respondents show a high risk aversion, since they would entirely invest on the most mature technology, which is represented by crystalline silicon solar cells. Another 6% would allocate the money in thin-films, a technology which is progressively gaining market share – nearly 23% in 2009 - but that is still significantly less exploited than crystalline silicon (REN21, 2010). Finally, 3% would invest only on third-generation solar cells, thus displaying a particular risk-taking attitude.

In order to better understand the degree of awareness of investors in this specific renewable energy market segment and to get a better feeling on their risk profile, a comparison was made between the average survey responses and the likely evolution of the PV market distribution in 2030, as reported in the IEA ETP publication (IEA, 2008a). The latter reports the projections to 2050, based on a comprehensive analysis of the historical evolution of costs and learning curves, market growth, technology developments and policy targets, as well as the review of the most authoritative technology and policy roadmaps, and the discussion of the main potential and barriers of PV technologies. As such, it can be used as an objective reference for the likely evolution of the PV market in the next decades.

Although the time horizons do not necessarily coincide (in particular, investment decisions may have a shorter horizon than 2030), it is remarkable to see that on average the distribution resulting from the survey perfectly matches the expected market share of PV technologies in twenty years from now (see Figure 22). This confirms that survey respondents have a quite robust knowledge of the current status and the expected evolution of renewable energy technologies, thus basing their decisions on factual considerations

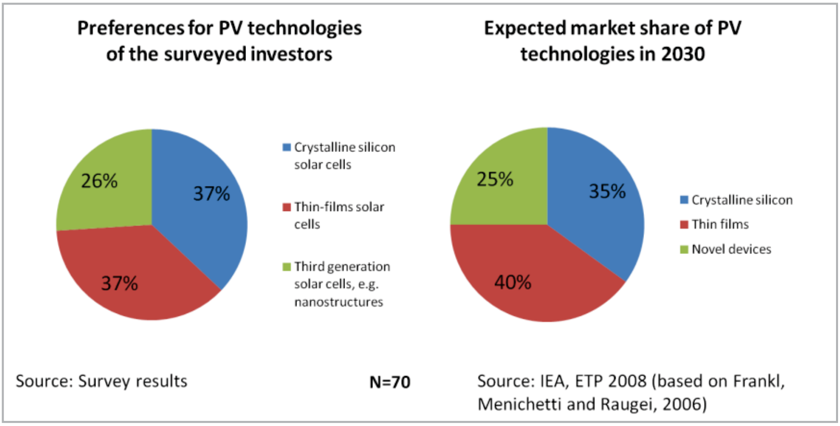


Figure 22: Forward-looking attitude of investors

6.5 Assessment of performance

In the fourth section of the questionnaire, respondents were solicited to provide a self-assessment of the perceived past performance and of the expected future performance of their investments compared to their direct competitors. Results are displayed in Figure 23 and Figure 24, respectively.

As far as past performance is concerned, based on the three best performing investments done over the past five years, two thirds of respondents believe that their performance is in line with that of their direct competitors. More than one third of respondents think that their performance is well above the performance of direct competitors, whereas about 6% of respondents think that they underperform their direct competitors.

Looking at the expected future investment performance, over half of the sample has an optimistic view, thinking that the portfolio's return will be higher or significantly higher compared to current levels. Over 44% of respondents believe that their performance will remain in line with current levels, and only 4% of respondents think that future performance will be lower than current levels.

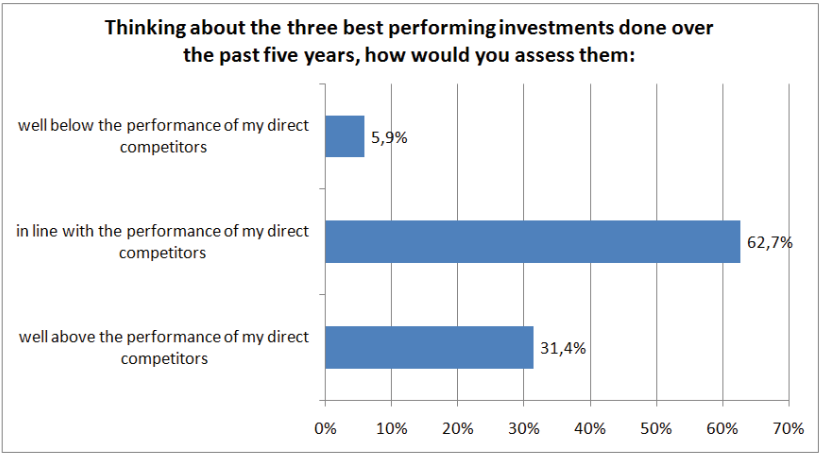


Figure 23: Perceived past investment performance compared to direct competitors

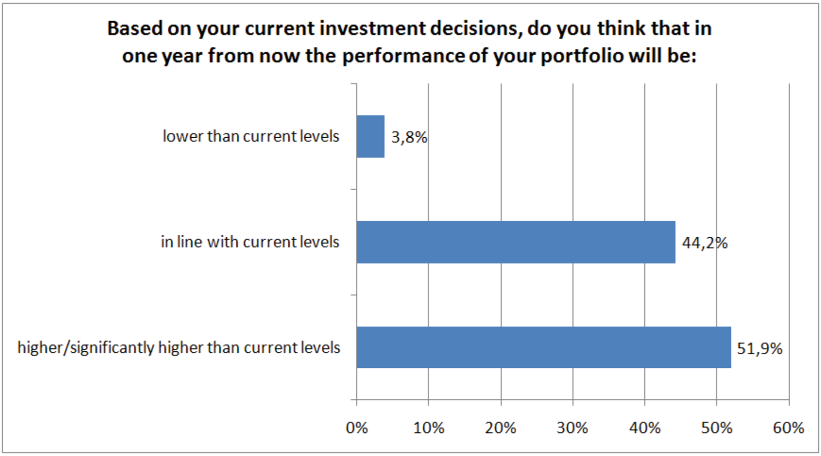


Figure 24: Expected future investment performance compared to direct competitors

Also in this case, some demographic segmentation has been conducted in order to see whether there is any influence of age and type of company on the perceived future performance.

Results are shown in Table 13 and Table 14. Regardless of the age, all investors display a positive attitude, which is even more pronounced in more experienced professionals. There is also no significant difference amongst investors' profiles. All types of companies in fact think that in one year from the investment decision, the performance of their investment will be at least in line with current levels, and in many cases higher.

Table 13: Perceived future investment performance, by age groups

Perceived future investment performance (N=62)	Age group			
	< 30	31-40	41-50	> 50
Lower than current levels	12%	8%	0%	0%
In line with current levels	38%	46%	33%	60%
Higher/significantly higher than current levels	50%	46%	67%	40%
Total	**100%**	**100%**	**100%**	**100%**

Table 14: Perceived future investment performance, by company type

Perceived future investment performance (N=66)	Company type						
	1	2	3	4	5	6	7
Lower than current levels	100%	0%	0%	0%	0%	7%	0%
In line with current levels	0%	55%	40%	0%	0%	50%	39%
Higher/significantly higher than current levels	0%	45%	60%	100%	100%	43%	61%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

1= Pension Fund
2= Venture Capital
3= Bank
4= Hedge Fund
5= Insurance
6= Private Equity
7= Other

7 Analysis of policy preferences

As already described, an important step in the research process was the assessment of investors' attitudes toward renewable energy policies. Since renewable energy markets are regulated under several policy schemes, understanding which policy characteristics influence the most the likelihood to invest in a renewable energy project by reducing the perceived risk associated to the investment can provide useful insights to decision makers. To achieve this goal, adaptive conjoint analysis was used as a tool to investigate investors' preferences over renewable energy policy characteristics.

Below the main findings are presented and discussed. The results have been calculated using the Hierarchical Bayes approach, which is considered to provide more accurate estimates compared to conventional method for adaptive conjoint analysis like Ordinary Least Squares (Sawtooth, 2002 and 2006). However, in order to assess the influence of the evaluation method on results, a sensitivity analysis has been conducted using Ordinary Least Squares technique. The results are reported in paragraph 7.7.

7.1 General findings for the sample

The results of the adaptive conjoint analysis indicate in a clearer way than the descriptive analysis that the sample is composed of rather risk-averse investors who seek to maximize their return over a relatively short time horizon. Indeed, the most relevant policy attribute is the level of the premium incentive, which on average receives over 25% of preferences. The type of policy scheme is ranked second in terms of importance, being assigned over 21% of preferences. The third important element of policies according to the investigated sample is the duration of the financial support given to the renewable energy project. This seems to be almost equally important as the type of policy scheme, since it receives about 21% of preferences from the respondents. The length of the administrative process is ranked fourth, receiving 18% of preferences.

The least important policy attribute for the sample is the overall degree of acceptance toward the renewable energy technology manifested by the main stakeholders in the hypothetical policy framework described in the survey. In fact, social acceptance receives slightly more than 14% of preferences.

The above-described results are depicted in Figure 25, and in Table 15, which reports also the standard deviations.

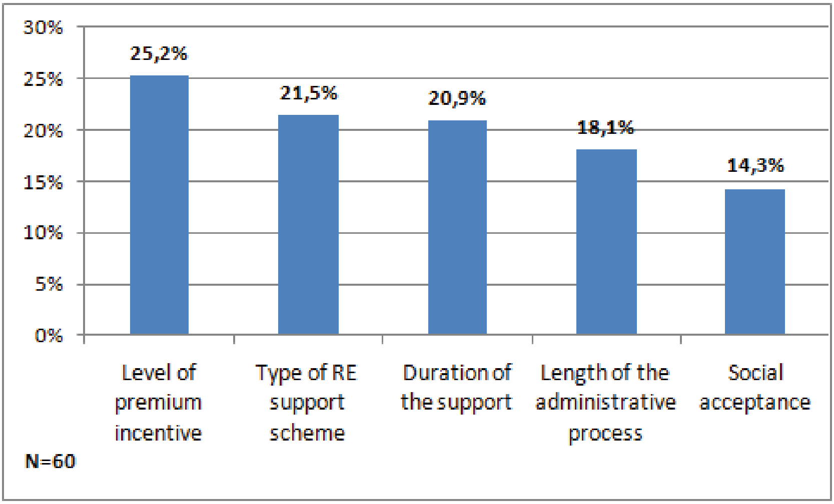


Figure 25: Average importance of policy attributes for the investigated sample

Table 15: Average importance of policy attributes for the investigated sample, and standard deviations

Policy attribute	**Average importance**	**Standard deviation**
Level of premium incentive	25.22%	4.32
Type of RE support scheme	21.48%	5.07
Duration of the support	20.91%	3.98
Length of the administrative process	18.08%	4.38
Social acceptance	14.31%	5.15
	100.00%	

(N=60)

The information provided above represents a first interesting result of the analysis. However, since data are presented in an aggregated way they do not provide enough detail on the different utilities associated to varying levels of the attributes described.

These additional details are provided in Figure 26 and Table 16, which show the part worth utilities. Part worth utilities describe the contribution of the various attribute levels to the overall utility, thus allowing to understand how the change in a variable level affects the investor's preferences for a certain policy framework. Part worth utility results are normalized using the Zero-centered differentials (diffs in the following) method. The diffs method rescales utilities so that the sum of the utility differences between the worst and the best level of each attribute is equal to the number of attributes times 100 (Orme, 2009b). This normalizes the data so that each respondent has equal impact when computing the population average.

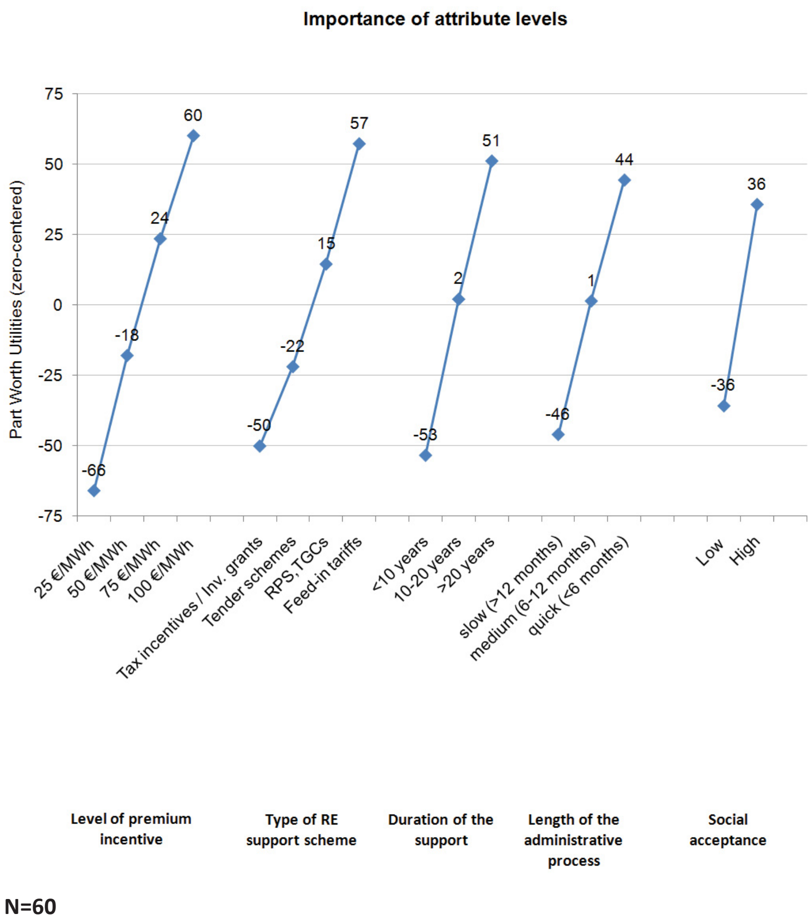


Figure 26: Importance of the various attribute levels

Table 16: Average utilities of policy attribute levels for the investigated sample, and standard deviations (N=60)

Zero-centered	Average utilities	Standard deviation
Level of the premium incentive		
100 €/MWh	60.21	10.11
75 €/MWh	23.60	7.33
50 €/MWh	-17.91	4.17
25 €/MWh	-65.91	15.67
RE support scheme:		
Feed-in tariffs	57.35	13.98
TGC/RPS	14.57	4.72
Tender schemes	-21.85	6.63
Tax incentives/ Investment grants	-50.06	8.22
Duration of the support:		
More than 20 years	51.21	10.20
10-20 years	2.13	5.10
Less than 10 years	-53.35	10.32
Length of the administrative process		
<6 months	44.45	10.73
6-12 months	1.49	4.36
>12 months	-45.93	11.58
Social acceptance:		
High	35.77	12.88
Low	-35.77	-12.88

This additional information reveals that significant differences exist also within each attribute. Starting from the most important policy attribute, i.e. the level of support granted to the renewable energy project, one can see that a premium incentive of 100 €/MWh is more desirable than a premium incentive of 75 €/MWh (60.21 against 23.60). This confirms the finding that the sample is composed of agents who look for the highest return of their investment. It is worth highlighting that the negative values associated to some attribute levels do not imply that these options are not desirable per se. In fact, by applying the Zero-centered diffs method, the utilities have been re-scaled to an arbitrary additive constant to sum 0 within each attribute. As a consequence, a negative value of part worth utilities does not mean that the particular attribute level is unattractive in absolute terms, but only that it is less preferred than an alternative option showing a higher part worth utility value. In other terms, while positive values indicate an increase in the utility, negative values indicate a decrease in utility for the observed respondent.

Regarding the type of renewable energy support scheme, feed-in tariffs are by far the most preferred instrument, with an average utility of 57.35. More market-based support mechanisms such as tradable green certificates or the renewable portfolio standard, receive an individual utility of 14.57. This finding is in line with a previous research conducted by Bürer (2008), where feed-in tariffs were found to be the most favoured renewable energy support scheme by a group of European and US venture capital and private equity investors. A following research conducted by Sovacool via interviews with 181 energy experts worldwide (Sovacool, 2009) confirms that feed-in tariffs are a very popular scheme, ranking third among the most favoured policy options identified by participants while tradable green certificates rank eleventh.

It is also worth adding that currently feed-in tariffs are the most diffused support instrument in the EU, with 21 countries out of 27 having in place feed-in tariff as either a partial or exclusive way to support renewables (Pfluger, 2009). Although all renewable energy support scheme options were described in detail in the survey in order to induce a perfectly informed choice, one cannot exclude that the very high ranking assigned by investors to feed-in tariffs might have been - at least partly - influenced by the popularity of this instrument compared to less familiar alternatives.

In their turn, tradable green certificates have been considered for long time as the most effective and cost-efficient means to stimulate renewable electricity production (EC, 1999; Verhaegen et al., 2009). More recently however, their popularity has started going down. This is reflected in the more reduced number of countries currently adopting this scheme in the EU (among them: the United Kingdom, Sweden, Belgium and Italy).

Tender schemes for renewables, as applied for example in Denmark, France, Ireland and the United Kingdom, are ranked third, with a utility value of -21.85. Finally, fiscal measures like tax incentives of investment grants receive by far the lowest utility value amongst the proposed options (-50.06). Again, this result might be partly explained by a certain lack of confidence with this instrument by the surveyed investors. In fact, this type of support scheme is currently in place only in a very limited set of EU Member States, like Finland and Malta, which were outside the scope of the survey.

In terms of the duration of the support granted to the renewable energy project, investors show a high interest for a long-term support: an incentive paid for more than 20 years is strongly preferred over an incentive paid for a 10 to 20 years timeframe (51.21 compared to 2.13, respectively). A time horizon shorter than 10 years receives a very negative score (-53.35), meaning that in order to embark in a renewable energy investment, agents ask policy makers to guarantee a financial support to the project over a minimum timeframe of 10 years.

As far as the duration of the administrative process is concerned, investors look for a smooth framework allowing to get the necessary authorizations and permits in a relatively short timeframe. A quick administrative process (less than 6 months) receives an average individual utility of 44.45, a medium process (6-12 months) records an individual utility of 1.49 while a slow administrative process (requiring more than 12 months) is assigned an individual utility of -45.93. This can be interpreted as a percentage change in choice probability: if all other elements of the policy framework remain constant, the likelihood that an investor prefers a given policy framework increases by approximately 50% if the administrative process is shortened from more than 12 months to 6-12 months.

The relatively lower importance assigned by the surveyed investors to the duration of the administrative process seems to contradict some preliminary findings from Lüthi and Wüstenhagen (2009), who found this policy attribute to be the most relevant for the investigated sample. However, this difference can be explained by at least three factors: i) the different sample analyzed (a group of project developers against a more diversified profile of investors); ii) the different geographical context (a selected group of mainly South EU countries against a broader group of EU countries); and, iii) the different operationalisation of the variable (5 levels of the attribute instead of the three levels used in the present survey).

As for the first factor, it is to presume that the length of the administrative and authorization process is a serious issue of concern for project developers, whereas this is certainly not an issue for other category of investors like for example insurance companies, banks or venture capital funds. In this respect, a segmentation analysis has been conducted (see paragraph 7.3), which has revealed that the company type has some influence on investors' preferences over different policy attributes. However, results also suggest that the geographical location where the investor operates might be a better parameter to explain the different values assigned to attribute levels by similar companies.

