Schweizerische Eidgenossenschaft
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Bundesamt für Energie BFE

Schlussbericht Dezember 2013

Implicit cognition and renewable energy investments: An empirical analysis of differences between financial and strategic investors

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BFE-Vertrags- und Projektnummer: 8100087 / SI/500701-01

Zusammenfassung

Die Umsetzung der Energiestrategie 2050 erfordert hohe Investitionen in die Energieinfrastruktur. Während öffentlich-private Partnerschaften etwa zwischen Stadtwerken und institutionellen Investoren im europäischen Ausland bereits ein etabliertes Modell zur Finanzierung von erneuerbare Energie-Projekten sind, agieren hiesige potentielle Investoren teilweise mit grosser Zurückhaltung.

Gegenstand des vorliegenden Projekts ist die empirische Analyse von Energie-Investitionsentscheidungen strategischer (Energieversorgungsunternehmen) und finanzieller Investoren (Pensionskassen, Versicherungsunternehmen, Banken, unabhängige Asset Manager).

In einem ersten Untersuchungsschritt wurden 20 semistrukturierte Experteninterviews mit Investoren geführt. Hieraus ging hervor, dass die interviewten Entscheidungsträger erneuerbare Energien als risikobehaftete Investition betrachten. Diese Wahrnehmung kristallisierte sich als ein Haupthindernis zur Investition heraus. Gefragt nach der Art des wahrgenommenen Risikos wird bei erneuerbaren Energien zu allererst das politische Risiko genannt. Dieses Risiko ist zweifellos vorhanden, die Fördermechanismen ändern sich und passen sich laufend der dynamischen Entwicklung der Technologien an. Andererseits unterliegen auch andere Anlagemöglichkeiten Risiken, man denke etwa an komplexe Finanzprodukte oder eine Gaspipeline durch politisch instabile Regionen im Ausland. Was beeinflusst die Risikowahrnehmung der Investoren? Und was sind die Konsequenzen für Investitionsentscheidungen, beispielsweise im Hinblick auf erneuerbare versus nicht-erneuerbare Energien?

Die neuesten Erkenntnisse der Entscheidungsforschung legen nahe, dass die Wahrnehmung von Risiken nicht nur auf analytischen Überlegungen beruht, sondern dass Investoren bei ihrer Einschätzung von Investitionsobjekten auch von unbewusst ablaufenden, affekt-basierten Assoziationen beeinflusst werden. Wirtschaftsnobelpreisträger Daniel Kahneman nennt dieses assoziative Denken das „schnelle Denken“. Die Psychologie hat Methoden entwickelt, um diese intuitiven Einflüsse auf das Entscheidungsverhalten zu messen. Eine dieser Methoden, den Implicit Association Test (IAT), haben wir in der vorliegenden Studie genutzt, um unbewusste, affekt-basierte Assoziationen mit erneuerbaren und nicht-erneuerbaren Energien bei Schweizer Investoren zu untersuchen und daraus Ansatzpunkte für eine realitätsnahe Erklärung des Investitionsverhaltens zu gewinnen. Jeder der 112 teilnehmenden Investoren absolvierte dabei rund 180 Reaktionsaufgaben. An der experimentellen Untersuchung nahmen insgesamt 24 strategische und 88 finanzielle Investoren teil.

In Teilstudie 1 haben wir Risiko-Rendite-Wahrnehmungen der Investoren im Hinblick auf einen erneuerbaren (Photovoltaik) und einen nicht-erneuerbaren Energieträger (Erdgas) gemessen; die Resultate zeigen, dass Investoren Photovoltaik und Gas gleichermassen mit Risiko und Rendite assoziieren, es gab also in diesem Experiment keine systematischen Anzeichen dafür, dass die Befragten beispielsweise Photovoltaik mit höheren Risiken oder tieferen Renditeerwartungen assoziieren als Erdgas. In Teilstudie 2 haben wir die generelle Wahrnehmung der Investoren bei Solarenergie und Erdgas untersucht und gefunden, dass unbewusste Assoziationen klar positiver sind gegenüber der Solarenergie. Interessiert haben uns insbesondere Unterschiede nach Investortyp; haben strategische Investoren eine systematisch andere Wahrnehmung als finanzielle Investoren? Weder in Teilstudie 1 noch in Teilstudie 2 sind die Mittelwerte des IAT-Resultats signifikant unterschiedlich nach Investortyp. Aber einen interessanten Unterschied nach Investorentyp gibt es dennoch: Einen systematischen Zusammenhang zwischen impliziten Assoziationen und Entscheidungsverhalten lässt sich nur bei strategischen Investoren feststellen. Bei Entscheidungsträgern aus der Energiebranche, deren implizite Assoziationen gegenüber Photovoltaik negativer ausfallen als gegenüber Gas, spiegelt sich diese unbewusste Präferenz auch in ihrem Anlage-Portfolio wider. Bei finanziellen Investoren lässt sich dieser Zusammenhang nicht nachweisen. Eine mögliche Erklärung könnte darin liegen, dass letztere

ihren Entscheidungsprozess nach Anlageklassen (Aktien, Obligationen, Immobilien, usw.), und nicht nach Energietechnologien strukturieren. Daher ist für diese Investoren auch die Frage der Präferenz für die eine oder andere Energiequelle nicht relevant bei der Investitionsentscheidung.

Executive Summary

The realization of the energy strategy 2050 requires substantial investments in the energy infrastructure. While public-private partnerships for example among electric utility companies and institutional investors are a common way to finance renewable energy projects in other European countries, some potential investors in Switzerland act with great hesitance.
Subject of the present project is the empirical analysis of energy investment decisions of strategic (electric utility companies) and financial investors (pension funds, insurance companies, banks, independent asset managers).
In a first investigation phase, we conducted 20 semi-structured expert interviews with investors. It appears from the interviews that decision makers perceive renewable energies as investments fraught with risk. This perception emerged as one of the main investment obstacle. When asked for the type of perceived risk, investors first and foremost name political risk in the context of renewable energies. Political risk is present without doubt, as policy instruments are constantly changing in order to adjust to the dynamic development of the technologies. On the other hand, other investment opportunities are subject to risks, too, thinking of complex financial products or a gas pipeline through politically instable regions. What influences investors' risk perception? What are consequences for investment decisions, for example regarding renewable versus non-renewable energy sources?
Recent findings from decision research imply that the perception of risks does not only emerge from analytical reasoning, but that investors are influenced by unconsciously occurring, affect-based associations in their risk assessments. Nobel laureate Daniel Kahneman calls this associative thinking "fast thinking". Psychologists have developed methods to measure such intuitive influences on decision-making. One such method is the Implicit Association Test (IAT), which we have used to measure unconsciously occurring associations of Swiss investors toward renewable and non-renewable energies in order to get new insights for a realistic explanation of investor behavior. Each of the 112 investors who participated in the energy-IAT has conducted 180 reaction tasks. In total, 24 strategic investors and 88 financial investors took part in the experimental study.
In substudy 1 we measured risk-return perceptions of investors regarding a renewable (photovoltaics) and a non-renewable energy source (natural gas); the results show that investors associate photovoltaics and gas equally to risk and return. This experiment did not reveal systematic evidence that the participants would associate photovoltaics with higher risks or lower returns than natural gas. In substudy 2 we assessed investors' general perception regarding solar energy versus natural gas and found that implicit associations are clearly more positive toward solar energy. We were particularly interested in differences by investor type; do strategic investors have a systematically different perception than financial investors? In none of the two substudies we found significantly different IAT-scores by investor type. However, one interesting difference by investor type prevails: A systematic correlation of implicit associations with decision making only occurs among strategic investors. Decision makers from the energy industry who have more negative implicit associations toward photovoltaics than gas tend to invest less in photovoltaics. For financial investors we could not establish this correlation. One possible explanation could be that financial investors structure their investment decisions in terms of asset classes (shares, bonds, real estate, etc) and not according to energy technologies. Therefore, the investors' preference for one energy source over the other is irrelevant for the investment decision.

Contents

1 Introduction

A key pillar of the Swiss energy strategy 2050 is a substantial increase in electricity generation from renewables. Hydropower is expected to grow moderately from 30 to 38.6 TWh, whereas new renewable energies like wind, biomass and solar are expected to increase from 0.9 to 24.4 TWh (BFE, 2011; 2013). Achieving those targets requires significant investment in new renewable energy projects. Such investment can either come from traditional electric utilities (referred to as *strategic investors* in this report) or from new investors, such as pension funds or other *financial investors*. While in the past, strategic investors have been the dominant source of capital for financing power generation infrastructure, there is currently a shift towards a broader set of investors for at least three reasons: 1) Due to a combination of market- and policy-related factors, the profitability of electric utilities has eroded, constraining their ability for new investments. 2) The distributed nature of new renewables has lowered barriers to entry for new investors. 3) In a low-interest environment, financial investors are actively looking for new long-term investment opportunities with favorable risk-return characteristics. As a result, an increasing share of renewable energy projects are financed by non-utility investors. Current levels of investment, however, are far from being adequate to reaching the targets. Effective renewable energy policies could therefore be an important element to mobilize the required capital flows, but a thorough understanding of investment processes of strategic and financial investors is a necessary condition to designing such policies. Based on recent advances in decision sciences, this requires a combination of understanding conscious, analytical factors with other, less conscious and more intuitive factors affecting investment decision-making. This report combines a set of qualitative interviews with an experimental method to capture both elements and thereby contributes to a comprehensive understanding of investment obstacles and possible solutions, with regard to both strategic and financial investors.

1.1 Research questions and context

Using three complementary empirical approaches, we address the following research questions:

With expert interviews:

(1) What drives renewable energy investment decision making of strategic and financial investors?

(2) What are differences between strategic and financial investors?

With the Implicit Association Test:

(3) What is strategic and financial investors' implicit cognition on renewable vs. fossil energy?

(4) What is the impact of investors' cognition on energy investments?

(5) How does implicit cognition and its influence on energy investments differ between managers of financial versus strategic investors?

With survey data:

(6) How do organizational capabilities and incentives influence energy investments?

(7) What are the implications for designing effective energy policies in Switzerland?

This research project evolved in the context of the Swiss energy market, where renewable energy technologies currently challenge and even change market logics.

The fundamental changes pose a threat to the energy industry, but there are also reasons to consider renewable energies as investment opportunity. In particular, (1) Kost et al. (2012) show that in Germany, it is (depending on technological features and place) cheaper to produce wind or solar energy with an own power plant instead of buying electricity from the electric utility company; (2) renewable energies enable a country to reduce its carbon footprint and thus comply with climate policy goals; (3) energy customers in German speaking Europe prefer renewable over fossil and nuclear energy (e.g. Kaenzig et al., 2013; Chassot & Wüstenhagen, 2013; Greenberg, 2009;), and are willing to pay a premium for it (Kaenzig et al., 2013).
What, then, determines if a potential investor perceives renewable energies as threat or rather as investment opportunity? A short literature review on this question follows in the next section.

1.2 Previous research

1.2.1 Managerial cognition and dual process theories

While opportunity recognition within an organization is a multilevel process involving not only the individual level, but also the interindividual, group-, organizational and societal level, at the root of this multilevel phenomenon "remain individual processes that are poorly understood." (Grégoire et al., 2010).
In psychology, Freud and Jung revolutionized the understanding on individual processes at the beginning of the 20th century with their emphasis on what they called the unconscious – associationistic, intuitive, or *implicit* cognition.
In economics, cognition that goes beyond rational choice did not receive much attention until the pioneering work from Simon (1955, 1956). In management research, by the end of the 90ies, the importance of individual cognitive processes for organizational decision-making was widely accepted. Managerial cognition has together with organizational capabilities and organizational incentives received most attention as an explanation for managerial decision making (Kaplan, 2011).
In particular in times of fundamental change when organizational capabilities and incentives are lacking or unclear, research has shown that managerial cognition drives recognition of threats and opportunities (Kaplan, 2008; Benner & Tripsas, 2012; Tripsas & Gavetti, 2000; Garud & Rappa, 1994) – and success or failure in the adoption of an innovation (e.g. Tripsas & Gavetti, 2000). Being more specifically on the type of cognition, a series of studies emphasize the predominance of what they call intuition in managerial cognition (Hodgkinson et al, 2008; Sonenshein, 2007; Dane & Pratt, 2007; Miller & Ireland, 2005; Sadler-Smith & Shefy, 2004; Burke & Miller, 1999).
At the next level of abstraction, dual process theories in psychology make a fundamental distinction of intuitive versus analytical cognitive processes. As a warm up on dual process theories, the reader may solve the following puzzle: A bat and a ball cost $1.10 together. The bat costs $1 more than the ball. How much costs the ball? It is worth trying to solve this task before continuing the lecture.