Regarding the second factor, several studies have already pointed out that administrative hurdles represent a barrier to renewable energy investments in some EU countries like for example Greece, the Netherlands, Spain and the

United Kingdom (Papadopoulos and Karteris, 2009; Reiche and Bechberger, 2004), while they are less of an issue in other countries like Germany or Finland. One of the major conclusions of the analysis of barriers to the development of renewable electricity in the EU Member States carried out within the OPTRES study (OPTRES, 2006) is that in general administrative and regulatory hurdles are perceived to be a quite severe obstacle in the development of renewable energy projects, according to project developers and other stakeholders. However, the magnitude of the obstacle is perceived differently by stakeholders, depending on the type of renewable energy technology and the national situation. The latter issue is particularly true for grid barriers.

A recent study developed by the Windbarriers consortium (http://www.windbarriers.eu; cited in Ragwitz, 2010) has revealed that actually administrative and grid-related barriers show a large variety in the EU Member States. The shortest lead time for the authorization process is found in Finland, followed by Belgium. Quite surprisingly, Germany shows a high variability in the lead time and an average length of the process higher than other EU countries, like for example Italy. However, this can be due to the fact that results are averaged across different types of technologies, which are subjected to different authorization processes. For example, in Germany the procedures related to offshore wind projects are still complicated compared to other technologies (OPTRES, 2006), and this might have affected the overall results.

Finally, from the results of Lüthi and Wüstenhagen (2009), it seems that project developers are particularly attracted by the possibility to get the authorization in 1- 2 months timeframe; anytime longer than this time span becomes less preferable compared to other alternatives. Since in the current survey a different measurement scale was adopted, it is not possible to capture this difference. However, it is worth highlighting that according to previous surveys (OPTRES, 2006) on average acquiring permits for grid connection can take quite a long time, which ranges from 6 to 16 months in the case of France to up to 10 years in the case of Cataluña.

With respect to the last policy attribute analyzed, a higher social acceptance is obviously preferred to a more resilient framework for renewable energy investments. Nevertheless, the social acceptance component is less relevant compared to the other policy attributes previously analyzed. This finding can be interpreted in several ways. One explanation could be that investors believe that addressing social acceptance issues is a task to be carried out by policy makers, not by private operators. This is tantamount to saying that investors look for adequately designed top-down policies that take into account all relevant barriers that might hamper the diffusion of renewable energy technologies, including social acceptance.

Another possible explanation is that investors believe that onshore wind technology is a relatively not disputed technology. Therefore they tend to assign a relatively lower importance value to social acceptance simply because they do not perceive a strong opposition to this renewable energy technology in the EU community. Previous research seems to support this explanation. In fact, the results of the OPTRES survey (OPTRES, 2006) indicate that onshore wind is the second least controversial renewable energy technology after solar photovoltaics, in the perception of investors.

However, again important national differences can be observed. For example, social acceptance scores lowest in countries like Ireland, Estonia, Italy and France, whereas it receives a high ranking (meaning high barrier) in Belgium, Slovenia, the Netherlands and Austria, mostly for aesthetic or noise reasons. Survey respondents indicated that the involvement of local population in the planning phase can significantly decrease opposition, and therefore recommended clear information and early participation in the decision making process. Allocating revenues to local authorities or making them financial partners in the development of the project are two suggested solutions in order to overcome social acceptance barriers.

Reiche and Bechberger (2002) also suggest that consensus-based decision making is a very important factor in order to increase the share of renewables. In this respect, policy can influence public awareness, for example by granting tax exemptions for renewable energy.

Finally, it is worth remembering that a large majority of the surveyed sample is represented by venture capital and private equity firms, which operate in the early stage of the project value chain. These actors typically invest in technology assets, but do not physically build renewable energy projects. Therefore they are less concerned by social acceptance issues than other investors' typologies like for example project developers and utilities. In order to account for the variation on these perceptions according to the different profiles of investors, a sensitivity analysis has been conducted (see paragraph 7.3 below).

7.2 Analysis of single policy attributes

After presenting the data in an aggregated way for the total of the investigated sample, in the following the various policy attributes are further analyzed in order to show the distribution of individual utilities.

7.2.1 Level of the premium incentive

The highest level of the premium incentive presented to the investors during the survey was Euro 100/MWh. The raw utility assigned to this attribute level ranges from a minimum of 1.27 to a maximum of 2.78, with a mode of 1.27[12], a mean value of 2.14 and a median value of 2.2. It is worth remembering that in a symmetric distribution these common measures of central tendency are identical, while differences occur in case of skewed distributions.

As one can see from Figure 27, the frequencies are quite symmetrically distributed around the mean value. This is confirmed by the low value of the standard deviation (0.39), indicating that the data points tend to be very close to the mean. About 68% of the values fall within one standard deviation of the mean (2.14+-0.39). The values of the 25° and 75° percentiles are, respectively, 1.94 and 2.41. The asymmetry coefficient is -0.526 while kurtosis is -0.462, meaning that the distribution is slightly skewed to the left.

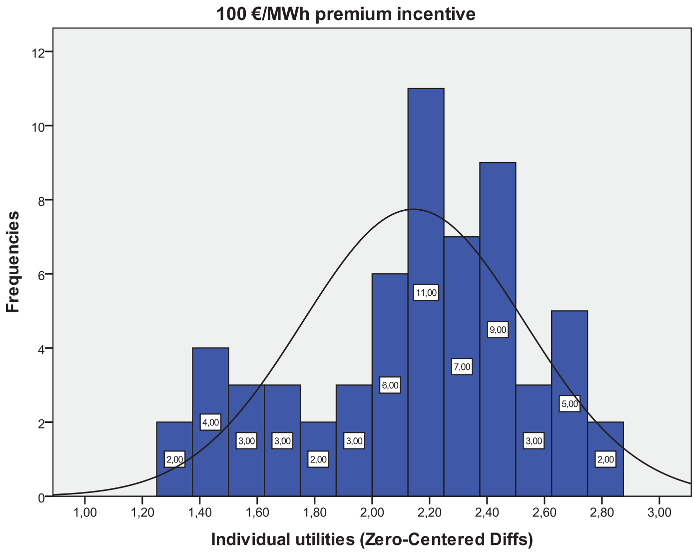


Figure 27: Distribution of raw utilities for 100 €/MWh

[12] Actually, this is a multimodal distribution. Only the lowest mode is reported here.

Figure 28 shows the distribution of individual utilities for the second level of premium incentive proposed: 75 €/MWh.

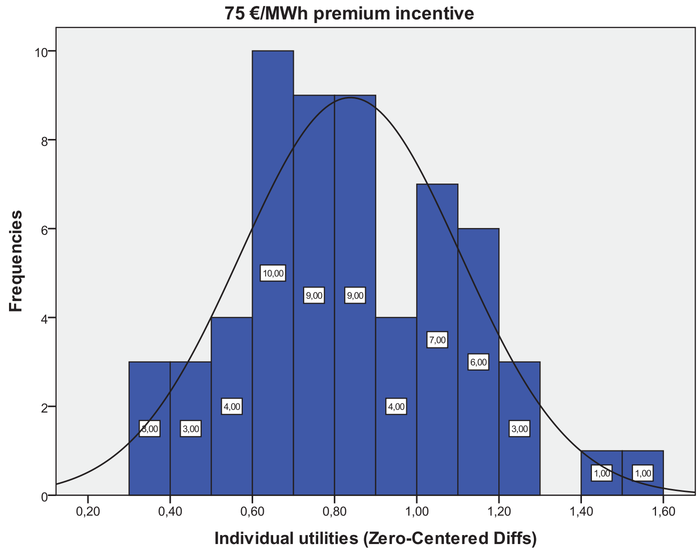


Figure 28: Distribution of raw utilities for 75 €/MWh

The minimum level observed is 0.37 and the maximum is 1.56. The mean and median values are quite close (0.84 and 0.81, respectively) while also in this case more modes are observed (the minimum value is 0.37). The standard deviation has a value of 0.27. Approximately 69% of the frequencies are comprised between one standard deviation of the mean. The values of the 25° and 75° percentiles are 0.63 and 1.04. The asymmetry value is 0.35 and the kurtosis is -1.15.

The distribution of individual utilities for the level of incentive 50 €/MWh is shown in Figure 29. The minimum and maximum levels observed are, respectively, -0.97 and -0.28. The mean value for this distribution is -0.63, while the median value is -0.66.

Multiple modes are observed, with a minimum value of -0.93. The standard deviation has a value of 0.15, meaning that the frequency distribution tends to be very close to the mean. In fact, 72% of the frequencies are comprised between one standard deviation of the mean. The values of the 25° and 75° percentiles are -0.74 and -0.52. The asymmetry value is 0.24, and the kurtosis is -0.25. These values confirm that the observations are quite normally distributed, although slightly skewed to the right and that the observations are not dispersed along the tails.

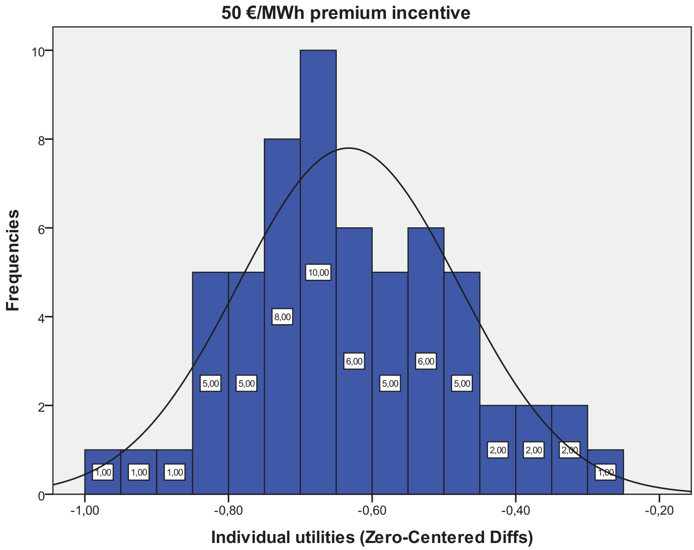


Figure 29: Distribution of raw utilities for 50 €/MWh

The last level of the premium incentive analysed (25 €/MWh) has a mean value of -2.35 and a median value of -2.49. The minimum and maximum levels observed are, respectively, -3.37 and -1.17. The standard deviation has a value of 0.57. This implies that the frequency values are more dispersed compared to the previous distributions, as one can see from Figure 30.

The analysis of frequencies reveals that 62% of data are comprised between one standard deviation of the mean. The values of the 25° and 75° percentiles are -2.84 and -1.91. The asymmetry value is 0.28, and the kurtosis is -0.93, indicating a platykurtic distribution characterized by a wider peak around the mean and thinner tails.

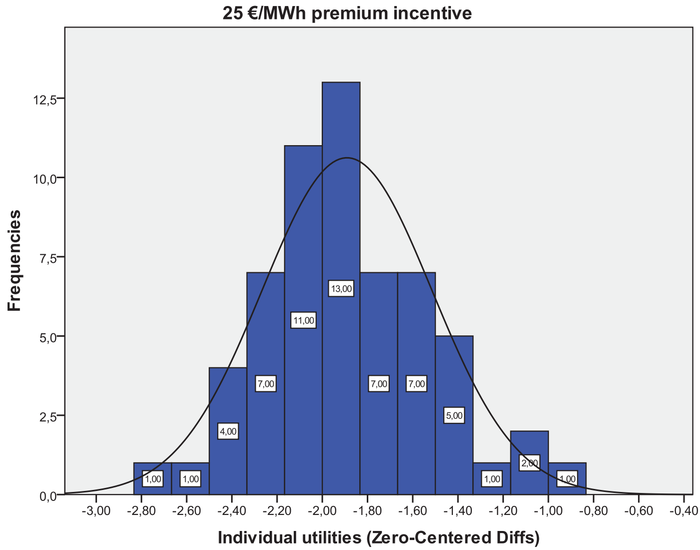


Figure 30: Distribution of raw utilities for 25 €/MWh

7.2.2 Type of renewable energy support scheme

As reported above, in the survey four different support schemes were proposed to respondents: feed-in tariffs, tradable green certificates/renewable energy portfolio standards, tender schemes and tax incentives/investment grants.

Figure 31 illustrates the distribution of raw utilities calculated with the Hierarchical Bayes method for the type of scheme "feed-in tariffs". This attribute level was assigned the highest share of preferences by respondents.

The raw utilities range from a minimum value of 1.14 to a maximum of 2.98. The values of the mean and the median are quite close (2.04 and 2.06, respectively). The minimum value reached by the modes is 1.14. The values of the 25° and 75° percentiles are 1.56 and 2.38. The graph shows a platykurtic distribution, characterized by a wider peak around the mean and thinner tails. This is confirmed by the relatively higher value of the kurtosis (-1.05) compared to the other observations previously shown. The asymmetry is 0.03, meaning that the distribution is symmetric, as the graph reveals. The standard deviation is 0.53. The analysis of the frequency tables indicates that 62% of preferences are distributed around the mean value.

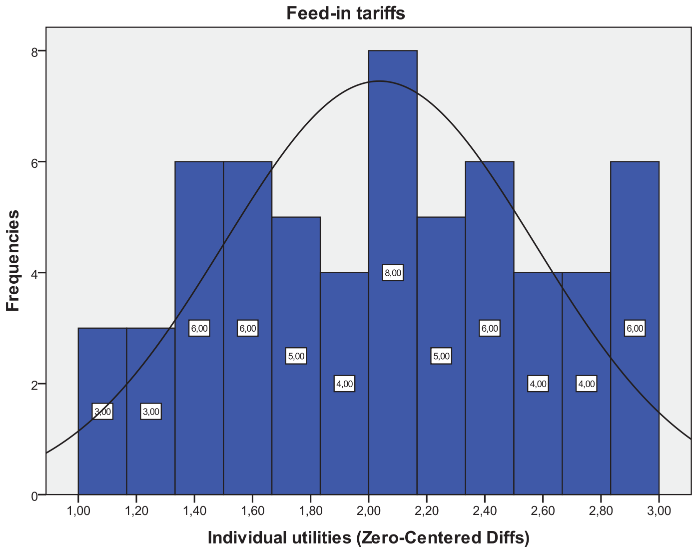


Figure 31: Distribution of raw utilities for FITs

The second preferred attribute level amongst those investigated was the support scheme “tradable green certificates”, also known as “renewable portfolio standard”. The distribution of raw utilities is shown in Figure 32. The frequencies vary from a minimum value of 0.04 to a maximum of 0.96. The values of the 25° and 75° percentiles are 0.44 and 0.60. The mean, median and mode of the distribution are, respectively, 0.52, 0.51 and 0.37. The standard deviation is quite low, with a value of 0.16. In fact, 72% of the raw utilities are clustered within one standard deviation of the mean.

As far as the asymmetry value and kurtosis are concerned, these are respectively -0.14 and 1.55. These values indicate a quite symmetric distribution with a leptokurtic shape.

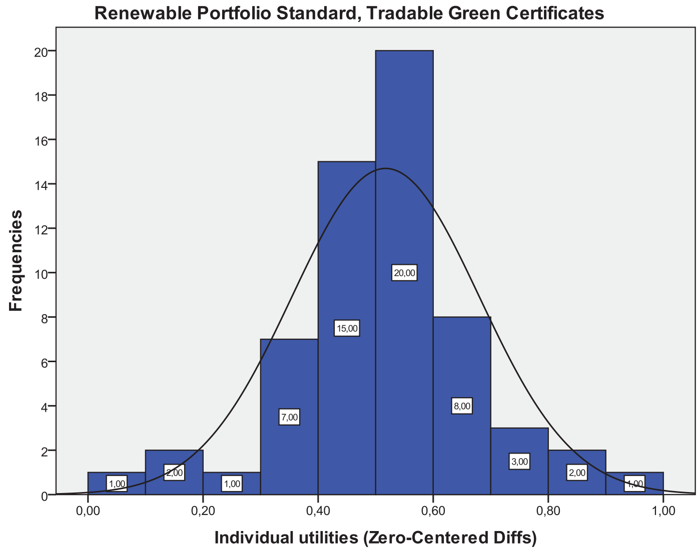


Figure 32: Distribution of raw utilities for RPS, TGCs

Figure 33 illustrates the distribution of raw utilities for tender schemes.

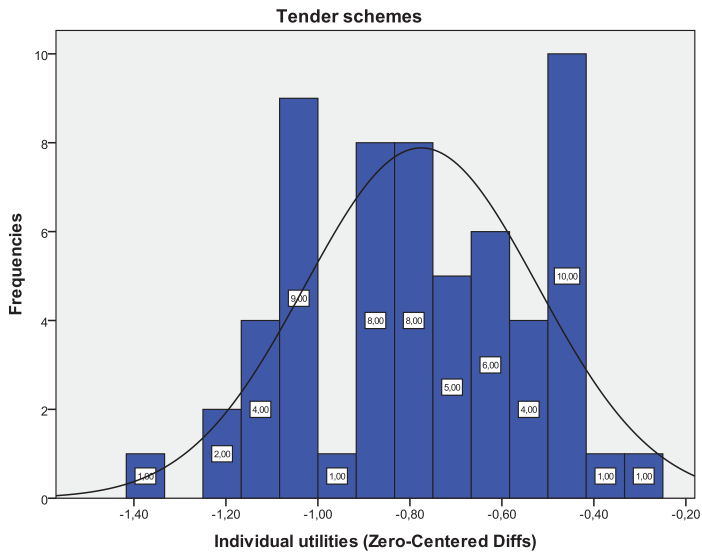


Figure 33: Distribution of raw utilities for tender schemes

The distribution shows a minimum value of -1.41 and a maximum value of -0.30. The values of the 25° and 75° percentiles are -1.02 and -0.56. The mean is -0.77, the median is -0.79, the minimum level of the mode is -1.41.

The standard deviation is 0.25. As the graph shows, only about 57% of the utilities are concentrated between one standard deviation of the mean, the remaining values are quite dispersed. By looking at the asymmetry (-0.18) and kurtosis (-0.68), it is possible to understand that this distribution is slightly platikurtic.

The least preferred level amongst the support scheme category is represented by tax incentives and investment grants. As shown in Figure 34, the raw utilities range from a minimum value of -2.26 to a maximum of -0.98. The mean and median are respectively -1.78 and -1.79. The values of the 25° and 75° percentiles are -2.02 and -1.60.

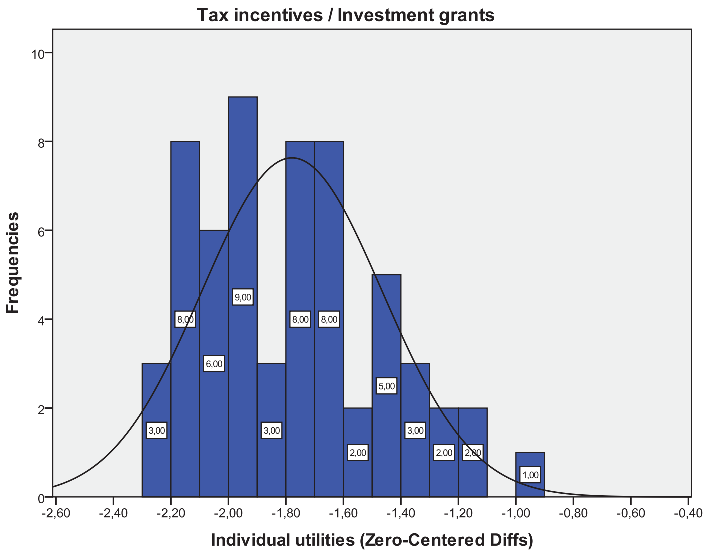


Figure 34: Distribution of raw utilities for tax incentives, investment grants

The curve has a standard deviation of 0.31. About 65% of utilities are concentrated within one standard deviation of the mean.

The distribution is characterised by a positive asymmetry (0.47) with a right tail, and by a platikurtic shape (kurtosis=-0.51).

7.2.3 Duration of the support

The policy attribute "duration of the support" is articulated in three different levels: support incentive paid for more than 20 years, 10 to 20 years, and less than 10 years. Figure 35 shows the results of the distribution for the first level described. As it is possible to see, the raw utility values range from a minimum of 1.01 to a maximum of 2.88. The values of the 25° and 75° percentiles are 1.58 and 2.04. The mean is 1.82, the median is 1.80, the minimum level of the mode is 1.01. The standard deviation is 0.38.

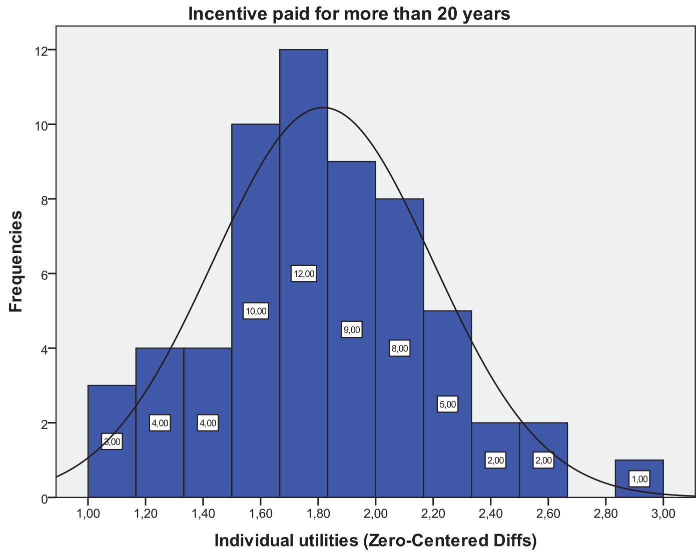


Figure 35: Distribution of raw utilities for more than 20 years

The analysis of frequency reveals that 70% of the sample is clustered within one standard deviation of the mean value. There is a positive asymmetry (0.14) and the level of kurtosis is 0.25, indicating a leptokurtic distribution.

Figure 36 illustrates the results for the second level of the duration of incentive analysed, corresponding to 10-20 years. The distribution is comprised between the minimum value of -0.39 and the maximum value of 0.43. The mean and the median have both a value of 0.07. Multiple modes are observed, with a minimum value of -0.39. The values of the 25° and 75° percentiles are -0.04 and 0.20. The standard deviation is 0.17. The utilities are quite distributed around the mean value; in fact 73% of frequencies fall within one standard deviation of the mean, as the graph indicates. There is a negative asymmetry, with a value of -0.33. Finally, the kurtosis is 0.37.

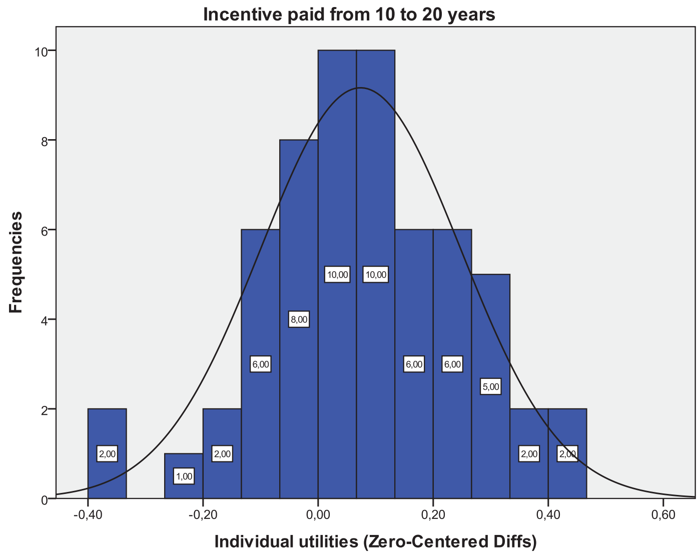


Figure 36: Distribution of raw utilities for 10- 20 years

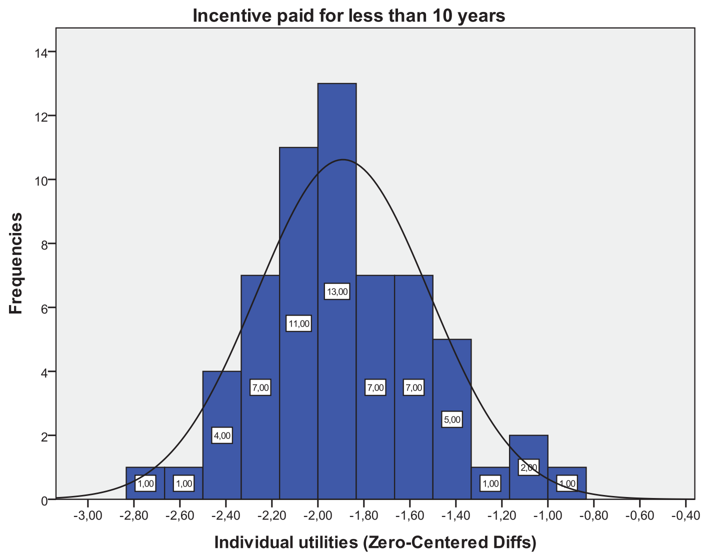


Figure 37: Distribution of raw utilities for less than 10 years

The third level of this policy attribute was an incentive paid for less than 10 years. Figure 37 reports the results for this distribution.

The mean value is -1.89, the median is -1.92 and the minimum mode is -2.79. Minimum and maximum values for the distribution are, respectively, -2.79 and -0.92. The standard deviation is 0.38. The analysis of the frequency table reveals that 68% of utilities are concentrated within one standard deviation of the mean. The asymmetry is 0.27 and the kurtosis is 0.10.

7.2.4 Length of the administrative process

As far as the length of the administrative process is concerned, three alternative options were offered to respondents: an iter shorter than 6 months ("quick"), during from 6 to 12 months ("medium"), or longer than 12 months ("slow").

Figure 38 shows the distribution of raw utilities in the first case. The values range from a minimum of 0.95 to a maximum of 2.39. The mean is 1.57 and the median is 1.48. The values of the 25° and 75° percentiles are 1.32 and 1.79.

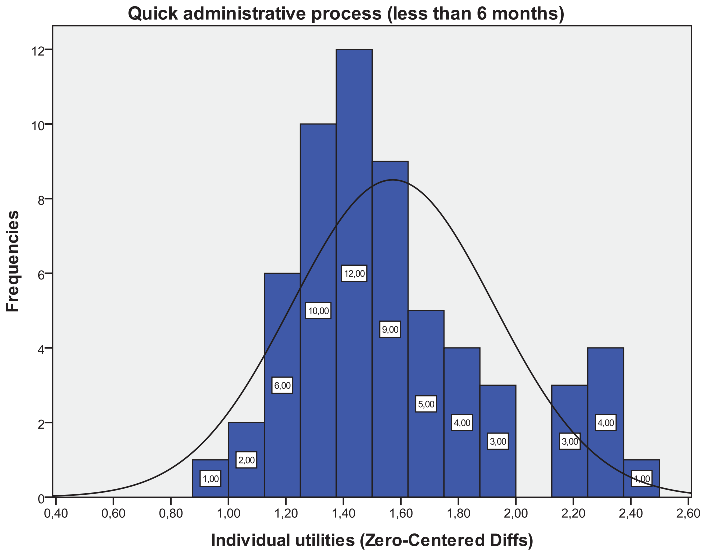


Figure 38: Distribution of raw utilities for less than 6 months

The standard deviation is 0.35. As it is possible to see from the graph, the frequency values are quite concentrated around the mean. Indeed, 73% of frequencies fall within one standard deviation.

The graph also indicates a positive asymmetry (0.76). The kurtosis is -0.16, meaning that the values are quite concentrated and not dispersed toward the tails.

Figure 39 illustrates the distribution for the second level observed. The minimum level of the distribution is -0.38 and the maximum is 0.39. The mean has a value of 0.06, while the median is 0.04. Multiple modes are observed (the minimum value is -0.38). The values of the 25° and 75° percentiles are -0.04 and 1.14.

The standard deviation has a very low value (0.15). About 65% of frequencies fall within one standard deviation of the mean.

The distribution is quite symmetric, with an asymmetry value of 0.13, and a kurtosis of 0.13.

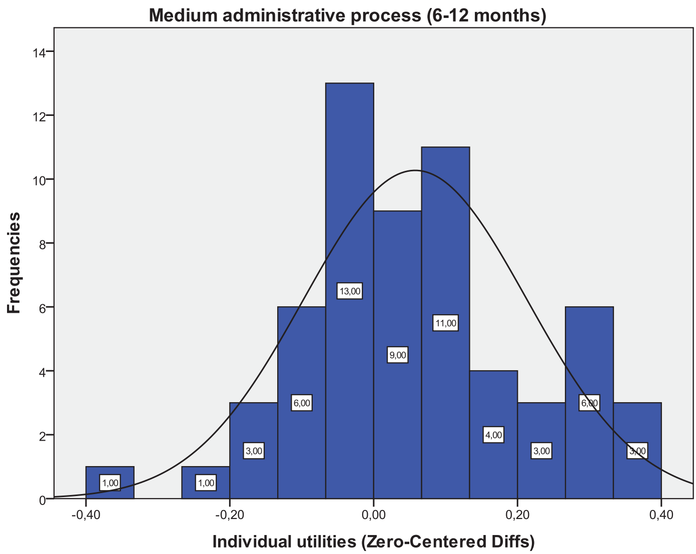


Figure 39: Distribution of raw utilities for 6-12 months

Finally, the distribution of raw utilities for the last level of the administrative process proposed is displayed in Figure 40. This distribution has a minimum value of -2.65 and a maximum of -0.85. The 25° and 75° percentiles are respectively -1.85 and -1.37. The mean is -1.63, the median -1.56 and the minimum level of the mode is -2.65. The standard deviation is 0.40. About 68% of frequencies fall within one standard deviation of the mean. The asymmetry value is -0.62, and the kurtosis is -0.10.

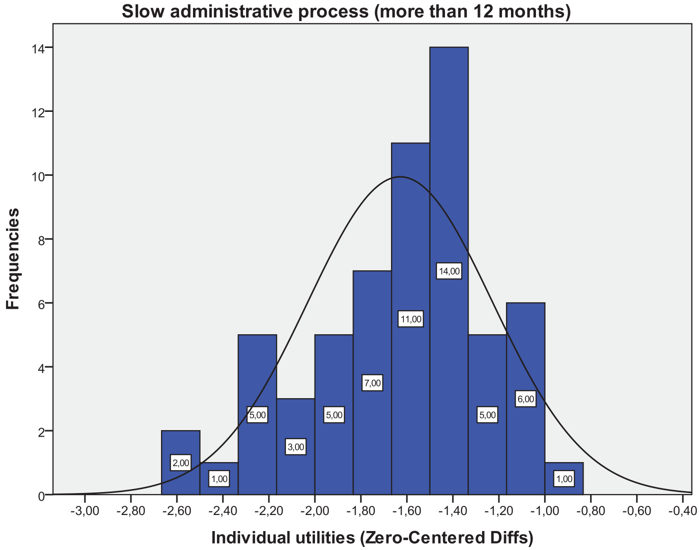


Figure 40: Distribution of raw utilities for more than 12 months

7.2.5 Social acceptance

The last policy attribute which was investigated during the survey is social acceptance. Two levels are given: high social acceptance, characterized by pro-wind activism of NGOs, favourable press, pro-wind citizens' coalitions, and low social acceptance, where anti-wind activism, negative press and anti-wind demonstrations are in place.

The distribution of raw utilities in the first case is shown in Figure 41. The values range from a minimum of 0.28 to a maximum of 2.35. The 25° and 75° percentiles are respectively -0.95 and 1.64. The mean of the distribution is 1.27, and the median is 1.25. Also in this case, multiple modes are observed (the minimum value is 0.28). The analysis of the frequency table indicates that 68% of utilities are concentrated around one standard deviation of the mean (the standard deviation is 0.44). The asymmetry value is 0.17, and the kurtosis is -0.23.

Figure 42 shows the results for the low social acceptance case. The values range from a minimum of -2.35 to a maximum of -0.28. The 25° and 75° percentiles are respectively -1.64 and -0.95. The mean of the distribution is -1.27, and the median is -1.25. Also in this case, multiple modes are observed (the minimum value is -2.35). The analysis of the frequency table indicates that 68% of utilities are concentrated around one standard deviation of the mean (the standard deviation is 0.44). The asymmetry value is -0.17, and the kurtosis is -0.23.

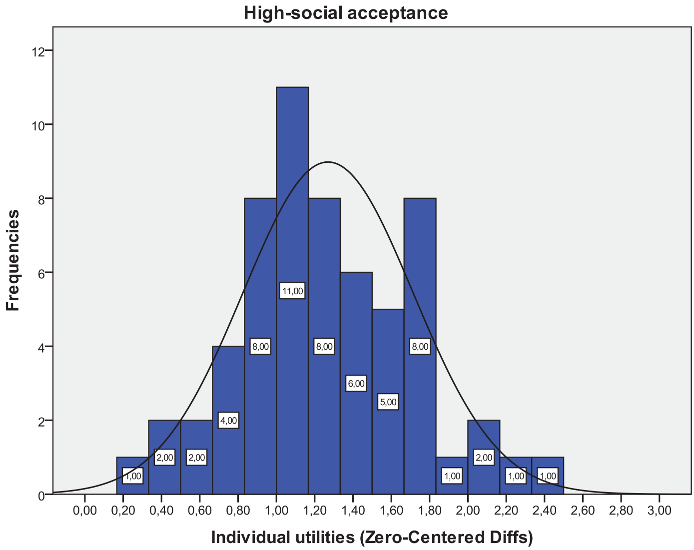


Figure 41: Distribution of raw utilities for high social acceptance

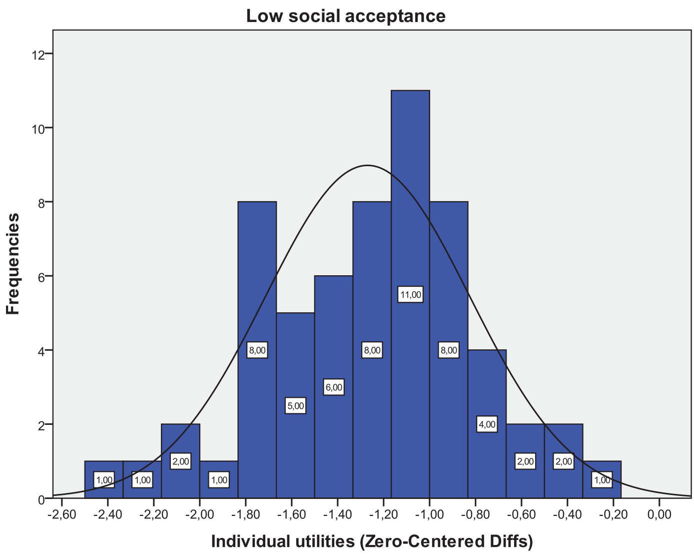


Figure 42: Distribution of raw utilities for low social acceptance

7.3 Sample segmentation

In order to better capture the differences in the share of preferences for renewable energy policy attributes amongst the various profiles of investors, a series of analyses through sample segmentation have been conducted using the Market Simulator tool of the Sawtooth software package. The survey responses have been elaborated according to the following criteria: type of companies, experience in the renewable energy investing domain, share of renewable energy technologies in the portfolio, portfolio composition, working experience of respondents, and academic background of respondents. Results are presented and discussed in the following paragraphs.

7.3.1 Influence of company type

To assess the influence of company type, respondents have been regrouped in the following three categories:

- Venture Capital, Private Equity or Hybrid combinations (including private or family-run VC and PE funds)
- Banks, Hedge Funds, Pension Funds, Personal Funds/Private Companies and Insurance Companies
- Other (Project developers and utilities, Infrastructure Funds, Engineering companies)

It is worth highlighting that the total number sums up to 55, since 5 out of the 60 investors who have completed the ACA section of the questionnaire have provided no response to the related demographic question and are therefore excluded from the segmentation analysis.

Results are provided in Figure 43, which displays the average attribute importances for the sample and the selected sub-samples, and in Table 17, which reports the comparison of part worth utilities.

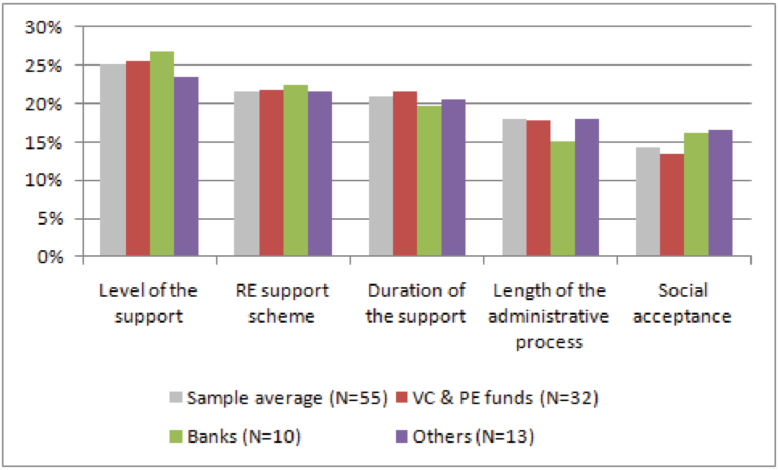


Figure 43: Average importance of policy attributes for the sample and for the selected sub-samples

Table 17: Comparison of part worth utilities between the overall sample and the selected sub-samples

Zero-centered	**Sample total**	**VC / PE**	**Banks**	**Others**
	N=60	**N=32**	**N=10**	**N=13**
Level of the premium incentive				
100 €/MWh	60.21	61.64	63.91	56.09
75 €/MWh	23.60	24.17	24.75	19.76
50 €/MWh	-17.91	-18.94	-18.04	-16.95
25 €/MWh	-65.91	-66.87	-70.63	-58.90
RE support scheme				
Feed-in tariffs	57.35	57.85	56.85	58.53
TGC/RPS	14.57	14.68	12.79	14.03
Tender schemes	-21.85	-21.97	-21.53	-23.27
Tax incentives/ Investment grants	-50.06	-50.56	-48.11	-49.28
Duration of the support				
> 20 years	51.21	52.02	49.49	49.82
10-20 years	2.13	1.88	0.19	3.95
< 10 years	-53.35	-53.90	-49.69	-53.77
Length of the administrative process				
<6 months	44.45	44.11	43.43	43.09
6-12 months	1.49	1.14	2.01	3.24
>12 months	-45.93	-45.25	-45.44	-46.34
Social acceptance				
High	35.77	33.91	36.22	42.09
Low	-35.77	-33.91	-36.22	-42.09

As far as the category of venture capital and private equity funds is concerned, the results of the segmentation analysis reveal that their share of preferences is quite in line with the average for the whole sample. This indeed is not surprising since venture capital and private equity funds represent the largest majority of the represented population in the sample therefore they have a higher weight compared to other categories of investors.