The intuitive answer that comes to mind is 10 cents. However, doing the math shows that this intuitive answer is wrong – 5 cents is the correct answer. What happens in this example, which Daniel Kahneman describes in his book (2011), is that system 1 – the fast and intuitive system for mental processing – hooks up to the number 10 and leads to a wrong answer. About 50% of subjects realize this mistake while they check for correctness of their answer and consult the analytical system 2, the other 50% rely completely on their system 1. This example illustrates the two systems human beings use in everyday life for any kind of mental process. System 1 is fast, based on intuition, emotions, gut feelings, system 2 is slow, effortful, analytic, based on reasoning.
In the psychology literature, the terminologies are many;

System 1	System 2	(Stanovich & West, 2000; Kahneman, 2011)
Fast	Slow	(Kahneman, 2011)
Reflexive	Reflective	(Hodgkinson & Healey, 2011)
Experiential	Analytical	(Slovic et al., 2004)
Impulsive	Reflective	(Strack & Deutsch, 2004)
Affect	Cognition	(Slovic et al., 2002)
Implicit	Explicit	(Greenwald & Banaji, 1995)
Experiential	Rational	(Epstein, 1994)
Peripheral	Central	(Petty et al., 1983)
Heuristic	Systematic	(Chaiken, 1980)

In this research, we use the terminology by Greenwald & Banaji (1995), who developed the Implicit Association Test, the empirical method we use to measure investors' implicit cognition on energy sources. Greenwald & Banaji define cognition as a mental "operation for attitudes and stereotypes"; cognition – or simply thinking – guides human behavior. "Implicit" is used as synonym for unconscious or indirect cognition (Greenwald & Banaji, 1995, p.4).

1.2.2 The challenge: measuring managerial cognition

Psychologists have developed a range of tests to measure implicit cognition. A prototype was the word association test by Jung (1919), where subjects had to name all spontaneous associations that came to their mind when confronted with a specific stimulus. Later on, variants of this initial association test emerged, with the Implicit Association Test (IAT) as the most widely used nowadays (for an overview, see Bargh, 2007; Fazio & Olsen, 2003; Uhlmann et al., 2012). Greenwald and Banaji (1995) developed the IAT in order to assess stereotypes on gender, race, or other sensible topics the test participants may not be willing to reveal their opinion about (or are not consciously aware of).
The challenge with association methods is that participants have to conduct a high number of association tasks. To some participants the test procedure might appear cumbersome, or even frightening. Nevertheless, different versions of the IAT attracted more than 1 million participants alone on the webpage *Project Implicit*, but these are samples with lay people, mostly students, whereas professional samples are rare.
In management research, scholars often have to rely on methods that are more convenient for survey participants – mostly case study methods such as expert interviews or document analysis. For example, in an attempt to quantify managerial cognition in order to explain why some firms invested in fiber optics whereas others where reluctant to do so, Kaplan counted words on fiber optics in CEO letters to shareholders (Kaplan, 2008; Eggers & Kaplan, 2009). Thus, Kaplan implicitly equalized managerial cognition with attention, being aware that she might not capture the most relevant – the implicit – part of cognition (Kaplan et al., 2003, p.229): „While using word counts from letters to shareholders to measure recognition does offer some important advantages, they are not an ideal measure of the mental framing or cognitive maps of senior

managers, and we would like to explore alternative, possibly qualitative, measures.“ Uhlmann et al. (2012, p.554) provide a review of management research using implicit methods and conclude:

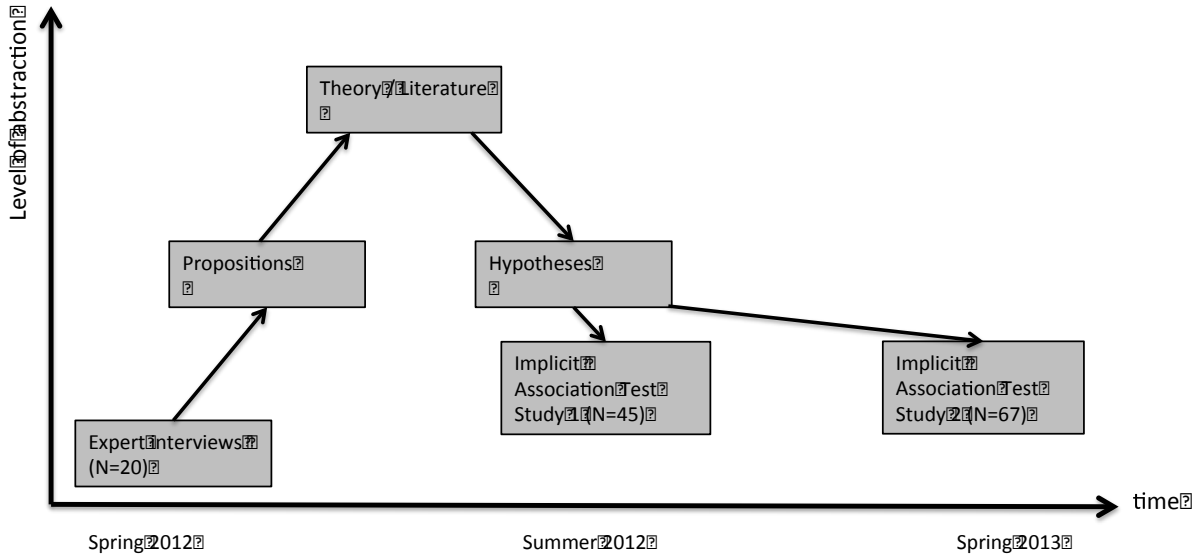
“Organizational scholars have largely underutilized a highly impactful discovery (…): nonconscious processes and the implicit measures developed to capture them. Despite their limited use, implicit measures hold great promise for organizational research because many phenomena of interest operate outside employees’ complete awareness and control.”