Looking at the average importances, it is worth noticing that the scale of preferences is the same for this sub-group and the total sample. The only difference which is worth pointing out is that venture capital and private equity funds seem to assign a relatively lower importance to social acceptance compared to the other investors' categories.

Banks and the other financial actors included in this sub-group show some differences compared to the sample average. The level of the premium incentive is ranked first and receives a higher share compared to the sample average (27% against 25%). Looking at the part worth utilities, there is a stronger preference for high levels of the premium incentive (100 €/MWh and 75 €/MWh) compared to the sample average. The type of the renewable energy support scheme, the duration of the support and the length of the administrative process are less relevant attributes for this category of investors compared to the overall sample. Quite remarkably, social acceptance seems to have a certain influence in the decision to invest in renewables for this sub-group and is assigned a higher value than the length of the administrative process, which is the least relevant attribute.

Finally, the category of project developers, utilities, infrastructure funds and engineering companies displays some interesting peculiarities. For instance, the level of support seems to be less significant for this sub-group (23% against 25% for the overall sample), whereas social acceptance receives a higher ranking (17% against 14%). All remaining attributes seem to be well in line with the average for the sample.

The analysis of part worth utilities indicates that this sub-group is particularly attracted by feed-in tariffs compared to other renewable energy support schemes, and that they would be more willing to accept a shorter duration of the support (between 10 and 20 years) and a longer length of the administrative process (between 6 and 12 months) compared to the other investors.

7.3.2 Influence of the level of exposure to the RE investing domain

As already presented in the descriptive statistics section (chapter 6), two thirds of investors in the sample have already invested in the renewable energy sector, while one third has not yet invested in this market. Therefore a segmentation analysis has been carried out in order to see whether there is any significant difference in the share of preferences between RE and non RE investors.

As illustrated in Figure 44, there does not seem to be significant differences between the two categories. Indeed, in both cases the share of preferences seems to be well aligned with those expressed by the sample average, with only minor deviations. In particular, non RE investors show less interest for the duration of support while RE investors assign a greater weight to this policy attribute compared to the average. As for social acceptance issues, one possible explanation for this result is that non RE investors tend to overestimate this aspect compared to RE investors due to lack of knowledge of the sector, therefore being more influenced by negative press or anti-wind activism.

Additional qualitative research would be needed in order to provide a careful explanation for this phenomenon.

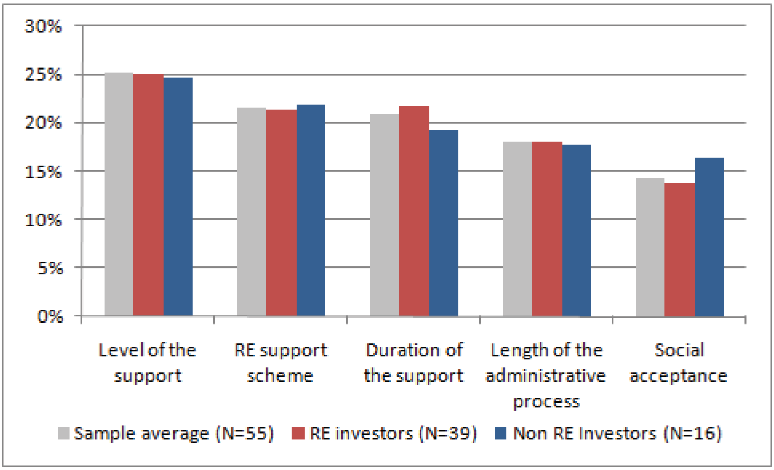


Figure 44: Importance of policy attributes for the sample and for RE and non-RE investors

7.3.3 Influence of the share of renewables in the portfolio

Figure 45 below presents the results of a segmentation analysis where the sample has been split according to the share of renewable energy technologies in the investment portfolio. As one can see, the level of the incentive granted to renewable energy project is the most important attribute, regardless of the share of renewables composing the portfolio. Also the ranking for the remaining policy attributes remains fairly homogeneous across the sub-sample, and in line with the sample average. The only slight deviation that can be observed is that those companies which only invest in renewables seem to assign lower importance to the length of the administrative process and to social acceptance compared to the other categories and to the sample average.

This corroborates the previous finding, i.e. that those investors who have more familiarity with the renewable energy business tend to be less concerned by social acceptance issues.

Companies investing only in renewables consider the duration of the support given to the renewable energy project a very important policy attribute, more important that the type of policy support scheme implemented per se. It is worth noticing that no clear correlation can be identified between the ranking assigned to the various attribute levels and the share of renewables in the portfolio.

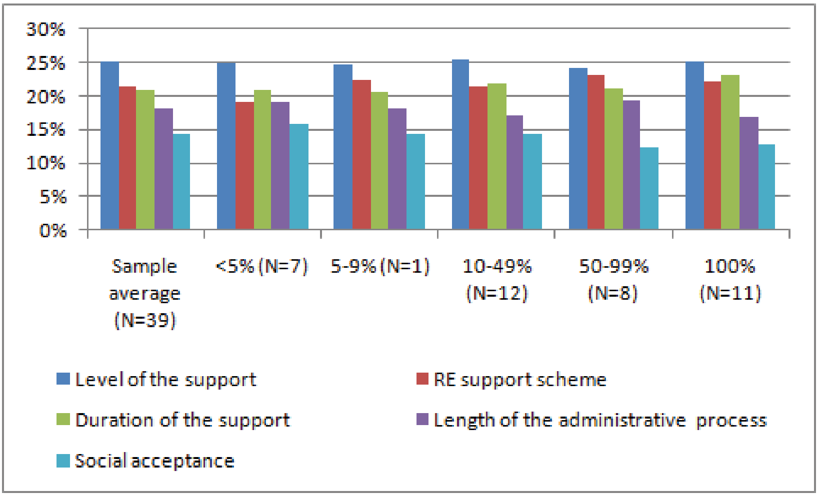


Figure 45: Importance of policy attributes for the sample and for RE investors

7.3.4 Influence of portfolio composition

In order to gather more analytical insights on what are the policy attributes which influence the most the likelihood to invest in single renewable energy technologies, an additional segmentation has been carried out, by identifying a sub-group of respondents investing exclusively on one renewable energy technology. It is worth highlighting that the sample is small (only 10 respondents have such characteristics), therefore this segmentation analysis needs to be interpreted with care. Nevertheless it provides useful indications for future research. In fact, as shown in Figure 46 policy attributes seem to have different impacts on respondents depending on the type of technology they are investing in.

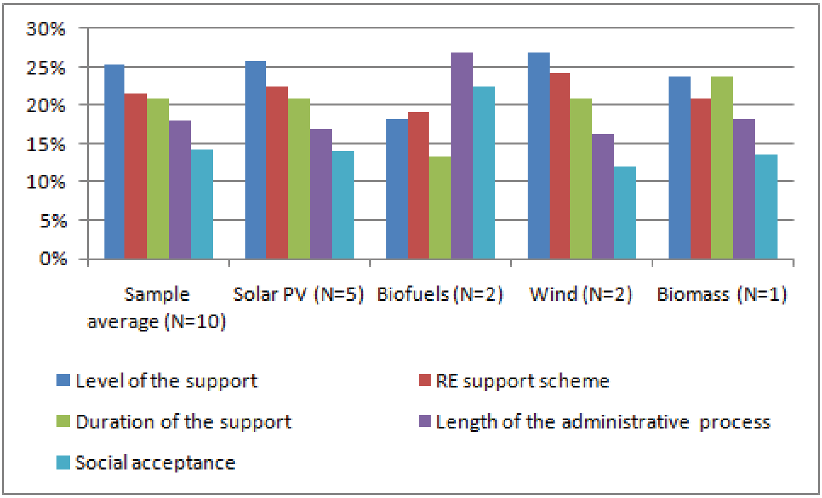


Figure 46: Importance of policy attributes for the sample and for respondents investing only on one specific technology

One remarkable finding is that the length of the administrative process and social acceptance issues play a much greater role on the decision to invest in biofuels rather than other renewable energy technologies. These two attributes are perceived to be much more relevant than other attributes influencing the profitability of the investment (such as the level of incentive and the duration of support). As a matter of fact, the current debate around the sustainability of biofuels has a direct impact on the framework conditions to invest in this technology; this can provide an explanation for such peculiar scales of preferences. Further research is recommended in order to see if these preliminary findings are validated or not based on a larger sample of investors operating in the biofuel market. Respondents investing either on solar PV or on wind technologies assign a higher preference to the level of support, type of support scheme and duration of the support compared to the sample average, and a lower preference to the administrative framework and social acceptance, thus confirming earlier results.

7.3.5 Influence of experience

The influence of experience on investors' preferences for different renewable energy policies is assessed in two ways: i) by looking at the number of years of experience in the renewable energy investing domain, and ii) by looking at the investors' age as a proxy for their overall experience in the investment sector.

As far as the first aspect is concerned, Figure 47 reveals that there is no significant relation between preferences for specific policy attributes and experience. The only remarkable exception is related to the administrative framework; indeed, the importance of this policy attribute decreases with the increasing of the number of years of experience in the renewable energy market. It is worth noticing that the most experienced investors (more than 10 years) assign a higher value to the type of renewable energy support scheme and to the duration of the support compared to the others and to the sample average.

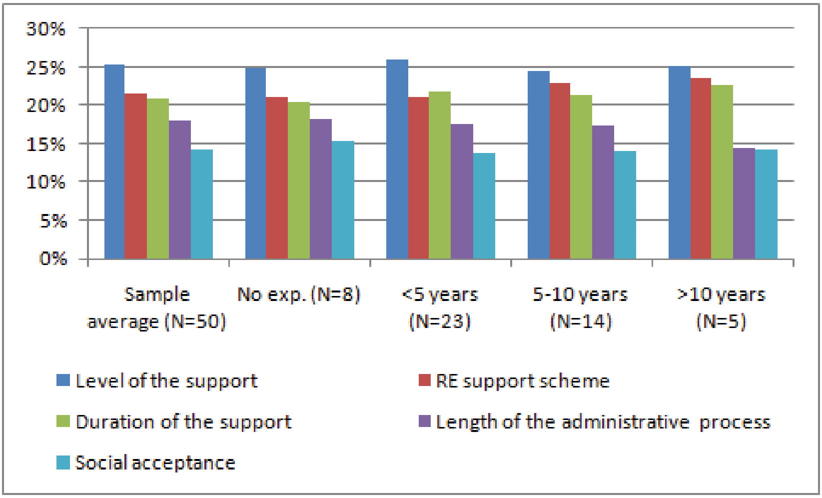


Figure 47: Importance of policy attributes for the sample and for the sub-sample split by years of experience in the RE investing domain

By looking at Figure 48, it can be seen that there is no relationship between preferences for specific policy attributes and the age of respondents. This seems to support the finding that investors' preferences for different policy types are influenced by the specific experience they have gathered in the renewable energy industry business, rather than by their overall working experience.

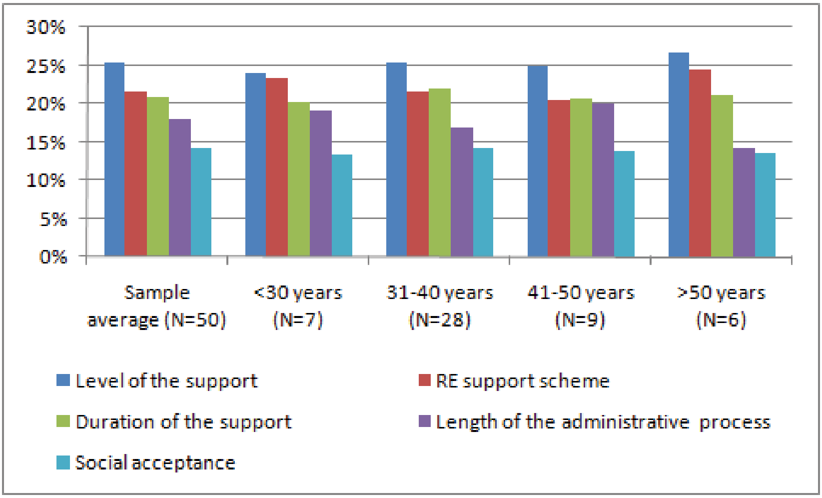


Figure 48: Importance of policy attributes for the sample and for the sub-sample split by age of respondents

7.3.6 Influence of the background

The analysis of investors' academic background offers interesting insights. Compared to the sample average, the type of renewable energy support scheme receives a high ranking by all categories with the only exception of legal experts. The latter assign a much higher importance to social acceptance issues and to the level of the incentive compared to the other respondents.

Level and duration of the support provided to renewables seem to have the same importance for those respondents who have a background either in economics and business administration or in engineering.

Results are shown in Figure 49.

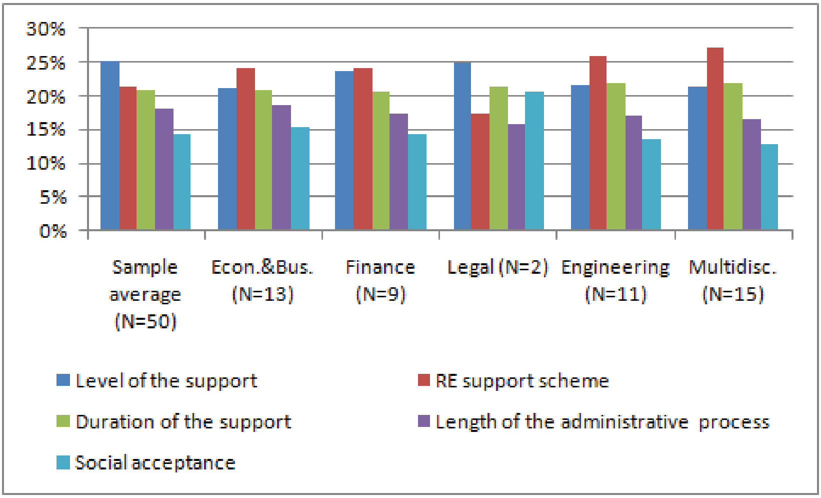


Figure 49: Importance of policy attributes for the sample and for the sub-sample split by academic background

7.4 Renewable energy optimism and preference for policy schemes

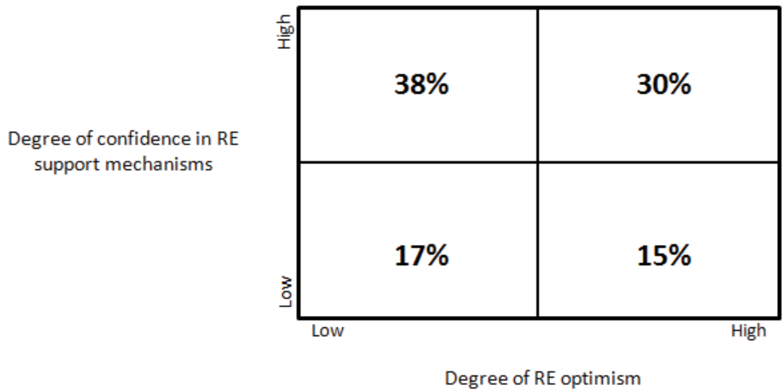
In the present paragraph, some complementary findings on the relationship between the investors' beliefs about the technological and market potential of renewable energies, and their preferences for renewable energy policy schemes are presented, based on additional statistical analysis of the sample responses.

The degree of "renewable energy optimism" was assessed by looking at the responses given by the sample to the questions regarding some technological and market beliefs, as reported in section two of the questionnaire. In particular, a "renewable energy optimism" index was built by factor-analysing the variables related to a high penetration rate of renewables (up to 80% and 100%) in Europe by 2050, the variable related to the growth potential of renewables worldwide in the next 20 years, and the variable related to the competitiveness of solar PV electricity within the next decade.

The sample was split in two categories: "RE optimists", characterised by a value higher than the mean, and "RE pessimists", if the ranking was equal or below the mean.

The degree of renewable energy optimism was measured against the utility values assigned by investors to the policy attribute "type of RE support scheme", as investigated in the ACA section of the questionnaire. To this end, the sample was split in two categories: the first regroups those respondents whose individual utilities assigned to the various policy attributes are above the mean, whereas the second is composed of respondents whose individual utilities are equal or below the average for the sample.

Figure 50 shows the distribution of utilities for the attribute "type of RE support scheme". About 17% of the investors fall in the category characterised by a low degree of RE optimism and low degree of confidence in RE support mechanisms. Conversely, an additional 38% of "RE pessimists" have a high degree of confidence in RE support mechanisms, thus implying that only a strong policy intervention can help overcome technical and market barriers for renewables. About 15% of the sample has a high degree of RE optimism but a low degree of confidence in RE support schemes, thus displaying a certain policy aversion, whereas 30% of investors have both a high degree of RE optimism and a high degree of confidence in RE support mechanisms.



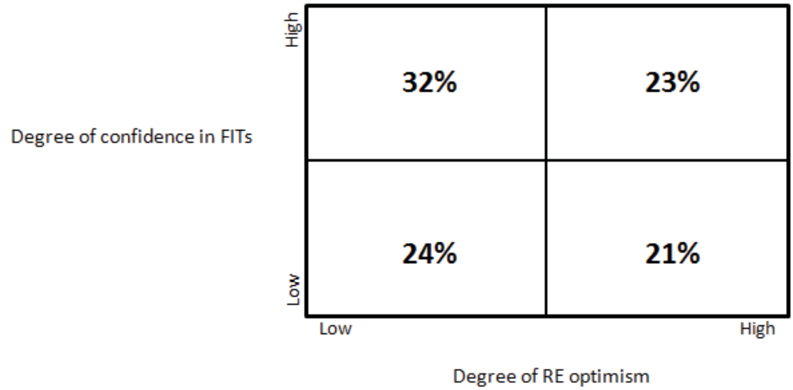
(N=60)

Figure 50: RE optimism and confidence in RE support schemes

Figure 51 and Figure 52 look more in detail at the two most important types of policies for the sample, i.e. feed-in tariffs and tradable green certificates.

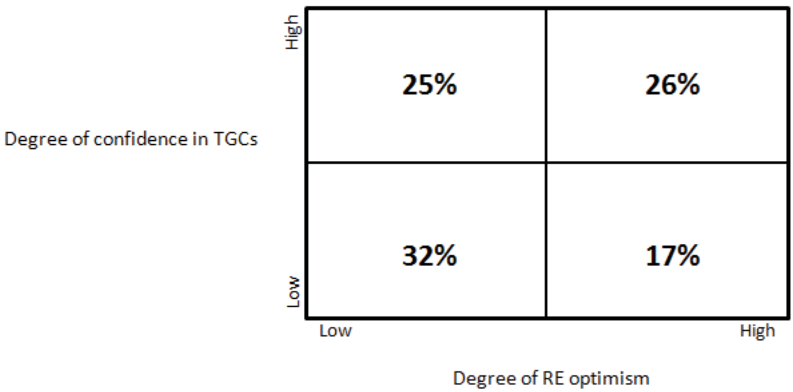
Following the procedure already described above, the degree of confidence in feed-in tariffs and in tradable green certificates has been measured by looking at the individual utilities, as revealed by the ACA analysis. A high degree of confidence in feed-in tariffs (or tradable green certificates) corresponds to individual utilities above the mean, whereas a low degree of confidence corresponds to utility values below or equal to the mean.

It can be seen that the sample is fairly homogeneously distributed. In the case of feed-in tariffs, in fact, about one fourth of the investors show both a RE pessimism and a low degree of confidence in this type of RE policy scheme; 32% of the sample is characterised by a low degree of RE optimism but a high degree of confidence in feed-in tariffs, 21% have a high degree of RE optimism but a low confidence in FITs, and 23% are both RE optimists and have a high confidence in FITs.



(N=60)

Figure 51: RE optimism and confidence in feed-in tariffs



(N=60)

Figure 52: RE optimism and confidence in tradable green certificates

In the case of tradable green certificates, the percentage of pessimists is slightly higher: in fact 32% of the sample display a low degree of RE optimism and a low degree of confidence in TGCs; 25% have a high degree of confidence in TGCs while being RE pessimists, 17% are RE optimists and have a low degree of confidence in TGCs and 26% are RE optimists and have a high degree of confidence in TGCs.

7.5 Degree of confidence in market efficiency and preference for policy schemes

The degree of confidence in market efficiency was measured by looking at the ratings given by the investors to the following two statements:

- Government intervention does more harm than good, let governments stay out of the way (used as a proxy for a high degree of confidence in market efficiency), and
- Market forces alone will never lead to a significant exploitation of renewables (used as a measure for low confidence in market efficiency)

The purpose was to understand whether investors displaying a higher confidence in the role of markets have a stronger preference for a more market-based RE support scheme like green certificates compared to feed-in tariffs, and if, conversely, less market confident investors (ergo investors displaying a more pro-government attitude) assign higher utility values to feed-in tariffs.

The analysis reveals that indeed there is a correlation between a certain dislike of government intervention and a stronger preference for more market-oriented renewable energy support schemes. For example, by looking at Figure 53 it can be seen that those investors who agree or strongly agree with the statement reported, also have a stronger preference for tradable green certificates.

On the other end, those investors who do not agree with the same statement have stronger preference for feed-in tariffs, as shown in Figure 54.

As far as the lower degree of confidence in market efficiency (or more pro-government attitude) is concerned, the link with a higher preference for feed-in tariffs is clear (see Figure 55), whereas no significant relationship can be identified with the preference for tradable green certificates, as displayed in Figure 56.

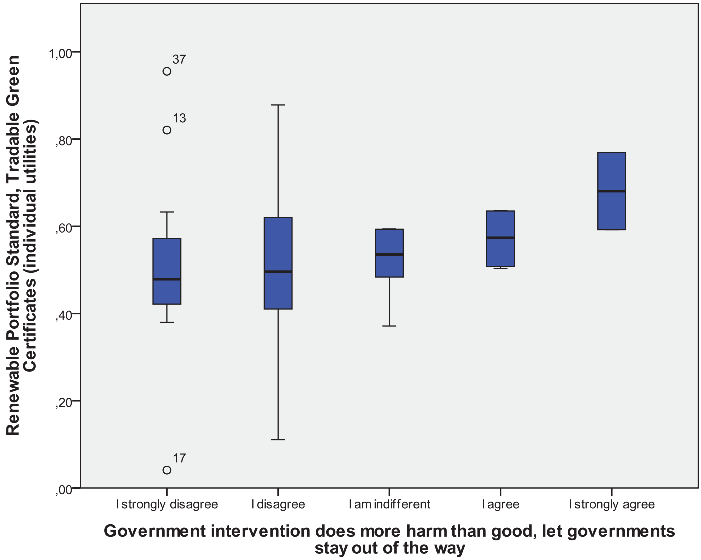


Figure 53: High confidence in market efficiency and preferences for TGCs

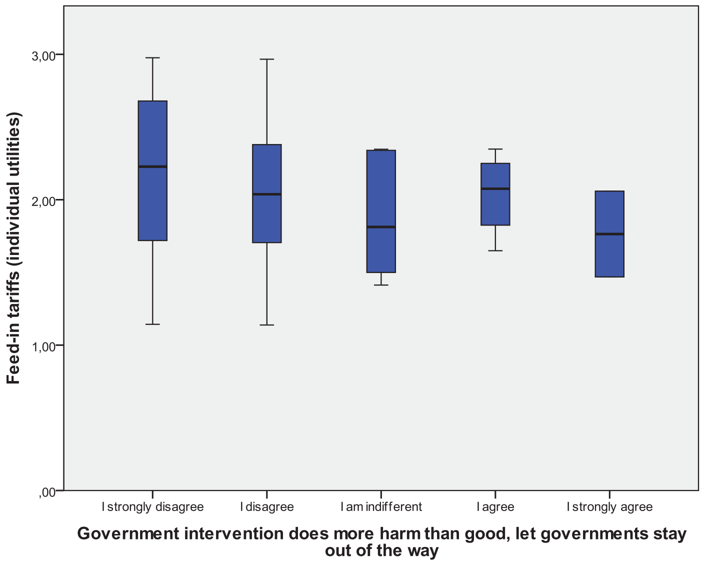


Figure 54: High confidence in market efficiency and preferences for FITs

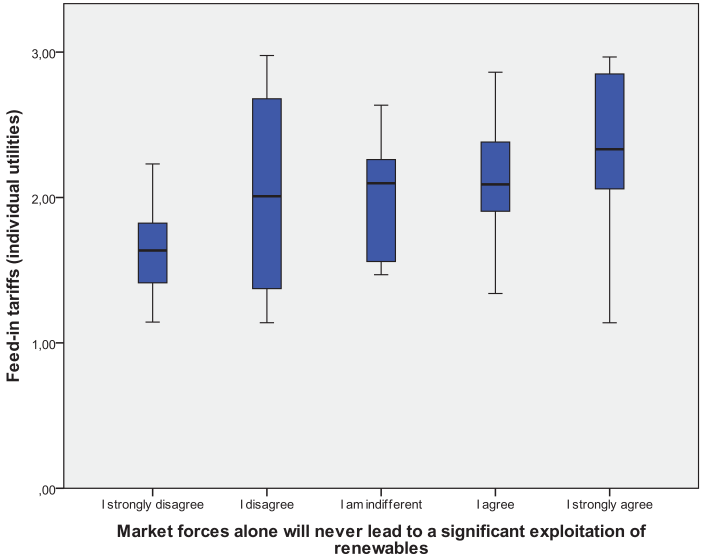


Figure 55: Low confidence in market efficiency and preferences for FITs

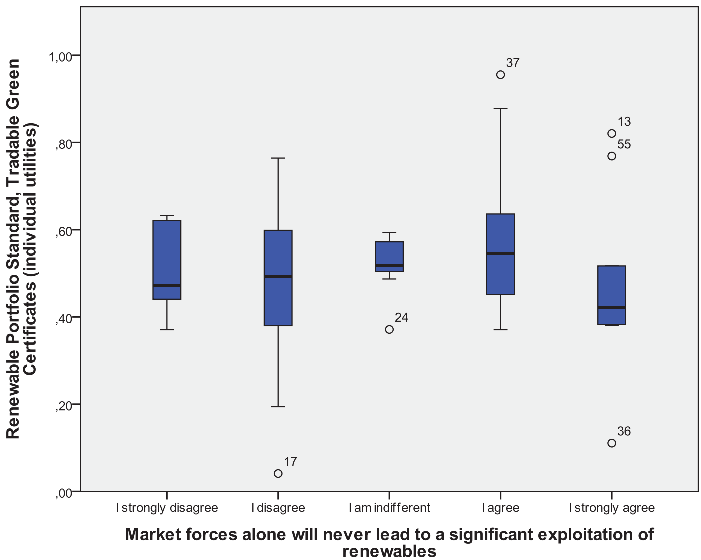


Figure 56: Low confidence in market efficiency and preferences for TGCs

In order to get a better understanding on the relationship between the degree of confidence in market efficiency and the preferences for more market or government-based support schemes, the information has been further elaborated and summarised in the following matrices. The index of confidence in market efficiency was built by looking at the ratings assigned to the two statements reported above, while the preference for TGCs was calculated according to the utility values assigned to this policy attribute (below, equal or above the mean).

According to Figure 57, 43% of investors have a low degree of confidence in market efficiency and assign low utilities to TGCs. This might seem to confirm that more pro-government investors have a lower preference for market-based instruments. However, another 39% of investors have a low degree of confidence in market efficiency but a high level of confidence in TGCs. At the other extreme, 14% of investors have a high degree of confidence in market efficiency and have a high preference for TGCs, while 4% have a high degree of confidence in market efficiency and have a low preference for TGCs.

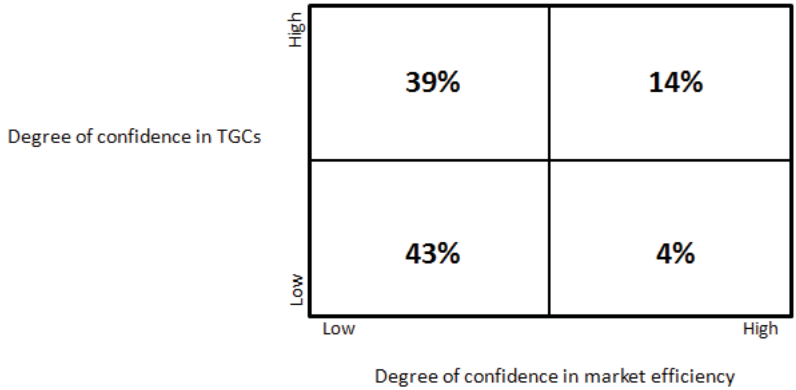


Figure 57: Distribution of the sample according to the degree of confidence in market efficiency and preferences for TGCs

Figure 58 reveals that those investors who have a low degree of confidence in market efficiency also assign high utility values to FITs (64% of the sample). This confirms the previous finding, i.e. that pro-government investors look for more regulation in the renewable energy market. Another 25% of investors have low confidence in market efficiency but a low level of confidence in FITs. At the other extreme, 11% of investors have a high degree of confidence in market efficiency and have a low preference for FITs, while none of the investors having a high degree of confidence in market efficiency has also a high degree of confidence in FITs.

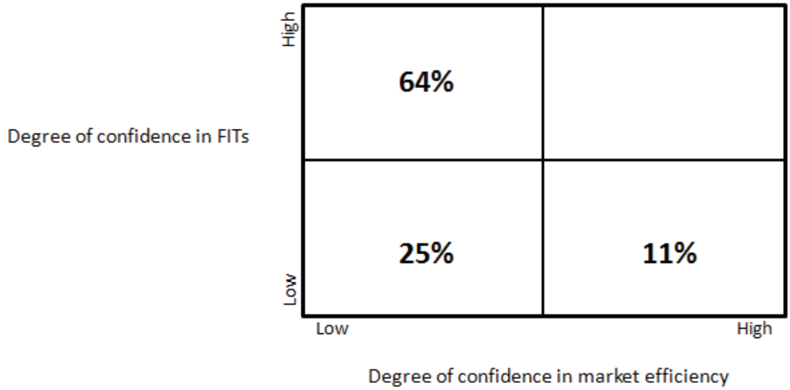


Figure 58: Distribution of the sample according to the degree of pro-government attitude and preferences for FITs

7.6 Assessing the likelihood to invest in different policy scenarios

The market simulator tool allows to investigate how the likelihood to invest in a renewable energy project might change depending on the variation of each attribute level. To this end, a base case scenario has been defined, based on the utility values assigned by respondents and already presented in paragraph 7.1. The ACA analysis in fact has shown that the level of the support is the most important attribute, followed by the type of renewable energy support scheme, the duration of the support, the length of the administrative process and social acceptance. Additionally, it has revealed that among the proposed renewable energy support schemes, feed-in tariffs are by far the most preferred mechanisms. Based on these elements, a base case policy scenario has been selected, which is characterized by the following attribute levels:

- Type of policy scheme: feed-in tariff
- A premium incentive of €/MWh 50
- A duration of the support longer than 20 years
- A length of the administrative process of 6-12 months
- A high social acceptance

As far as the type of policy scheme is concerned, feed-in tariff has been chosen in the base case scenario both because it is the most relevant support scheme for the surveyed investors and because it is the most widespread policy instrument in Europe. Regarding the premium incentive, the average tariffs for onshore wind paid in EU countries range between 50 €/MWh and 75

€/MWh, with Italy being closer to the highest attribute level proposed (100 €/MWh) and Spain and Denmark being closer to the lowest attribute level listed (25 €/MWh). Therefore, in the base case a premium incentive of 50 €/MWh has been selected, which reflects the average premium incentive paid for onshore wind in a country like Germany over the past years. The base case scenario also assumes that a stable framework is in place, offering the support for more than 20 years, and a reasonable length of the administrative process, in line with the findings of the OPTRES study (OPTRES, 2006) already commented in paragraph 7.1. Finally, by default a high social acceptance of wind energy is assumed, again in line with the results of the OPTRES survey. Once defined the attributes of the reference scenario, a series of simulations have been run by changing one more parameters at a time. The results are summarized in Table 18.

Table 18: Comparison between the base case scenario and a scenario characterized by a very high level of the incentive (100 €/MWh) and varying levels of other attributes

Simulation	Scenario	Likelihood to invest
1st simulation	Base case	6%
	Base case + 100 €/MWh incentive	94%
2nd simulation	Base case	27%
	Base case + 100 €/MWh incentive and 10-20 yrs support duration	73%
3rd simulation	Base case	70%
	Base case + 100 €/MWh incentive and <10 yrs support duration	30%
4th simulation	Base case	26%
	Base case + 100 €/MWh incentive and length of the admin process >12 months	74%
5th simulation	Base case	45%
	Base case + 100 €/MWh incentive and low social acceptance	55%

Since the level of the premium incentive turned out to be the most important policy attribute, in the first simulation the base case scenario is compared against an alternative scenario characterized by a very high level of incentive (100 €/MWh) and varying levels of the other attributes. As reported in Table 18 the second scenario is much more attractive than the reference case, given the higher remuneration provided to the renewable energy project, obtaining 94% of preferences all other attributes being equal. However, by changing the level of the remaining attributes, the alternative scenario becomes the less and less attractive. For instance, if the duration of the support guaranteed to the renewable energy project is shortened from more than 20 years to 10-20 years, the share of preferences for the alternative scenario is of 73%, despite the very high level of the incentive. Quite remarkably, if the duration of the support is shortened to less than 10 years, the base case scenario becomes much more preferable than the alternative one, even if the amount of the incentive provided to the renewable energy project is exactly the half. This supports the results provided above, and represents a very important indication for policy design. Indeed, it seems that a timeframe of 10-20 years is the minimum to guarantee the stability of the market and to attract investments in the sector. Stop and go policies, or frequent changes in the policy design are very detrimental to the growth of the renewable energy market, since they create uncertainty and discourage investments.

As for the length of the administrative process, the simulation confirms what has been presented already in the previous sections, i.e. that the administrative framework is less of a concern for investors than other policy attributes. In fact, even if the duration of the administrative process becomes longer than one year, still the alternative scenario is more preferable than the base case. This finding suggests that respondents are ready to spend a certain amount of time after the bureaucratic and authorization procedures, provided that they receive enough remuneration for their investment.

Finally, in the case social acceptance becomes low, the base case and the alternative scenario receive almost the same share of preferences. This is an indirect confirmation of previous findings. It seems in fact that in general investors (and particularly the most experienced ones) believe that social acceptance is not an issue for onshore wind in Europe. However, in a scenario characterised by strong opposition, social acceptance becomes an important attribute to be considered while taking an investment decision.

As reported in Table 19, if the incentive premium is lowered to 75 €/MWh, the base case scenario becomes preferable over the alternative scenario already if the duration of the support is shortened to 10-20 years (57% against 43%).

In the case the support duration is shorter than 10 years, the base case scenario receives 90% of preferences.

The duration of the administrative process has a much higher impact in the case the amount of the incentive level of 75 €/MWh. In this case in fact the base case scenario is preferred over the alternative scenario if the latter is characterized by a longer duration of the administrative process. In other terms, investors prefer obtaining 25 €/MWh less provided that the administrative process is ended within one year.

Finally, the base case is definitively more attractive than the alternative scenario if social acceptance in the country is low (71% against 29%).

Table 19: Comparison between the base case scenario and a scenario characterized by a high level of the incentive (75 €/MWh) and varying levels of other attributes

Simulation	Scenario	Likelihood to invest
1st simulation	Base case	19%
	Base case + 75 €/MWh incentive	81%
2nd simulation	Base case	57%
	Base case + 75 €/MWh incentive and 10-20 yrs support duration	43%
3rd simulation	Base case	90%
	Base case + 75 €/MWh incentive and <10 yrs support duration	10%
4th simulation	Base case	54%
	Base case + 75 €/MWh incentive and length of the admin process >12 months	46%
5th simulation	Base case	71%
	Base case + 75 €/MWh incentive and low social acceptance	29%

Two additional simulations are offered in Table 20, which compares the base case against a scenario characterized by a very low level of the premium incentive (€ 25/MWh). Quite obviously, the base case receives 83% of preferences compared to the alternative scenario, given the more attractive level of incentive. However, if the low level of the incentive in the alternative scenario is compensated by a quick administrative process, shorter than 6 months, the two scenarios become comparable.

This finding confirms that investors are primarily driven by financial considerations on the profitability of their investment, but some of them are ready to accept lower remunerations if a more rapid administrative process is guaranteed.

Table 20: Comparison between the base case scenario and a scenario characterized by a low level of the incentive (25 €/MWh) and a quick administrative process

Simulation	Scenario	Likelihood to invest
1st simulation	Base case	83%
	Base case + 25 €/MWh incentive	17%
2nd simulation	Base case	54%
	Base case + 25 €/MWh incentive and length of the admin process <6 months	46%

7.7 Sensitivity analysis: the influence of the estimate method

The Hierarchical Bayes is recommended in the analysis of part worths since it proves to produce more robust results compared to traditional estimation methods, like the ordinary least squares. As highlighted by several scholars (e.g.: Allen, 2004; Lenk et al.,1996), when the goal is to estimate the heterogeneity in the customers' part-worths, the least squares method requires each subject to respond to a higher number of product profiles than product attributes, resulting in lengthy questionnaires and in higher risk of biased responses. Conversely, the Hierarchical Bayes models do not require the individual-level design matrices to be of full rank. This leads to the possibility of using fewer profiles therefore having shorter questionnaires. The Hierarchical Bayes method therefore helps in situations where the data collection task is so large that the respondent cannot reasonably provide preference evaluations for all attribute levels. In fact the Hierarchical Bayes approach uses average information about the distribution of utilities from all respondents to estimate attribute level utilities for each individual. This approach again allows more attributes and levels to be estimated with smaller amounts of data collected from each individual respondent. Having said that, for sake of completeness the main results for the sample calculated with the ordinary least squares method are reported as well. This allows to assess the influence of the estimate method on the results.