This is why we chose to apply the Implicit Association Test, a method that was designed to capture implicit cognition, to enhance the understanding on renewable energy investment decision making.

1.3 Contribution of this project

Data collection for this research comprises of two phases: First, we conducted explorative expert interviews with portfolio managers or higher level managers of strategic and financial investors. The interviews focused on energy investments as well as general investment decision-making. In depth analysis of word-by-word transcriptions of the face-to-face interviews delivered a solid understanding on the context in which renewable energy investment decisions occur. Across the 20 interviews, certain patterns became evident, suggesting theoretical implications and, together with the more general literature on investment decision-making, hypotheses to be tested. Whereas the first empirical phase is inductive and explorative, the second phase tested hypotheses in a deductive manner. In line with previous research on opportunity recognition, we found in the expert interviews that managerial cognition influences renewable energy investments. For the second phase of data collection, we developed a tool to measure managerial cognition in a novel way. The central element of the online data collection was an Implicit Association Test (IAT), which was complemented with a range of survey questions. Applying the energy-IAT for the first time among professional investors, we used the 20 months project duration to try two slightly different versions of the IAT in study 1 and study 2.

Figure 1 Inductive and deductive phases of the research project



Through this research we offer contributions both to the literature and to policy making. Contributions to literature are threefold: Management scholars mostly agree that managerial cognition has a large influence on a company’s response to an innovation. In psychology, “cognition” is a whole separate research branch, and the fact that cognition influences decision-

making may sound trivial. By looking in particular at *implicit* cognition, we provide some clarification on what type of cognition is relevant. Secondly, we provide a direct measure of investors' implicit cognition, using a research method developed in psychology specifically to measure implicit as opposed to explicitly and consciously expressed thinking. Finally, we empirically exemplify the boundaries of the power of implicit cognition in managerial decision-making, by showing that it has an impact on strategic investors' energy investments, but no correlation with financial investors' portfolio management.

The main contribution to policy making is that we provide evidence how to incentivize renewable energy investments. The most relevant obstacle is that investors perceive renewable energy investments as risky, and financial investors more so than strategic investors. For financial investors, riskiness is aggravated because renewable energy project finance is not yet packaged into standard, less risky asset classes such as bonds. Instead, the asset classes that have come into consideration so far are typically more risky asset classes where financial regulation recently became more strict – e.g. real estate, private equity, alternative investments – so that after all, it remains questionable if packaging renewable energy projects into these asset classes will foster investments, because of investors' risk aversion and regulatory constraints. Thus, a way to incentivize financial investors is to offer investment solutions via bonds or similar, less risky asset classes.

When asked about what particular type of risk investors have in mind, the most important risk is regulatory risk – the announcement of changes in the feed-in tariff for example implies high risk for investors which is hard to manage, in particular if lengthy political processes lead to a long period of regulatory uncertainty. Renewable energy technologies are evolving fast, and adjusting the policy framework may be necessary in a dynamic energy market. Nevertheless, investors need the insurance that the rules based on which they calculate the return of an investment remain the same throughout the duration of the investment.

Another result from the expert interviews was that financial investors consider the question which energy source they invest in as of secondary relevance; enhancing the focus on what real underlying assets the managers invest in could be a promising avenue to guide investments into new directions. As for strategic investors, rather than changing focus, the matter is changing mindsets or mentality, as one interviewee called it. Implicit cognition correlates with strategic investors' energy investments; in a new investment area that involves high uncertainty, it is not only financial viability that decides, but also the investor's automatic, fast and intuitive perception of this new investment area.

2 Preliminary evidence from expert interviews

2.1 Purpose of the expert interviews

The purpose of the expert interviews was to gain a thorough understanding of renewable energy investment processes of strategic and financial investors. The evidence we discuss in this chapter complements the quantitative data presented in chapters 3, 4 and 5. Summarizing the main findings in propositions, this section on the expert interviews is theory building in an inductive sense. In chapter 4 we test hypotheses that emerged from the expert interviews.

2.2 Method

After reviewing the existing literature, we developed an interview guideline and conducted 20 semi structured expert interviews in May to July 2012. „Semi-structured" means that we made sure that we covered the following topics with each interviewee: (1) the decision-making process in general, (2) energy investments, (3) personal background of the interviewee, and (4) information about the interviewee's company (see Appendix A

Guideline for expert interviews). However, if an interviewee mentioned an issue we did not plan to cover but which seemed relevant nevertheless, we were open to this additional information. To make sure that we interviewed the right people, we always asked for the person who is in charge for (renewable) energy investment decisions (for a sample overview, see Table 1).
Average duration of the face-to-face interviews was 50 minutes; the shortest interview lasted 28 minutes, the longest 120 minutes. All interviews were audio-recorded and transcribed word by word. Data analysis of the word-by-word transcriptions was supported by nvivo, a software to handle qualitative data.