Table 21: Average importance of policy attributes for the investigated sample, according to the estimate method selected

Policy attribute	HB		OLS	
	Average importance	**Standard deviation**	**Average importance**	**Standard deviation**
Level of the support	25.22%	4.32	26.58%	8.68
RE support scheme	21.48%	5.07	21.07%	7.23
Duration of the support	20.91%	3.98	19.43%	9.17
Length of the administrative process	18.08%	4.38	16.69%	8.65
Social acceptance	14.31%	5.15	16.23%	8.10
	100.00%		**100.00%**	

As it is possible to see from Table 21, the ranking order of the average importance remains the same in the two cases. However, the attribute importance weight is different. In particular, via the Ordinary Least Square method the level of the support receives an even higher score than through the Hierarchical Bayes. Conversely, the importance assigned to the administrative process is much lower. It is worth signalling that social acceptance receives a higher weight by using the OLS method. Although it does not impact the overall ranking order, this is a very significant difference (16.23% against 14.31%) which makes the importance of social acceptance become very close to the length of the administrative process if using the OLS instead of the HB method. This should be kept in mind while selecting different elaboration techniques. Sensitivity analysis is therefore always commendable. Finally, the standard deviations are higher in the OLS results than in the HB, thus confirming the analytical superiority of the latter tool.

Looking at the part-worth utilities (Table 22), it can be noted that some differences are less pronounced while using the OLS method, while others increase even further. For example, the distance between FITs and TGCs increases. Nevertheless, the absolute distance between the best and worst level is shorter compared to the HB analysis results. In terms of the duration of support and duration of the administrative process, the distance between the offered levels is shorter than in the HB results. Finally, as already discussed above, part-worth utilities for social acceptance are higher when using OLS compared to HB.

Again, it is worth highlighting that the standard deviations are higher in the OLS results than in the HB estimates.

Table 22: Importance of policy attribute levels for the investigated sample, and standard deviations calculated with HB and OLS method

Zero-centered	HB		OLS	
	Av. utilities	Sd	Av. utilities	Sd
Level of the premium incentive				
100 €/MWh	60.21	10.11	58.25	28.61
75 €/MWh	23.60	7.33	24.44	24.66
50 €/MWh	-17.91	4.17	-17.61	25.28
25 €/MWh	-65.91	15.67	-65.07	28.61
RE support scheme				
Feed-in tariffs	57.35	13.98	52.78	29.75
TGC/RPS	14.57	4.72	5.74	27.56
Tender schemes	-21.85	6.63	-24.47	24.16
Tax incentives/ Investment grants	-50.06	8.22	-34.04	27.61
Duration of the support				
More than 20 years	51.21	10.20	43.43	28.14
10-20 years	2.13	5.10	4.11	20.24
Less than 10 years	-53.35	10.32	-47.54	28.71
Length of the administrative process				
<6 months	44.45	10.73	37.27	27.06
6-12 months	1.49	4.36	2.42	18.65
>12 months	-45.93	11.58	-39.68	24.90
Social acceptance				
High	35.77	12.88	39.71	21.92
Low	-35.77	-12.88	-39.71	21.92

8 Results of the regression model

The previous chapters have provided descriptive statistics for the sample, as well as an analysis of policy preferences.

In this section the conceptual model is tested against the data collected in order to see if and to what extent the hypotheses are confirmed, or if they need to be rejected. To this end, the two equations described in paragraph 5.3.2.3 (page 74) have been tested using several estimation methods.

8.1 Most relevant findings for the sample

First and foremost, it is worth signalling that the empirical study depicts a business context dominated by highly rational and well informed investors, who tend to minimise the risk of their choices by founding their decisions on factual, technical information, as already reported in chapter 6. The analysis of the survey results carried out in the previous chapters has revealed that the investors in the sample have clear preferences for relatively mature renewable energy technologies (as displayed in Table 6). They also look for stable policy frameworks axed on high levels of financial support as a prerequisite for investment decisions.

Against this background, the multivariate regression analysis has brought some additional findings to light. In particular, it has identified a series of causal relationships between behavioural attitudes and the share of renewables in the investment portfolio, as well as between behavioural attitudes and the investment performance, thus addressing the two research questions.

Table 23 displays the descriptive statistics for the investigated variables and Pearson's correlations, while the results of the multivariate regressions for the renewable energy share model and the investment performance model are reported in Table 24 and Table 25, respectively. It is worth remembering that in order to exclude possible endogeneity problems in the data structure, the model was tested using four different estimation methods: the Ordinary Least Squares (OLS), 2-stage Least Square (2SLS), 3-stage Least Square (3SLS), and Seemingly Unrelated Regression (SUR) as well[13].

For sake of simplicity in the following discussion I refer to the OLS results only. As can be seen from the Tables, the estimates are consistent across the

[13] Please refer to chapter 5 for a thorough explanation of this methodological issue.

different methods applied. This confirms the robustness of the conceptual model developed.

In order to take duly into account the methodological limitations deriving from the use of a qualitative measurement method based on a three-point likert scale in the assessment of performance, the equation 2 reported at page 74) was re-estimated using also a multinomial logit model. In fact, as the Hausman test revealed no endogeneity problems, it was possible to estimate equation 1 and 2 separately.

The estimates of the logit model are consistent with the original OLS estimates, thus confirming the validity of results. For sake of completeness, they are reported in Table 26, but not commented in the interest of space. Eventually, additional analysis based on quantitative longitudinal data sets will be needed in order to further corroborate the findings.

Table 23: Descriptive statistics and Pearson Correlations

	Min	Max	Mean	Std	Confidence in market efficiency	Confidence in technology adequacy	Technological risk seeking attitude	Perceived importance of policy type	Perceived importance of support level	Perceived importance of support duration	Perceived importance of the length of administrative process	Investor's experience	RE share in the investment portfolio
Confidence in market efficiency	1.00	5.00	3.45	0.79	1	-0.03	0.03	0.17	0.21	0.20	0.15	0.22	0.37
Confidence in technology adequacy	2.00	5.00	3.56	0.72	-0.03	1	0.06	0.08	-0.02	-0.06	0.02	0.12	0.13
Technological risk seeking attitude	0.00	9.00	0.48	1.02	0.03	0.06	1	0.03	-0.08	-0.05	-0.01	-0.17	-0.15
Perceived importance of policy type	0.71	5.17	1.68	0.78	0.17	0.08	0.03	1	0.85	0.88	0.81	0.06	0.14
Perceived importance of support level	0.64	8.86	2.02	1.19	0.21	-0.02	-0.08	0.85	1	0.94	0.82	-0.01	0.04
Perceived importance of support duration	0.48	6.91	1.67	0.95	0.20	-0.06	-0.05	0.88	0.94	1	0.81	0.08	0.15
Perceived importance of the length of the administrative process	0.49	4.34	1.35	0.56	0.15	0.02	-0.01	0.81	0.82	0.81	1	-0.05	0.07
Investor's experience	1.00	4.00	2.29	0.62	0.22	0.12	-0.17	0.06	-0.01	0.08	-0.05	1	0.34
RE share in the investment portfolio	0.00	5.00	2.11	1.94	0.37	0.13	-0.15	0.14	0.04	0.15	0.07	0.34	1
Investment performance	1.00	3.00	2.24	0.41	0.21	-0.11	-0.32	0.01	0.10	0.13	-0.01	0.08	0.26

Table 24: Results of the multivariate regression for the first part of the conceptual model (all coefficients are standardized)

RE share in the investment portfolio	OLS			2SLS			SUR			3SLS		
	Estimate	Std Err	p	Estimate	Std Err	p	Estimate	Std Err	p	Estimate	Std Err	p
Confidence in market efficiency	0.34	0.24	0.17	0.34	0.24	0.17	0.33	0.24	0.18	0.27	0.25	0.27
Confidence in technology adequacy	0.81	0.22	0.00	0.81	0.22	0.00	0.83	0.22	0.00	0.87	0.22	0.00
Technological risk seeking attitude	-0.37	0.09	<.0001	-0.37	0.09	<.0001	-0.37	0.09	<.0001	-0.36	0.09	0.00
Perceived importance of policy type	0.32	0.43	0.46	0.32	0.43	0.46	0.31	0.43	0.46	0.28	0.44	0.52
Perceived importance of support level	-1.34	0.53	0.01	-1.34	0.53	0.01	-1.32	0.53	0.02	-1.19	0.54	0.03
Perceived importance of support duration	1.29	0.59	0.03	1.29	0.59	0.03	1.30	0.59	0.03	1.30	0.61	0.03
Perceived importance of the length of the administrative process	0.33	0.58	0.58	0.33	0.58	0.58	0.28	0.59	0.64	0.05	0.60	0.93

Table 24: Results of the multivariate regression for the first part of the conceptual model (all coefficients are standardized) (cont.)

RE share in the investment portfolio	OLS			2SLS			SUR			3SLS		
	Estimate	Std Err	p	Estimate	Std Err	p	Estimate	Std Err	p	Estimate	Std Err	p
Investor's experience	0.52	0.28	0.07	0.52	0.28	0.07	0.51	0.28	0.07	0.51	0.28	0.07
Dummy Funds	-0.84	0.93	0.37	-0.84	0.93	0.37	-0.86	0.93	0.36	-0.95	0.95	0.32
Dummy VC	0.24	0.60	0.69	0.24	0.60	0.69	0.22	0.60	0.72	0.14	0.60	0.81
Dummy other investors	-0.40	0.59	0.50	-0.40	0.59	0.50	-0.42	0.59	0.48	-0.50	0.60	0.41
R^2	0.35			0.35			0.35			0.35		
F	4.14		<0.01									

Table 25: Results of the multivariate regression for the second part of the conceptual model (all coefficients are standardized)

Investment performance	OLS			2SLS			SUR			3SLS		
	Estimate	Std Err	p	Estimate	Std Err	p	Estimate	Std Err	p	Estimate	Std Err	p
RE share in the investment portfolio	0.05	0.02	0.04	0.09	0.06	0.15	0.06	0.02	0.02	0.09	0.06	0.15
Technological risk seeking attitude	-0.12	0.03	0.00	-0.11	0.03	0.00	-0.12	0.03	0.00	-0.11	0.03	0.00
Investor’s experience	0.01	0.10	0.89	-0.03	0.11	0.79	0.00	0.10	0.95	-0.03	0.11	0.79
Dummy Funds	-1.12	0.16	<.0001	-1.08	0.18	<.0001	-1.11	0.16	<.0001	-1.08	0.18	<.0001
Dummy VC	-0.93	0.16	<.0001	-0.96	0.17	<.0001	-0.94	0.16	<.0001	-0.96	0.17	<.0001
Dummy other investors	-0.86	0.13	<.0001	-0.83	0.14	<.0001	-0.85	0.13	<.0001	-0.83	0.14	<.0001
R^2	0.23			0.20			0.23			0.20		
F	3.61		<0.01									

Table 26: Analysis of the investment performance: results of the logit model

Dependent Variable: Investment Performance			
	Estimate	Std Err	$p>X^2$
RE share in the investment portfolio	0.86	0.36	0.02
Technological risk seeking attitude	-0.76	0.43	0.08
Investor's experience	-0.05	0.33	0.89
Dummy Funds	-14.17	189.40	0.94
Dummy VC	-12.98	189.40	0.95
Dummy other investors	-13.39	189.40	0.94
-2LL	83.60		
X^2	21.33		<0.01

Both the renewable energy share model and the investment performance model are significant ($F = 4.14$ with $p < 0.01$ and $F = 3.61$, $p < 0.01$ respectively) and have an acceptable explanatory power ($R^2 = 0.35$ and 0.23 respectively).

8.2 Main results of the first part of the regression model

Starting from the analysis of Table 24, it can be noted that a priori beliefs have a positive influence on the investors' willingness to back renewable energy projects. However, the degree of confidence in technology adequacy has a stronger impact than the confidence in the market efficiency ($\beta=0.81$ with $p < 0.01$ versus $\beta=0.34$ with $p = 0.17$).

This might be interpreted as an indication that the proven reliability of a technology is a conditio sine qua non for investing, whereas investors believe that possible market inefficiencies can be corrected through the adoption of appropriate policy instruments. In other terms, investors seem to have a strong preference for those technologies which have already overcome both the technology and cash flow "valleys of death" (Grubb, 2004; Murphy and Edwards, 2003). This finding is in line with the results of a survey carried out by Fritz-Morgenthal et al. (2009) where the majority of the sample stated that investors are expected to focus less on innovation and more on established technologies in the next 2-3 years, as a response to the financial crisis.

Quite surprisingly, and in sharp contrast with the hypothesized effect, a higher propensity for technological risk (i.e. a tendency to invest in radically new technologies which are still far from commercial viability) is negatively associated with the renewable energy share in the portfolio. This can be due to the fact that most of the portfolios are skewed towards relatively well known renewable energy technologies. Investors who have an appetite for technological risk and invest in radically new technologies need to hedge against this risk by including a higher share of conventional technologies in their portfolios compared to those who invest in less innovative technologies. Thus, the total renewable energy share in their portfolios will be lower than investors with a moderate appetite for technological risk. Another explanation could be that investors willing to invest in radically new technologies still do not find enough credible and well documented investment opportunities in the renewable energy sector in Europe.

Policy preferences have different impacts on the share of renewables in the investment portfolio. The analysis of their specific effects offers interesting insights. The influence of the type of policy scheme is statistically not significant ($p = 0.46$). As the analysis of the conjoint measurement results has highlighted already, this is due to the fact that the surveyed investors have a clear and strong preference for feed-in tariffs over other policy instruments. In other words, the investors in the sample believe that feed-in tariffs are by far the most effective policy instruments to attract investments in renewable energy technologies. This limits the variance of the policy type variable and its consequent effect on investment choices.

A high perceived importance of the level of support is negatively associated with the share of renewable energy in the investment portfolio ($\beta = -1.34$ with $p = 0.01$), suggesting that investors implicitly believe that the level of support currently allocated to renewable energy technologies is still inadequate. In other words, this means that investors are reluctant to embark in renewable energy investments and tend to wait until higher levels of support are given.

Conversely, and in sharp contrast with the above result, a high perceived importance of the duration of the support is positively associated with the renewable energy share ($\beta = 1.29$ with $p = 0.03$). This suggests that investors believe that the time horizon of the policies currently in place is already adequate, and therefore no additional action should be put in place by governments with respect to this particular policy attribute.

These results seem to reinforce the impression that investors in the sample are extremely risk averse. The statistical analysis in fact suggests that short term policies that provide high levels of financial incentives for a limited amount of time are preferred over long term policies that guarantee a moderate but stable level of support for a longer amount of time. This finding should be interpreted with care, because the sample is skewed toward venture capital and private equity funds, which have rather short-term investment horizons. The segmentation analysis reported in the previous chapter has revealed indeed that, for some particular categories of investors such as infrastructure funds and project developers, the incentive level has a relatively lower importance, while other policy attributes such as the type of support scheme and the duration of support play a more important role in shaping the investors’ preferences.

Finally, the influence of the perceived importance of the length of the administrative process is statistically not significant ($p=0.58$).

As far as the control variables are concerned, the investor’s experience has a slight positive influence on the share of renewables in the investment portfolio ($\beta=0.52$ with $p = 0.07$), thus confirming that the investors’ confidence in renewable energy technologies increases with an increase of knowledge in this specific business. This implies also that those fund managers who have a larger experience in the renewable energy investing domain are more capable to recognize the value of more innovative technologies, thus being more inclined to prefer renewables over traditional energy sources.

These results reinforce what the ACA analysis had already suggested, thus increasing the validity of the empirical findings.

8.3 Main results of the second part of the model

The analysis of the performance model in Table 25 reveals that higher shares of renewable energy technologies in the investment portfolio are associated with a slightly higher performance relative to direct competitors ($\beta = 0.05$ with $p = 0.04$).

This provides evidence against the belief that investments in renewable energy technologies yield lower returns compared to investments in conventional energy systems.

This finding appears very relevant for both practice and theory. Firstly, demonstrating that renewable energy technologies can represent a profitable investment can help financiers to allocate more capital in this sector, thus fostering the growth of the renewable energy market. Secondly, this result is in line with previous findings in management literature, which have highlighted the positive relationship between sustainability investments and financial performance. Finally, the result is coherent with portfolio theory, which has highlighted the positive role of renewable energy investments in risk hedging strategies. In this respect, the present finding contributes to highlight the positive role of renewables under the framework of investment diversification strategies.

As already pointed out, the present results are based on a self-assessed performance of investors compared to their direct competitors. Even though the performance equation does not result to be affected by self-reported biases according to the results of the econometric tests performed, additional analysis with external data series is recommended to validate the findings in future research.

It is also interesting to note that the investors' attitude towards renewable energy technological risk has a strong negative impact on the investment performance. This effect is both direct and indirect through its impact on the renewable energy share in the investment portfolio. Once again, this reinforces the impression that the surveyed investors display aversion not only for financial risk, but also for technological risk. One possible explanation for this result is related to the fact that the majority of respondents in the sample have rather limited experience in the renewable energy sector. Since investors have not accumulated enough experience in an industry that is very promising, but also risky, they might fail to analyse investment opportunities in a proper way, thus privileging short term returns instead of embarking in projects that guarantee superior returns only in the long run.

As far as the indirect effect of the investors' attitude towards renewable energy technology risk is concerned, a possible explanation is that risk adverse investors tend to include a lower share of renewable energy technologies in their portfolio, and this leads to a lower performance.

Finally, the type of companies undertaking the investment seems to have a negative impact on the investment performance. In particular, the results suggest that - among the three categories of investors - banks, pension funds and insurance companies are the least performing ($\beta = -1.12$ with $p < 0.01$), whereas project developers, utilities, infrastructure funds and engineering companies show better performance.

This makes sense intuitively. In fact, the category of project developers regroups investors with a specific know how in the renewable energy investment domain, while banks, pension funds and insurance companies on average have the least specific knowledge among the three categories analysed. This finding is in line with the considerations already expressed above regarding the influence of specific experience on the investment performance.

9 Conclusions

Renewable energy sources can play a crucial role in reducing carbon emissions and fossil fuel consumption, thus enabling a real energy technology revolution. Economies of scale, technology improvements and renewable energy targets are all factors that have contributed to the acceleration of renewable energy penetration, particularly over the last decade.

Evidence suggests also that renewable energy technologies have long-term growth prospects and can constitute safe investment opportunities to hedge against fluctuations of fossil fuel prices.

Despite this promising outlook, their potential is far from being significantly exploited. Mainstreaming renewable energy technologies requires to inject in the market an amount of money two to four times higher than the current values by 2020. Mobilising private capital becomes therefore a priority. Private investors represent already the largest source of capital for renewable energy projects. However, they are still reluctant to scale up the share of their investments in this sector. Needless to say, this is particularly challenging in a context of global economic slowdown such as the one the world is currently experiencing. To bridge the gap between the current level of investments and the actual requirements, significant improvements are needed in terms of innovative policy design, the development of more accurate evaluation tools and the understanding of investors' acceptance of renewable energy.

The literature analysis has emphasized some important aspects. Firstly, it has highlighted that there is a positive relationship between renewable energy investments and financial performance; however, the strength and direction of this relationship has not been thoroughly assessed by scholars. Secondly, it has shown that policy plays a paramount role in increasing investors' confidence and decreasing the investment risk. At the same time, however, it has higlighted that policy can be perceived as an additional risk factor for investors. Thirdly, it has emphasized that cognitive factors have an impact on the decision to invest in renewables. Therefore policy effectiveness is critically dependent upon its impact on investors' behaviours. Distorted risk perceptions may lead to suboptimal decisions and represent additional barriers to renewable energy market growth. This issue has relevant implications both at a micro and macroeconomic level. Under a microeconomic perspective, biased perceptions vis-à-vis renewable energy technologies can lead investors to overlook promising opportunities in a sector characterized by a significant growth potential. At a macroeconomic level, if renewable energy policies fail to understand the behavioural context in which investors make decisions, they will not be able to leverage the needed amount of capital to foster the transition toward more sustainable energy paths. In order to maximize the impact of future energy policies, public regulators therefore need to get a better understanding of how investors behave, and of how they take their decisions, particularly in regards to the key psychological factors that may influence their actions.

Yet, there is a surprising lack of rigorous empirical studies examining these issues in the energy policy and strategic management literature. This work represents one of the first attempts to fill this gap.

Drawing upon a comprehensive literature review encompassing energy policy, finance, management and cognitive psychology studies, a conceptual model has been put forth in order to address the two main research questions of the doctoral work. The model examines whether behavioural factors have a measurable influence on the decision to invest in renewable energy projects and whether, in turn, the share of renewable energy in the portfolio that results from these decisions is reflected into the portfolio performance. Three main categories of behavioural factors have been included as independent variables in the model: i) a priori-beliefs, ii) policy preferences and, iii) attitudes toward technological risk. As for the dependent variables, these are the renewable energy share in the portfolio and the investment performance.

The methodological approach followed is rigorous since it combines cognitive psychology approaches with quantitative measurement techniques, therefore allowing to gather statistically relevant results. Two main measurement tools were adopted, serving specific research purposes. More specifically, ACA was used to investigate investors' preferences over renewable energy policy characteristics, whereas the multivariate regression analysis had the goal to measure the statistical relationships between the dependent and independent variables. The conceptual model developed has proven to be able to capture the elements influencing the investment decision making process in the renewable energy field, as well as the strength and the direction of the relationship between variables, therefore providing clear answers to the research problem.

In particular, it has demonstrated that cognitive factors have a measurable influence on the decision to invest in renewables. The multivariate regression results have revealed that a priori beliefs on the technical effectiveness of the investment opportunities play a much more important role than market efficiency beliefs in driving investments. This implicitly suggests that agents consider the proven reliability of a technology as a necessary condition for investing in it, whilst they believe that market inefficiencies can be corrected through the adoption of appropriate policy instruments.

The analysis of the performance model has found that higher shares of renewable energy technologies in the investment portfolio are associated with a slightly higher performance relative to direct competitors, thus answering the second research question.

The results have also depicted a group of investors with relatively short investment horizons, who have a strong preference for policies that provide high levels of financial incentives for a limited amount of time over policies that guarantee a moderate but stable support for a longer time. Furthermore, a tendency to invest in radically new technologies does not translate automatically into a higher share of renewable energies in the portfolio.

The research has also revealed that the majority of survey respondents have rather limited experience in the renewable energy sector. Although this is not surprising, since the renewable energy market has evolved only quite recently, the lack of accumulated experience implies that financiers might fail to analyse investment opportunities in a proper way. In fact, common financial rules of thumb are not necessarily suited to guide investment decisions in a highly specialised field as the renewable energy market. This might lead to overlook promising opportunities by privileging short term returns instead of embarking in projects that tend to guarantee superior returns over a longer term horizon. This issue has profound implications also for policy making, since time horizons of relevance to investors are not necessarily those which are socially optimal. This is a very important point to be taken into account when investigating the relationship between policy and investment.

Furthermore, the ACA results reveal that investors are primarily driven by total remuneration opportunities. Therefore reasonably high levels of the premium incentive should be given to renewable energy projects in order to ensure that investments will be undertaken. Feed-in tariffs are the most favoured policy instruments. Investors also ask for continuity of support, over a timeframe longer than 20 years. Other aspects like the administrative process and social acceptance seem to represent less of an issue. However, the segmentation analysis has emphasized some important differences across the sample. Results indicate that policies are perceived differently, depending on the investor category, the geographical location and the type of renewable energy technology.

The present study makes a contribution to management, energy policy and behavioural finance literature, and has some important implications for managerial practice.

Firstly, by providing statistically robust results on the positive relationship between renewable energy investments and financial performance, the research corroborates the existing literature by providing empirical evidence on an under-investigated topic so far.

Secondly, the research had the purpose to assess investors' attitudes toward renewable energy policies. Since renewable energy markets are regulated under several policy schemes, understanding which policy characteristics influence the most the likelihood to invest in a renewable energy project by reducing the perceived risk associated to the investment can help policy makers design more effective policy instruments to support the market deployment of renewables.

Furthermore, the development of a conceptual model which incorporates cognitive and behavioural elements into the analysis of the renewable energy investment decision making process is an important methodological contribution which produces a more accurate description of the relationship between policies and investment.

The analysis of the influence of behavioural factors on the investment decision making process represents an important contribution also to behavioural finance. By providing empirical findings on how and to what extent investment behaviours in the renewable energy sectors deviate from the expectations of traditional finance theories, the present works help corroborate this stream of research.

The study also contributes to the theory of social acceptance of renewable energy innovation. As observed by Wüstenhagen et al. (2007), while factors influencing socio-political and community acceptance are increasingly recognized as being important in the understanding of policy effectiveness, market acceptance has received less attention so far. By investigating investors' acceptance of renewable energy policies, the present research contributes to fill this gap.

Finally, the results appear also relevant for practitioners in the renewable energy market. A priory beliefs and cognitive biases create additional risk elements that restrain the likelihood of raising capital for clean energy investments. The analysis of these elements as opposed to more rational risk factors can help investors get a more balanced view of policy risks and opportunities in this promising business sector.

Like most research, also this study is not exempt from limitations.

As far as the ACA analysis is concerned, the current experiment included five policy attributes for a total number of 16 attribute levels. Additional research is recommended by using the same number of levels across attributes in order to accurately assess to what extent a higher number of levels influence the attribute importance.

As far as the regression model is concerned, a methodological shortcoming is related to the fact that the variables used in the portfolio performance model are self assessed and measured by means of a three-point likert scale. This choice was dictated by the results of the pre-test, which revealed that investors were reluctant to disclose any performance-related information beyond a mere first order assessment of their ranking with respect to peers (below, in line with, above). Although the analysis excluded the presence of common method variance problems and the performance equation was re-estimated through a multinomial logit model, the use of objective, quantitative measures of performance would have been ideal and remains necessary to further validate the findings.

Additionally, the presence of a reverse causal relationship between investment performance and the share of renewables in the investment portfolio cannot be excluded a priori. Over time, it can be expected that rational investors who obtained above-average returns by adding renewables to their portfolios, will also tend to increase the share of renewables in their portfolios in the next investment round. Therefore it would be interesting to test the relationship between investment performance at time t and the renewable energy share in the investment portfolio at time t+1.

Fully disentangling this reverse causality would require the availability of longitudinal data, which, unfortunately, were not available for this study. Addressing some of these issues in follow-up research would bring both methodological and theoretical added values. In this respect, additional analysis through face to face interviews with a selected sample of stakeholders might help overcome some of the barriers encountered during the questionnaire survey, thus perhaps facilitating the obtaining of additional information on performance data. It is also worth adding that many companies investing in the renewable energy domain have a relatively short history. This limits the possibility to get performance data on a relatively long period of time. Further research could therefore restrict the focus on a smaller sub-sample with a longer experience in the renewable energy investment business. On the one hand, a smaller sub-sample would allow performing more in-depth case studies; on the other hand, the need to obtain objective performance measurements would imply also the possibility to get access to subscription-based magazines and directories in order to cross-check the information provided by companies against external sources.

The present study is based on a specific empirical context. Results may be difficult to generalize because the sample is skewed toward venture capitalists and private equity funds. Additional research is recommended with a wider sample of investor categories. Ideally, it would be worth conducting investor-specific studies that can be compared to each other in order to gather more accurate insights on the investment decision making process and on policy perceptions of different category of stakeholders.

Furthermore, the relatively limited sample size did not allow for a better differentiation among the various types of renewable energy investments. The survey included investments in a wide range of renewable energy technologies characterized by different degrees of innovativeness and risk. Clearly, some of the phenomena observed may be technology-dependent and require further investigation. Therefore, technology-specific studies would be also very appropriate. In this respect, four renewable energy technologies appear of particular interest for specific reasons: biofuels, solar PV, solar CSP and offshore wind.

As for biofuels, evidence reveals that the market hype has been followed by a rapid disappointment and the current rate of investments remains below expectations. Investigating the role of herd behaviours in explaining such phenomenon would bring very useful indications to policy makers. Furthermore, the segmentation analysis has found that social acceptance issues have a greater weight in the decision to invest in biofuels compared to other technologies.

Solar PV is the fastest-growing renewable energy technology and is expected to play an important role in future energy scenarios thanks to its flexibility, technology improvements and the rapid cost reduction. Therefore, a more in-depth analysis of how investors perceive solar PV and what they expect from solar PV policies would be greatly beneficial.

Solar CSP is also expected to give an important contribution to future energy supply, particularly in the sunbelt countries. For instance, a series of policy and industrial initiatives in the South Mediterranean region have the objective to install 20 GW of additional renewable energy capacity by 2020, to be satisfied mostly by solar CSP. Understanding how investors undertake their investment decisions in the solar CSP market and what are the main policy risks associated to this technology is an additional topic for further research.

Wind offshore is expected to give a significant contribution to the achievement of renewable energy targets in the EU by 2020. However, wind offshore presents peculiar challenges with respect to interconnection and grid integration. This makes this technology an additional relevant case study.

Finally, the study was restricted to the European region. Results might be different in other empirical contexts, due to the different policy frameworks in place and other country specific boundary conditions, as well as investors' attitudes. In order to capture these differences and get a better understanding of investors' behaviours, it would be interesting to conduct similar surveys in other world regions. Particularly interesting case studies would be countries like the United States, China, India and Brazil which are currently triggering investments in various segments of the renewable energy market. Such additional studies would provide relevant insights for national and international investors, as well as for policy makers and international institutions.

Summarising, the main recommendations deriving from the study results are that more targeted policies should be designed, which must take into account the degree of renewable energy technology maturity, country-specific conditions and that serve the specific needs and concerns expressed by different categories of operators. Using the term coined by Hamilton (2009), more "investment-grade" policies are needed in order to stimulate scaled-up financial resources in the renewable energy field. At the same time, policies can also contribute to a change in the way financial actors approach the renewable energy business, by fostering a longer term perspective. As pointed out by Grubb "technological advances, and in some cases breakthroughs, are certainly needed: but the revolution required is one of attitudes" (Grubb, 1990, page 716). Therefore, if the share of renewables in the global energy mix is to be increased, significant innovations are needed not only in the technical field, but also in the social and institutional context (Krewitt et al., 2007).

While working on the current dissertation, a series of suggestions for further research have come out. In particular, it became evident that so far government spending in the renewable energy sector has been directed mainly to renewable energy deployment. As a consequence, most literature studies have concentrated on evaluating the effectiveness of various policy mechanisms in leading to a widespread diffusion of renewable energy technologies. Much less attention has been devoted to the assessment of policy effectiveness in bringing renewable energy technology innovation and development, as also highlighted by Nemet and Kammen (2007). This seems to be a research priority. In fact, in order for renewables to become mainstream, both policy makers and financiers need to better understand the main issues and identify the appropriate solutions to overcome the valley of death. This would accelerate cost reduction, bridge the current competitiveness gap and lead to the creation of a self-sustaining market for renewables.

Within this framework, studies incorporating the behavioural finance perspective in the analysis of technology-push policies would bring significant added value.

Another aspect which became clearer while working on the present project is that the success of a sustainable energy technology does not depend only on the effectiveness of dedicated policies, but on a more complex mix of ingredients, which include also the existence of a dynamic industrial environment, the implementation of additional measures to support innovation, and public/private partnerships in the R&D area.

In a previous paper (Menichetti, 2005) I had already highlighted the positive role of spillover effects in nurturing the growth of PV. The spillover approach seems to be particularly appropriate to study renewable energy technology innovation dynamics. Conducting further research by analyzing the underlying factors which can explain why some sustainable technologies have become more successful than others (e.g: PV vs. hydrogen) is a clear priority in my next works.

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Annex 1: The questionnaire

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Start

Welcome to this survey!

In the following, you will be asked to answer a series of questions regarding the main factors influencing your interest in renewable energy (RE) investments

Please type your user name and password and then click the "Next" button to continue...

Username:

Password:

We would like to remind you that **all answers will be treated confidentially**, and that results will be presented only in an **aggregated way**. In return for your participation, you will receive a **copy of the results** where **your performance is benchmarked against the average**. To this end, please indicate **your e-mail address** on the last page. Your email address will not be used **for any other purpose** and will be **stored separately** from your survey answers.

Next

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IntroPositioning

In this first part of the questionnaire, we are going to ask you some general questions regarding your investments in renewables. You will also be invited to react to a series of statements on the potential and constraints of renewable energy technologies

Positioning1

Do you at present invest in renewable energy technologies?

- yes
- no

Next

0% 100%

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Positioning3

What percentage of your portfolio is in renewable energy technologies?

- less than 5%
- from 5 to 9%
- from 10 to 49%
- from 50 to 99%
- I only invest in renewables

Positioning2

In which renewable energy technology do you currently invest? Please, click all that apply:

- Positioning2_1 biofuels
- Positioning2_2 biomass
- Positioning2_3 geothermal
- Positioning2_4 hydropower
- Positioning2_5 concentrated solar power (CSP)
- Positioning2_6 solar photovoltaics (PV)
- Positioning2_7 solar thermal
- Positioning2_8 tidal/wave
- Positioning2_9 wind onshore
- Positioning2_10 wind offshore
- Positioning2_11 none of the above

Next

0% 100%

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ETP2050

If CO2 emissions are to be significantly reduced by 2050 compared to current levels, huge investments in new and innovative technologies are required. How would you assess the following estimates of investment needs provided by various researchers:

	too low	appropriate	too high	no opinion
An increase in the global investment needs of USD 17 trillion between 2005 and 2050 compared to a business as usual scenario	ETP2050_r1	ETP2050_r1	ETP2050_r1	ETP2050_r1
An increase in the global investment needs of USD 45 trillion between 2005 and 2050 compared to a business as usual scenario	ETP2050_r2	ETP2050_r2	ETP2050_r2	ETP2050_r2
An increase in the investment needs of 1.1% of cumulative global GDP between 2005 and 2050 compared to a business as usual scenario	ETP2050_r3	ETP2050_r3	ETP2050_r3	ETP2050_r3
An increase in the investment needs of 0.4% of cumulative global GDP between 2005 and 2050	ETP2050_r4	ETP2050_r4	ETP2050_r4	ETP2050_r4

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ShareofRES

Which share of renewable energy (including electricity, transportation fuels and heating fuels) do you think Europe could reach by 2050? (0 = completely unfeasible to 5 = perfectly feasible)

	1	2	3	4	5
Up to 20%	ShareofRES_r1	ShareofRES_r1	ShareofRES_r1	ShareofRES_r1	ShareofRES_r1
Up to 50%	ShareofRES_r2	ShareofRES_r2	ShareofRES_r2	ShareofRES_r2	ShareofRES_r2
Up to 80%	ShareofRES_r3	ShareofRES_r3	ShareofRES_r3	ShareofRES_r3	ShareofRES_r3
100%	ShareofRES_r4	ShareofRES_r4	ShareofRES_r4	ShareofRES_r4	ShareofRES_r4

Next

0% 100%

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Belief

Please, state to what extent you agree with the following statements (1=I strongly disagree; 2= I disagree; 3= I am indifferent; 4=I agree; 5= I strongly agree)

	1	2	3	4	5
Market forces alone will never lead to a significant exploitation of renewables	Belief_r4	Belief_r4	Belief_r4	Belief_r4	Belief_r4
Government intervention does more harm than good, let governments stay out of the way	Belief_r5	Belief_r5	Belief_r5	Belief_r5	Belief_r5
Investing in the subsidy-driven solar and wind energy markets represents a risk for my company	Belief_r6	Belief_r6	Belief_r6	Belief_r6	Belief_r6
Large-scale deployment of renewables is severely hampered by their intermittent availability	Belief_r3	Belief_r3	Belief_r3	Belief_r3	Belief_r3
Solar energy is a low-density resource, requiring a lot of land. Therefore it will never achieve a significant share of the world's energy mix	Belief_r2	Belief_r2	Belief_r2	Belief_r2	Belief_r2
Energy supply from new renewable electricity sources (e.g. wind and solar) will grow by more than 10% per year worldwide	Belief_r1	Belief_r1	Belief_r1	Belief_r1	Belief_r1

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IntroPV

The photovoltaics (PV) market is fast growing: it recorded over 40% yearly average growth over the last decade (+254% since 2004). Its market value reached about $30 billion in 2008. About 90% of the world market is represented by crystalline silicon cells, with second and third-generation PV still needing significant research and development.

SolarPV

Let's assume you have 10 million Euros to invest in solar PV(the type of investment, i.e. equity or project finance, is irrelevant). How would you distribute your money among the following options?

SolarPV_1 Crystalline silicon solar cells (mature technology)

SolarPV_2 Thin-films solar cells (emerging technology)

SolarPV_3 Third generation solar cells, e.g. nanostructures (future technology)

SolarPV_total Total

Next

0% 100%

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Filler1

Please, rank how relevant/important the following sources are in informing your investment decision (1=most important ... 5=least important)

InfoSource

InfoSource_1	Investments by well-known/high-profile investors in the sector
InfoSource_2	Technical reports
InfoSource_3	My personal intuition
InfoSource_4	In-house due diligence
InfoSource_5	Consultants' opinion

Next

0% 100%

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Filler

Now please assume that you have the opportunity to invest in an ONSHORE WIND project in several countries, each one presenting different policy frameworks. The investment type (e.g. equity or debt) is irrelevant therefore please refer to the most common one(s) for your company.

Overall, 5 different characteristics of a hypothetical policy framework will be investigated:

1) *Type of renewable energy support schemes*: such as feed-in tariffs, tradable green certificates, tender schemes, tax incentives or production grants

2) *Level of the incentive*: the premium paid per kWh produced and sold. The following options are given: 100 €/MWh, 75 €/MWh, 50 €/MWh, 25 €/MWh

3) *Duration of the financial support given to renewables*: the number of years for which the incentive is paid. Three possibilities are envisaged: less than 10 years, from 10 to 20 years, more than 20 years

4) *Duration of the administrative process*: time span from the submission of the request until the permissions are obtained. The following options are given: less than 6 months, from 6 to 12 months, more than 12 months

5) *Social acceptance*: overall degree of acceptance toward wind manifested by the main stakeholders (citizens, public authorities, investors). Two options are given: high social acceptance (pro-wind activism of NGOs, favourable press, pro-wind citizens' coalitions) and low social acceptance (anti-wind activism, negative press, anti-wind demonstrations)

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ACAIMP1

If two national policy frameworks were identical in all other ways, how important would this difference be in influencing your decision to invest in this country?