Table 1 Interview partners for expert interviews

Label interview	Investor type	Position of interviewee
PF I	Pension Fund	President of the Board
PF II	Pension Fund	CEO
PF III	Pension Fund	Chief Investment Officer
PF IV	Pension Fund	Head Asset Management
PF V	Pension Fund	Head Real Estate Asset Management
PF VI	Pension Fund	Head Real Estate Asset Management
IC I	Insurance Company	Head Asset Management
IC II	Insurance Company	Portfolio Manager
IC III	Insurance Company	Portfolio Manager
Bank I	Bank	Chief Investment Officer
Bank II	Bank	Head Institutional Business
Bank III	Bank	Head Sustainable Investments
Bank IV	Bank	3 Interviewees: Director and 2 Assistant Vice President in Real Estate Asset Management
Bank V	Bank	2 Interviewees: Head of Financial Clients and Head Client Services Asset Management
Bank VI	Bank	Portfolio Manager
EU I	Electric Utility Company	Head Asset Management
EU II	Electric Utility Company	Head Asset Management
EU III	Electric Utility Company	Head Asset Management
EU IV	Electric Utility Company	2 Interviewees: Head Renewable Asset Management; Lawyer of Renewable Energy Division
EU V	Electric Utility Company	Renewable Asset Management

2.3 Results

2.3.1 Existing energy investments

"What share of your company's portfolio is invested in renewable energy projects?" – the majority of interviewees working for **financial investors** could not give a precise answer to this question. One interviewee explains: *"We think in terms of stocks, bonds, private equity, real estate, but not in energy. Be it coal or biomass, that doesn't matter to us."* (interview PF I).
In addition to the investment share of renewable energies, interviewees indicated via which asset classes they invested in 16 different energy sources. Answers to these questions were much more precise, confirming the statement about financial investors' thinking in terms of asset classes. Of the 15 interviewees from financial investors, four made specific descriptions of investments in renewable energy projects. These interviewees work in real estate asset management and

consider renewable energy projects either as a part of a real estate investment (e.g. a rooftop solar power plant) or as similar investment. Furthermore, one interviewee mentioned his bank's exposure to renewable energy project finance via debt (e.g. for small scale solar energy projects of private households or farmers). However, these investments remained below 2% of the overall investment portfolio. Nevertheless, the more asset classes an interviewee mentioned as renewable energy investment channel, the more knowledgeable and involved he was in renewable energy investments. Two interviewees from banks work on the development of a fund product, which would enable institutional investors such as pension funds or insurance companies to invest in renewable energy in a more standardized way. Thus, two of 15 interviewees from financial investors mentioned activities that reveal strategic importance of renewable energy investments.

Not surprisingly, **strategic investors**, whose core business is energy trading, know more exactly to what extent they are invested in which energy sources. Strategic investors could tell precisely the share of several energy sources in their portfolio.

Summarizing this section on how managers answered questions on their energy investments, we arrive at proposition 1:

P1: The definition of investment strategies in terms of asset classes leads to cognitive disconnection from the underlying real assets in which financial asset managers invest. Financial investors do not know exactly to what extent their portfolio is exposed to renewable and other energy sources.

2.3.2 Planned energy investments

Answers to the question if interviewees planned to invest in energy projects in the following twelve months were quite diverse, even within the same group of investors. Among the six interviewees working for banks, two said clearly that no investments in energy projects were planned. The other four confirmed investment plans, either through debt finance, real estate, or the creation of larger investment funds. Similar heterogeneity prevails among pension funds and insurance companies; those interviewees who confirmed plans to invest mentioned real estate or investment funds as channels.

The five interviews from electric utility companies also reveal diversity, but with more affirmative answers: three interviewees mentioned plans to invest in renewable energy projects in significant ways; one interviewee plans to invest in a few selected projects, whereas one interviewee was hesitant to confirm any investment plans, because the priority for the company is currently financial consolidation due to the reduction of "overcapacity in the market" (interview EU III).

2.3.3 Investment obstacles

When we asked interviewees about renewable energy investments, they soon started talking about investment obstacles. Among financial investors, in coherence with their thinking in terms of asset classes, one of the most often mentioned obstacles was the lack of adequate investment vehicles; renewable energies are not new technologies, but they only recently started to move from niche to mass markets. Thus, large-scale investment solutions are rare. Up to now, renewable energy projects are usually financed via project finance or private equity (SAM, 2012). Recent revisions of financial regulations (e.g. Basel III, Solvency II (Severinson & Yermo, 2012), BVV2 (Credit Suisse, 2008)) restrict investments via these asset classes. Furthermore, one real estate asset manager reported critical reactions of the financial market regulation authority (FINMA) when he wanted to add photovoltaics to an existing real estate investment in his portfolio.

If financial investors mention the lack of an investment vehicle as an obstacle, they refer to the lack of a less risky vehicles such as bonds, where financial regulation is less restrictive. One

interviewee said that he would invest in renewable energy projects as soon as the right financial product is available. Therewith he represents the view of a majority of the interviewed financial investors. On the other hand, a portfolio manager from an insurance company questioned if renewable energy investments should be packaged into standard asset classes at all.
We summarize these findings in propositions 2 and 3:

P2: The lack of renewable energy investment vehicles with low risk is an investment obstacle for financial investors.

P3: Recent changes in financial regulation restrict renewable energy investments via asset classes such as private equity, project finance or real estate.

Strategic investors on the other hand are mostly concerned with the regulatory framework that is more closely related to energy investments – the availability and stability of support schemes, and time-consuming admission procedures are the main concerns.

P4: Strategic investors perceive policy risk and lengthy admission procedures as important investment obstacles.

Furthermore, one interviewee highlighted difficulties to invest in *any* power plant, given the low electricity prices at the European Energy Exchange (EEX). With regard to investments within Switzerland, both types of investors mentioned a lack of good utility-scale projects to invest in. The two main reasons for this are topography and industry development; on the one hand, the potential for large-scale wind parks or solar power plants is limited due to the Swiss topography. On the other hand, in comparison to Germany or France, the Swiss project development sector is less mature (interview EU I).

2.3.4 Co-investments of strategic with financial investors

Even though strategic and financial investors have a different viewpoint on energy investments, there is a case for both to invest. If interviewees mentioned experience in energy project finance, we asked them if they collaborated with strategic - respectively financial - investors. Three out of five interviewees from electric utility companies mentioned co-investments with banks, pension funds or insurance companies. However, all these investments were in renewable energy projects abroad, and the collaboration was established with financial investors of the respective country – or, interestingly, with financial investors from other European countries who are more experienced in renewable energy finance than Swiss financial investors (interview EU I). None of the interviewees mentioned significant co-investments with Swiss financial investors. On the one hand, collaborating with domestic financial investors certainly implies synergies (expertise on domestic legislation etc.). On the other hand, one interviewee said that another reason he had not co-invested with Swiss pension funds so far was the latter's lack of expertise in the field of renewable energy project finance (interview EU I). Interviewees from financial investors mostly confirm that they only started recently – if at all – to build up renewable energy expertise.
This leads to proposition 5:

P5: Lack of renewable energy-specific expertise is an investment obstacle in particular among financial investors.

2.3.5 Perception of energy policy

Another topic that often emerged throughout the interviews was the influence of energy policy – in the context of renewable electricity in particular the feed-in tariff. The interviewees' wording in this context is interesting – whereas some talk of the feed-in tariff as a "subsidy" and highlight potential negative impacts ("I mean, it is a market distortion. We don't want that. We don't play

this game." (interview EU III)), others perceive support mechanisms as necessary in order to make renewable energies competitive with conventional energy sources – and do not link the discussion to a general political worldview. Strategic as well as financial investors criticized policy changes in Spain and Germany, in particular the detrimental impacts on the value of investments. One strategic investor concludes: "Renewable energy policies are totally insecure. That's a disaster." (interview EU III). As proposition 4 already hints at, it seems to be strategic investors in particular who have a strong opinion about energy policy risk.

P6: Strategic investors react more strongly to energy policy risk than financial investors.

2.3.6 Perception of renewable energies

The perception of energy policy links to the general perception of renewable energies – interviewees who consider the feed-in tariff and other support mechanisms as a useful tool to establish competitiveness of renewables also tended to have a more positive view on the technological potential of renewables. Several interviewees from financial investors said they find it hard to judge the exact potential of renewables and the feasibility of the nuclear phase out and expressed confusion amidst the current political discussion in Switzerland. What sometimes followed was a more personal and intuitive viewpoint:

*„Personally I've had a few experiences in my life that made me think `It will be alright`- just look at water quality for example. When I was young we shouldn't drink any water from Lake Constance. But with technology it was possible to improve water quality to a great extent." (*interview Bank I*).*

Several interviewees from financial investors said that they consider renewable energies to be the future, but highlighted that this would be their personal opinion, not their opinion as a financial manager.

Interviewees from electric utility companies had more developed and generally more optimistic views about the technological potential of renewable energies. However, within the strategic investors we explicitly addressed managers who are responsible for the renewable energy unit. These managers might have a more positive view on renewable energies than other managers from electric utility companies. Indeed, two interviewees from electric utility companies mentioned company-internal differences in the perception of renewable energies. They said that the idea of investing in solar and wind, and the change from a centralized to a decentralized system, require a time-intensive change of mentality within the company. In sum, we propose:

P7: Investors have an opinion about the potential of renewable energies as energy generation technologies. This opinion is based on past experiences with technology, as well as general beliefs about the potential contribution of renewable energies to a sustainable energy future.

2.4 Discussion

We targeted the following two research questions with the expert interviews:

(1)What drives renewable energy investment decision making of strategic and financial investors?
(2)What are differences between strategic and financial investors?

For strategic investors, the energy strategy 2050 is a strong driver for renewable energy investments. The decision to phase out nuclear power is a political imperative to change investment strategies. Reactions among Swiss electric utility companies so far are heterogeneous; some are investing for learning by doing, some because they already defined a progressive renewable energy investment strategy and are exploring business opportunities in a

decentralized energy market. Others express difficulties to change course, in particular if they used to rely significantly on nuclear power. Regarding Swiss renewable energy projects, all strategic investors mention a lack of interesting investment opportunities. Investments in German or French projects are more in the focus, and co-financing with banks and to some extent also institutional investors is common – but primarily with foreign financial institutions, rather than the Swiss ones. Regulatory risk is an investment obstacle, and can sometimes stir strong reactions.

Financial investors' perspective on renewable energy investments is different; the investment strategy of banks, pension funds and insurance companies is defined in terms of asset classes. Whether they invest in nuclear, fossil or renewable energy is less relevant, and sometimes appears to be unknown to investment managers; if the risk-return profile is adequate, most financial investors said they would invest in renewable energy. In particular pension funds seek long term investment opportunities, and financing the renewable energy infrastructure is a long term investment. However, compared to their peers in neighboring countries, Swiss financial investors lack expertise in the field of renewable energy. An additional obstacle are the increasingly strict financial market regulations, in particular the restriction to invest in private equity or project finance, which are the currently most often used channels to finance renewable energy projects.

In sum, both types of investors consider renewable energy investments. At this point in time, to enhance investments from the financial investors' side, the development of investment vehicles and expertise are crucial. Furthermore, financial investors focus exclusively on financial returns, whereas for some strategic investors, electricity as the physical asset is an investment purpose in itself. Thus, finding a common language and ways to deal with diverging interests is important.

3 Implicit cognition on renewable vs. fossil energy

So far we have gained an insight into energy investment processes and have found similarities and differences between financial versus strategic investors. Some of the factors influencing the investment decision go beyond analytical risk-return considerations; personal beliefs and worldviews which are rooted in implicit, intuitive, *fast* thinking, have an influence, too. In order to analyze these implicit aspects, we need a method that allows capturing implicit thinking. Implicit cognition by definition often occurs without conscious awareness of a survey participant and can therefore not be captured with a method that relies on a participant's introspection. Therefore, we consider the Implicit Association Test as a particularly suitable research method to advance the understanding on energy investment decision making.

In this chapter, we address the following research question:

(3) What is strategic and financial investors' implicit cognition on renewable vs. fossil energy?

3.1 Method: How the Implicit Association Test works

An IAT tests how strongly the participant associates two target words (e.g. "black" and "white") with two associations ("e.g. "good" and "bad"). In order to test associations, reaction times across about 180 computer administered sorting tasks are measured. The crucial assumption of the IAT is that participants are faster if the words on the screen are grouped in a way that fits their personal implicit attitude. To test which constellation fits the personal attitude better, in one part of the test "black" and "good" are on one side of the screen and "white" and "bad" on the other side; in the complementary part, "black" and "bad" are on one side of the screen and "white" and "good" on the other side. The final IAT-score is the difference of reaction times across the two constellations.

The two target words of the test should be well known to test participants and specific. Therefore, we chose to contrast solar energy with gas in the energy-IAT. According to energy

scenarios, among renewable energy sources solar energy is the power source with highest growth potential (BFE, 2011) and seemed therefore a relevant case to consider. Gas fired power plant will be a complementary technology after the phase out of nuclear power. The future role of gas fired power plants depends on how much investment in renewable energy realizes.
Gas fired power plants and solar energy are different in several aspects. Gas fired power plants use a conventional energy generation technology that relies on a fossil resource, typically operates with large installed capacities and thus favors a centralized energy system. Solar energy, which is emerging to the mass market, typically operates with smaller installed capacities than gas, and therefore decentralizes the energy system. The fundamental differences of the two technologies link to different worldviews and beliefs about the energy system. Therefore, we argue that deeply held beliefs manifest themselves in different implicit associations to the different energy sources.
In the following, we describe the elements and the design of an IAT along the example our energy-IAT of study 1. The easiest way to understand how an IAT works is to participate in one; demo tests are available online on the homepage of Project Implicit, which was founded by the psychologists Greenwald, Banaji Nosek, who initially developed the IAT (Greenwald & Banaji, 1995; Greenwald et al., 2003).
We start with the elements that appear throughout the whole test, then describe the two central constellations of the test and finally present the entire layout of the IAT.
Before starting the test, a table with all stimuli words presented to the participants what target word or association category each stimulus belongs to (see Table 2). An instruction below the table explained that in the following task, the participants would have to sort these words to the target or association categories the words belong to.
Afterwards, the stimuli each appeared one by one in the middle of the screen, and participants sorted them to the respective side of the screen.

Table 2 Stimuli of the energy-IAT of study 1

Target words	**Stimuli**
Photovoltaics	solar cells, small-scale, solar energy, renewable energies
Gas	natural gas, large-scale, gas fired, fossil
Associations	
return	growth, profit, cashflow, yield
risk	insecure, policy risk, downside risk, hazard

We developed the IAT following 20 expert interviews with investment decision makers from electric utility companies (5 interviews), pension funds (6 interviews), banks (6 interviews), and insurance companies (3 interviews) (see chapter 2). The word-by-word transcriptions of the expert interviews allowed detecting common vocabulary of all investor types. This was important in order to make sure that the stimuli words of the IAT would be appropriate to strategic as well as financial investors. It is crucial that test participants know clearly which target word or association a stimuli word belongs to. As for the impact of the individual stimuli words themselves, De Houwer (2001) demonstrates that the IAT measures associations towards the main concepts, and not towards the individual stimuli words used in the test.
Throughout the test, participants had to group the words *as fast as they could*. Participants had to do this for different constellations. In one constellation the target word „Photovoltaics“ and the association „Risk“ were paired on one side of the screen, and „Gas“ and „Return“ on the other; in the other constellation „Gas“ and „Risk“ were paired on one side of the screen and „Photovoltaics“ and „Return“ on the other. The IAT measures differences in reaction times between the two constellations. The assumption of the test is that participants take longer

reaction times within the constellation they find counterintuitive. Figure 2 illustrates the two constellations. The IAT-software (Inquisit 3.0) allowed randomizing which constellation came first.

Figure 2 Illustration of 1 out of 40 tasks of blocks 4 and 7 of the Implicit Association Test of study 1

By pressing either the e-key for stimuli that belong to the left or the i-key for stimuli that belong to the right, participants performed the reaction tasks. In the task on the left of Figure 2, the participant would press the "e"-key to sort the word "Renewable Energies" correctly to "Photovoltaics". In the task on the right, the participant would press the "i"-key, because the target word "Photovoltaics" appears now on the right.

If the categorization was false, the participant received this information and had to repeat the categorization. Reaction time was recorded in milliseconds. The entire IAT consisted of 7 different blocks – 5 practice blocks and 2 actual test blocks with twice as many reaction tasks as in the practice blocks. In the practice blocks, participants familiarized themselves with the test. The first practice block only presented the two associations "Return" and "Risk" and participants had to sort the stimuli words to the corner where the respective association appeared. The second practice block presented only the two target words "Photovoltaics" and "Gas" and the respective stimuli words had to be sorted 20 times. The third practice block combined the target words and the associations. 20 times a stimuli word from Table 2 appeared and had to be sorted to the left or the right. The first actual test block (block 4) was exactly the same constellation as in block 3, but this time, 40 stimuli words appeared. After block 4, target words switched sides. If "Gas" was on the left-hand side before, it now appeared on the right. The following two training blocks allowed participants to get used to this new constellation: in block 5, only the target words appeared, in block 6, the target words appeared together with the associations. The final test block 7 was the complement to block 4 (see Table 4 for an overview of the 7 blocks). Figure 2 displays screenshots of blocks 4 and 7 of study 1, the actual test blocks.

The final IAT-score is the standardized difference in reaction times across the two types of tasks illustrated in Figure 2. The score ranges from -2 to 2. Cohen (1977) suggests the following cut-off values for association strength: scores between |0.15| and |0.35| imply a slight difference between the two tasks, |0.35|-|0.65| moderate, and values above |0.65| a strong difference. We programmed the test such that a positive IAT-score indicates a stronger association of photovoltaics to return and gas to risk, a negative IAT-score indicates a strong association of gas to return and photovoltaics to risk. Note that the final IAT-score is a *relative* measure of preference for one energy source over the other. If a participant is indifferent between the two, the final IAT-score is lower than |0.15|.

3.2 Comparison of study 1 and study 2

Applying the energy-IAT for the first time among professional investors, it was to be discussed to what extent we should adapt the design of the test to an investor's context. For study 1 we used portfolio-management specific jargon with the associations "risk" and "return". In study 2 we intended to resemble more the original IAT, using the more genuine associations "positive" and "negative". As the associations in study 1 and 2 are different, so are the stimuli; for risk and return we used more finance-specific stimuli, whereas the stimuli for positive and negative in study 2 relate to the market development more generally.

Another small distinction between study 1 and study 2 are the target words "photovoltaics" in study 1 versus "solar energy" in study 2; solar energy seemed to be a more intuitive name than photovoltaics. However, these are methodological details, which should not affect the main result of the IAT (De Houwer, 2001). The stimuli words for photovoltaics and gas are slightly different in the two studies, too; the experience from study 1 showed that the stimuli "small-scale" and "large-scale" were for some test participants not clearly associated to photovoltaics and gas, respectively. Therefore, we did not use them in study 2.

Table 3 Stimuli of the IAT of Study 1 and Study 2

Target words		**Stimuli**	
Study 1	**Study 2**	**Study 1**	Study 2
Photovoltaics	Solar Energy	solar cells, small-scale, solar energy, renewable energies	solar cell, renewable, solar energy, solar power plant
Gas	Gas	natural gas, large-scale, gas fired, fossil	gas, fossil, gas fired power plant, shale gas
Associations			
return	positive	growth, profit, cashflow, yield	return, growing market, high return, high market potential
risk	negative	insecure, policy risk, downside risk, hazard	loss, shrinking market, low return, low market potential

For study 1, we used the software Inquisit by Millisecond to programme the IAT and the survey items ourselves. In order to participate in the test, participants had to install a plug-in on their computer. This led to difficulties in the recruitment of participants, because several potential participants did not want to install the plug-in or could not do so due to restrictive firewall-settings on their computers. In order to avoid the plug-in, we collaborated with „Project Implicit" for study 2. Project Implicit hosts IATs and offers a solution to circumvent the plug-in-problem. Based on target words and stimuli, Project Implicit programmed the IAT on their server. Due to slightly different algorithms and experiences, Project Implicit suggested different numbers of reaction tasks per block than we had used in study 1 (see Table 4). The total of trials is 180 in study 1 and 176 in study 2.

Table 4 Procedure of the Implicit Association Tests, including training blocks (blocks 2, 3, 4 were randomly switched with blocks 5, 6, 7 for approximately half of the sample).

Block		Left key assignment		Right key assignment		Number of trials per block	
		Study 1	**Study 2**	**Study 1**	**Study 2**	**Study 1**	**Study 2**
1	Understand what to do	return	positive	risk	negative	20	16
2	Practice	Gas	Gas	Photovoltaics	Solar Energy	20	16
3	Practice trials for combination of energy sources with associations	Gas return	Gas positive	Photovoltaics risk	Solar Energy negative	20	32
4	Test trials to measure associations of energy sources with associations	Gas return	Gas positive	Photovoltaics risk	Solar Energy negative	40	32
5	Get used to that energy sources switched side	Photovoltaics	Solar Energy	Gas	Gas	20	16
6	Practice trials for new constellation	Photovoltaics return	Solar Energy positive	Gas risk	Gas negative	20	32
7	Test trials to measure associations of energy sources with associations	Photovoltaics return	Solar Energy positive	Gas risk	Gas negative	40	32

3.3 Samples

The surveys addressed investment decision-makers of Swiss strategic and financial investors. Within each company, we approached the person who is responsible for energy investments. Depending on the type of investor, the person in charge for energy investments is at a different level within the hierarchy; within energy utility companies, the head of portfolio management or even the chief executive officer was the most appropriate person to talk to; within small financial investors, we approached those who define the investment strategy, typically members of the boards. Within larger financial investors, more specialized portfolio managers turned out to have the most in-depth insights on energy investment decisions. The Swiss commercial register allowed identifying the relevant companies. If contact information was procurable via online research or telephone-inquiries, the respective potential participants were first contacted via mail and received a reminder via phone. In sum, 370 financial investors and 66 strategic investors received the invitation to study 1. From June to September 2012, 45 investors participated in the IAT. This sample size is sufficient for an IAT; Greenwald et al. (2003) mention 39 participants as the minimum required sample size. Table 5 provides sample information with regard to company type, position of the participant and some personal characteristics.

The target population in study 2 is identical with that of study 1. In order to exclude participants of study 1 from study 2, the market research institute received a list with all participants from study 1 and the instruction not to contact them again. Potential participants were first contacted via email and received up to three reminders via email and phone. In sum, 488 investors received the invitation to the survey. In March and April 2013, a total of 88 managers participated in the online test. Several participants had to be excluded because they indicated that they were not responsible for energy investment decision-making or because of too many errors in the reaction test. The final sample consists of 16 strategic and 51 financial investors.

Table 5 Descriptive statistics of the samples

Company type (N)	Study 1 (N=45)	Study 2 (N=67)
Electric utility company	8	16
Banks	2	25
Institutional Investors	35	26
Position within the company (N)		
CEO or member of the board	12	14
Chief financial or investment officer	23	21
Portfolio Manager	5	15
Analyst	1	11
Other	3	6
Demographics (years)		
Age	44.6 years (SD=9.7)	43 years (SD=10)
Experience in investment decision-making	8.1 years (SD=6.7)	7 years (SD=7)
Experience in renewable energy investment decision-making	2.7 years (SD=3.7)	3.7 years (SD=3.8)

3.4 Results

On average, study 1 revealed no clear preference for one energy source over the other in terms of risk-return assocations (IAT-score=0.045). The IAT-score was not significantly different between strategic and financial investors (0.054 vs. 0.050, p-value=0.807).

However, risk-return associations to photovoltaics versus gas-investments are dispersed in our sample; 16 participants have a slight, moderate or strong association of photovoltaics to return and gas to risk, and 19 participants have a slight, moderate or strong association of gas to return and photovoltaics to risk. A neutral test-score implies that participants where not significantly faster in one of the two test constellations of Figure 2; – nine participants have a neutral test score (see also Table 6).

Study 2 revealed a clearly more positive association to solar energy than to gas (IAT-score=0.633). The IAT-score was not significantly different between strategic and financial investors (0.648 vs. 0.580, p-value=0.734).