	Not Important	Somewhat Important	Important	Very Important	Extremely Important
Feed-in tariffs ---*instead of*--- Tax incentives / Investment grants	○	○	○	○	○

Fixed assumptions:
- wind resource availability of 2000 hours per year
- the size of the project is 25 MW

ACAIMP2

If two national policy frameworks were identical in all other ways, how important would this difference be in influencing your decision to invest in this country?

	Not Important	Somewhat Important	Important	Very Important	Extremely Important
100 €/MWh premium incentive ---*instead of*--- 25 €/MWh premium incentive	○	○	○	○	○

Fixed assumptions:
- wind resource availability of 2000 hours per year
- the size of the project is 25 MW

ACAIMP3

If two national policy frameworks were identical in all other ways, how important would this difference be in influencing your decision to invest in this country?

	Not Important	Somewhat Important	Important	Very Important	Extremely Important
incentive paid for more than 20 years --- *instead*	○	○	○	○	○

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ACAIMP4

If two national policy frameworks were identical in all other ways, how important would this difference be in influencing your decision to invest in this country?

	Not Important	Somewhat Important	Important	Very Important	Extremely Important
quick administrative process (less than 6 months) ---*instead of*--- slow administrative process (more than 12 months)	○	○	○	○	○

Fixed assumptions:
- wind resource availability of 2000 hours per year
- the size of the project is 25 MW

ACAIMP5

If two national policy frameworks were identical in all other ways, how important would this difference be in influencing your decision to invest in this country?

	Not Important	Somewhat Important	Important	Very Important	Extremely Important
High-social acceptance (pro-wind activism of NGOs, favourable press, pro-wind citizens' coalitions) ---*instead of*--- Low social acceptance (anti-wind activism, negative press, anti-wind demonstrations)	○	○	○	○	○

Fixed assumptions:
- wind resource availability of 2000 hours per year
- the size of the project is 25 MW

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IntroPair

To better understand the relative importance of each of the policy features presented before in influencing your investment decision you will be asked to indicate your preference within a set of trade-off options.

ACAPAR1

If two national policy frameworks were identical in all other ways, where would you most likely invest?

25 €/MWh premium incentive quick administrative process (less than 6 months)	or	100 €/MWh premium incentive medium administrative process (6-12 months)

Strongly Prefer Left	Somewhat Prefer Left	Indifferent	Somewhat Prefer Right	Strongly Prefer Right

Fixed assumptions:
- wind resource availability of 2000 hours per year
- the size of the project is 25 MW

ACAPAR2

If two national policy frameworks were identical in all other ways, where would you most likely invest?

slow administrative process (more than 12 months) High-social acceptance (pro-wind activism of NGOs, favourable press, pro-wind citizens' coalitions)	or	medium administrative process (6-12 months) Low social acceptance (anti-wind activism, negative press, anti-wind demonstrations)

Strongly Prefer Left	Somewhat Prefer Left	Indifferent	Somewhat Prefer Right	Strongly Prefer Right

Fixed assumptions:
- wind resource availability of 2000 hours per year
- the size of the project is 25 MW

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ACAPAR3

If two national policy frameworks were identical in all other ways, where would you most likely invest?

incentive paid for more than 20 years Low social acceptance (anti-wind activism, negative press, anti-wind demonstrations)	or	incentive paid from 10 to 20 years High-social acceptance (pro-wind activism of NGOs, favourable press, pro-wind citizens' coalitions)

Strongly Prefer Left | Somewhat Prefer Left | Indifferent | Somewhat Prefer Right | Strongly Prefer Right

Fixed assumptions:
- wind resource availability of 2000 hours per year
- the size of the project is 25 MW

ACAPAR4

If two national policy frameworks were identical in all other ways, where would you most likely invest?

Tax incentives / Investment grants incentive paid for more than 20 years	or	Renewable Portfolio Standard, Tradable Green Certificates incentive paid for less than 10 years

Strongly Prefer Left | Somewhat Prefer Left | Indifferent | Somewhat Prefer Right | Strongly Prefer Right

Fixed assumptions:
- wind resource availability of 2000 hours per year
- the size of the project is 25 MW

Next

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ACAPAR5

If two national policy frameworks were identical in all other ways, where would you most likely invest?

Tax incentives / Investment grants 50 €/MWh premium incentive	or	Feed-in tariffs 25 €/MWh premium incentive

Strongly Prefer Left	Somewhat Prefer Left	Indifferent	Somewhat Prefer Right	Strongly Prefer Right

Fixed assumptions:
- wind resource availability of 2000 hours per year
- the size of the project is 25 MW

ACAPAR6

If two national policy frameworks were identical in all other ways, where would you most likely invest?

Renewable Portfolio Standard, Tradable Green Certificates slow administrative process (more than 12 months)	or	Tender schemes quick administrative process (less than 6 months)

Strongly Prefer Left	Somewhat Prefer Left	Indifferent	Somewhat Prefer Right	Strongly Prefer Right

Fixed assumptions:
- wind resource availability of 2000 hours per year
- the size of the project is 25 MW

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ACAPAR7

If two national policy frameworks were identical in all other ways, where would you most likely invest?

50 €/MWh premium incentive High-social acceptance (pro-wind activism of NGOs, favourable press, pro-wind citizens' coalitions)	or	75 €/MWh premium incentive Low social acceptance (anti-wind activism, negative press, anti-wind demonstrations)

Strongly Prefer Left	Somewhat Prefer Left	Indifferent	Somewhat Prefer Right	Strongly Prefer Right

Fixed assumptions:
- wind resource availability of 2000 hours per year
- the size of the project is 25 MW

ACAPAR8

If two national policy frameworks were identical in all other ways, where would you most likely invest?

50 €/MWh premium incentive incentive paid from 10 to 20 years	or	100 €/MWh premium incentive incentive paid for less than 10 years

Strongly Prefer Left	Somewhat Prefer Left	Indifferent	Somewhat Prefer Right	Strongly Prefer Right

Fixed assumptions:
- wind resource availability of 2000 hours per year
- the size of the project is 25 MW

Next

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ACAPAR9

If two national policy frameworks were identical in all other ways, where would you most likely invest?

incentive paid for less than 10 years **quick administrative process (less than 6 months)**	**or**	**incentive paid for more than 20 years** **slow administrative process (more than 12 months)**

Strongly Prefer Left	Somewhat Prefer Left	Indifferent	Somewhat Prefer Right	Strongly Prefer Right
○	○	○	○	○

Fixed assumptions:
- wind resource availability of 2000 hours per year
- the size of the project is 25 MW

ACAPAR10

If two national policy frameworks were identical in all other ways, where would you most likely invest?

Feed-in tariffs **Low social acceptance (anti-wind activism, negative press, anti-wind demonstrations)**	**or**	**Tender schemes** **High-social acceptance (pro-wind activism of NGOs, favourable press, pro-wind citizens' coalitions)**

Strongly Prefer Left	Somewhat Prefer Left	Indifferent	Somewhat Prefer Right	Strongly Prefer Right
○	○	○	○	○

Fixed assumptions:
- wind resource availability of 2000 hours per year
- the size of the project is 25 MW

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ACAPAR11

If two national policy frameworks were identical in all other ways, where would you most likely invest?

medium administrative process (6-12 months) **Low social acceptance (anti-wind activism, negative press, anti-wind demonstrations)**	or	**slow administrative process (more than 12 months)** **High-social acceptance (pro-wind activism of NGOs, favourable press, pro-wind citizens' coalitions)**

○ Strongly Prefer Left ○ Somewhat Prefer Left ○ Indifferent ○ Somewhat Prefer Right ○ Strongly Prefer Right

Fixed assumptions:
- wind resource availability of 2000 hours per year
- the size of the project is 25 MW

ACAPAR12

If two national policy frameworks were identical in all other ways, where would you most likely invest?

25 €/MWh premium incentive **incentive paid for more than 20 years**	or	**75 €/MWh premium incentive** **incentive paid from 10 to 20 years**

○ Strongly Prefer Left ○ Somewhat Prefer Left ○ Indifferent ○ Somewhat Prefer Right ○ Strongly Prefer Right

Fixed assumptions:
- wind resource availability of 2000 hours per year
- the size of the project is 25 MW

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ACAPAR13

If two national policy frameworks were identical in all other ways, where would you most likely invest?

Renewable Portfolio Standard, Tradable Green Certificates quick administrative process (less than 6 months)	or	Feed-in tariffs medium administrative process (6-12 months)

Strongly Prefer Left	Somewhat Prefer Left	Indifferent	Somewhat Prefer Right	Strongly Prefer Right

Fixed assumptions:
- wind resource availability of 2000 hours per year
- the size of the project is 25 MW

ACAPAR14

If two national policy frameworks were identical in all other ways, where would you most likely invest?

Tender schemes 75 €/MWh premium incentive	or	Tax incentives / Investment grants 100 €/MWh premium incentive

Strongly Prefer Left	Somewhat Prefer Left	Indifferent	Somewhat Prefer Right	Strongly Prefer Right

Fixed assumptions:
- wind resource availability of 2000 hours per year
- the size of the project is 25 MW

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Performance1

Thinking about the three best performing investments done over the past five years, how would you assess them:

- well above the performance of my direct competitors
- in line with the performance of my direct competitors
- well below the performance of my direct competitors

Overconfidence

Based on your current investment decisions, do you think that in one year from now the performance of your portfolio will be:

- higher/significantly higher than current levels
- in line with current levels
- lower than current levels

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Demo1

To conclude, we are going to ask you some information regarding your profile

How many years of experience do you have in the renewable energy investing domain?

- no experience
- from 5 to 10 years
- less than 5 years
- more than 10 years

Demo

What type of company do you work for?

- Insurance Company
- Pension Fund
- Bank
- Venture Capital Fund
- Hedge Fund
- Private Equity Fund
- Other (specify) Demo_7_other

Demo2

What educational background do you have?

- economics & business administration
- finance
- legal
- engineering
- mathematics/statistics
- multidisciplinary
- none of the above

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Demo3

Please state your exact position within the organisation (e.g. senior analyst, head of unit, etc.)

Demo4

Please, specify your gender

- male
- female

DemoAge

Please specify your age group

- under 30 years
- from 31 to 40 years
- from 41 to 50 years
- more than 50 years

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Final

Thank you very much for your contribution!

Please feel free to circulate the link to this survey amongst your peers and colleagues.

Responses will be processed in a timely way. Results are expected to be available by October 2009. To receive a copy of the results, please indicate your email address

To validate your responses, please click "next"

Next

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Annex 2: List of companies contacted

France

ACE Management	AGF PE	Alven Capital
Arcis Group	A Plus Finance	Atlas Venture
Auriga Partners	Axa	BNP Paribas
Bryan, Garnier and Co.	Calyon	Capital Fund Management
CDC Innovation	CPR Private Equity	Crédit Agricole
Crédit Suisse France	CVC Capital Partners France	Dalkia
Debevoise and Plimpton	Demeter	Dexia
ECF	Emertec Energie Environnement	Eraam
Fortis PE France	Groupama Asset Management	HDF
Innoven	Iris Capital	Ixis
La Compagnie du Vent	Olympia Capital Management	Partech
Rothschild	Sinopia (HSBC)	Société Generale Asset Management
Sofinnova	TechFund	Theolia
Truffle	Ventech	Viveris Management
Xange	21 Centrale Partners	3i Gestion SA

Germany

Advent International	B.A.U.M. Group	Baytech
Bonventure GmbH	Capiton AG	Cipio Partners
Deutsche Bank	Earlybird	eCAPITAL entrepreneurial Partners AG
EUtech Energie & Management	Extorel	First Solar GmbH
Greenstream	HassoPlattner Ventures	High-Tech Gründerfonds
HVB/Unicredit	KfW	Mountain Cleantech
Munich RE	Neuhaus Partners	NRW Bank
PNE Wind	Seed Capital Brandenburg GmbH	Sj Berwin
Star Ventures	Target Partners	Technostart GmbH
Ventizz Capital Partners	Wellington Partners	West LB
White&Case	3i Deutschland Private Equity	

Italy

ABN Amro Capital	Accord Management	Actelios Falck
Advanced Capital	Advent International	Alcedo SGR
Alto Partners	Argan Capital Advisors	Argos Soditic Italia
Argy Venture Capital	AVM Private Venture	AXA Private Equity Italy
BC Partners	BCC Private Equity	BNP Paribas Asset Management
Centrobanca SpA	CI Partners	Cimino&Associati Private Equity
Cinven	CIR Ventures	Clessidra SGR
CVC Capital Partners	DGPA SGR	Doughty Hanson & Co.
Efibanca	Equiter	F2i
Fidi Toscana	Fidia SGR	Filas
Finlombarda	Fises	Fondamenta SGR
Friulia	Gruppo Banca Leonardo	Hat Holding
IA Partners Srl	ICQ Holding	IMI Investimenti
Innogest SGR	Interbanca SpA	Intesa San Paolo
IP Investimenti e Partecipazioni	L Capital Advisory	Mandarin Advisory
MPS	Orizzonte SGR	PAI Partners
Palladio Finanziaria	Permira Associati	Pino Partecipazioni
Quantica	ReFeel	S+R Investimenti e Gestioni
San Paolo IMI Fondi Chiusi	San Paolo IMI Investimenti per lo Sviluppo SGR	Sigefi Italia Private Equity
Sofipa	Solar Ventures	Strategia Italia SGR
The Carlyle Group	TT Venture	UniCredit corporate banking
Vertis	Vestar Capital Partners Italia	Wise SGR
Yarpa	21 Investimenti	3i SGR

Spain

Activos y Gestión Accionaria	Adara	AIG
Altamar Capital	Axon Capital e Inversiones	Banking Capital Riesgo
Baring Private Equity Partners España	Bridgepoint Capital	Caja Madrid
Capital Alianza Private Equity Investment	Cidem	Clave Mayor SA
Corphin Capital Asesores	Corsabe Corporación Sant Bernat	CVC Capital Partners Limited
Cygnus AM	Demeter Partners	Diana Capital
EBN Capital	Eland Private Equity	GED Iberian PE
Going Investment Gestion	Green Alliance	Grupo Santander
Qualitas Equity Partners	Sadim Inversiones SA	Sepides
SES Iberua Private Equity	SPPE	Torsa Capital
Valanza	Valcapital Gestión	Varde Europe
XesGalicia	YSIOS Capital Partners	3i Europe plc

Switzerland

Adveq Management	Aeris Capital	AIG Investments
AIG Private Equity	Alpha Associates AG	Aravis
Argos Soditic	Axon Partners	Baker & McKenzie
Barclays Private Equity	BC Partners	Bridgelink AG
BV Group	CTI Invest	Emerald Technology
Endeavour Vision	EPS Value Plus	Good Energies
Index Venture	Invision	LGT Capital
Luserve	Mountain Partners	NanoDimensions
New Energies	New Value	Partners Group
Quadrivium	SAM Services AG	Silverdale
Swiss RE	Syngenta Ventures	Venture Partners
Zurmont Madison Management	3D Capital	

United Kingdom

Advent Venture Partners	Aloe Private Equity	Amadeus Capital
AON	ARC InterCapital	Argo Capital
Atlas Venture	Balderton Capital	Barclay
Black River Clean Energy	BlackRock	BP
Brit Syndicater Lloyds	Camco	Carbon Trust
CC Capital	Cheyne Capital	Cisco Systems Europe
Citigroup	Cleantech Venture Network	Climate Investment Partners
Conduit Ventures	Consensus Business Group	DFJ Esprit
Doughty Hanson	Englefield Capital	Entrepreneur’s Fund
E-Synergy	Eversheds LLP	Fidelity Venture
Foursome	Frontiers Capital Partners	Gartmore Investment Management
GE Capital	Goldman Sachs	Good Energies
Headway Capital Partners	HG Capital	HSBC
Hunton & Williams	IP Group plc	ISIS Equity Partners
London Asia Capital	Macquarie	Man Group
Merrill Lynch	Morgan Stanley	New Star Asset Management
Nomura	North Star	Octopus Investments
Oxara Energy	Platina	Pond Ventures
Royal Bank of Canada	RREEP Private Equity	SEP
Silverdale	Sindicatum Carbon Capital	Standard Bank
Standard Charter	TLCom	Unicredit Group
Virgin Green Fund	WestLB AG	WHEB Ventures
Zouk Ventures		

Other countries

Attica Ventures	Capital-E Partners	Capricorn
Clean World Capital	EIB	Energi Invest Fyn A/S
Fortis	Global Cleantech Capital	GloCal Systems
Invest Equity	Piraeus Bank	Quest Management
Sitra	Stonefund	Strategus Management

Annex 4: Curriculum vitae

Surname / First name	**MENICHETTI Emanuela (Mrs)**
Address	3 Cité de Phalsbourg 75011 Paris, France
Telephone	+33 143 56 22 94
E-mail	emanuela.menichetti@unisg.ch
Nationality	Italian
Date of birth	26.07.1973
Gender	Female

Emanuela Menichetti is PhD candidate at the University of St. Gallen, Institute for Economics and the Environment, under the supervision of Prof. Dr. Rolf Wüstenhagen and the co-supervision of Prof Dr. Rolf Peter Sieferle. Her doctoral dissertation focuses on policy risk perceptions and investors' decision making behaviour in the renewable energy finance sector.

Mrs. Menichetti has over 10 years of working experience in the field of renewable energy and sustainability. Since September 2008 she has been serving as Senior Energy Analyst at the Observatoire Méditerranéen de l'Energie, an association of some 30 leading energy companies operating in the Mediterranean basin, located in France. Prior to this position, she worked as Associate Programme Officer at the Energy Branch of the United Nations Environment Programme (UNEP) Division of Technology, Industry and Economics (from December 2006 to August 2008), and as a researcher and consultant at Ambiente Italia, a leading environmental policy and analysis institute in Italy (from March 1999 to November 2006). Mrs. Menichetti is author or co-author of over 20 reports and about 15 publications.

Mrs. Menichetti enjoys a multidisciplinary background. After graduating summa cum laude in Economics and Business Administration with a thesis on Economics and Policy for the Environment in 1998, she completed an additional Master in Environmental Economics (final mark: 30/30) in 1999.

An Italian citizen, Mrs. Menichetti speaks also English, French and Spanish. Since 2007 she has been studying Arabic at UNESCO.

Mrs. Menichetti is a certified C++ programmer and is able to work with various softwares for environmental analysis. She has a good command of the Sawtooth software for computer-administered surveys and conjoint analysis, and a basic knowledge of SAS and SPSS for statistical analysis.

Statutory Declaration

Hereby I declare

- that I wrote this dissertation without any illicit assistance and without using any other aids than stated and that this dissertation was neither presented in equal nor in similar form at any other university;

- that I cited all references that were used respecting current academic rules.

Place and date of issue: Paris, 1 June 2010

Signature: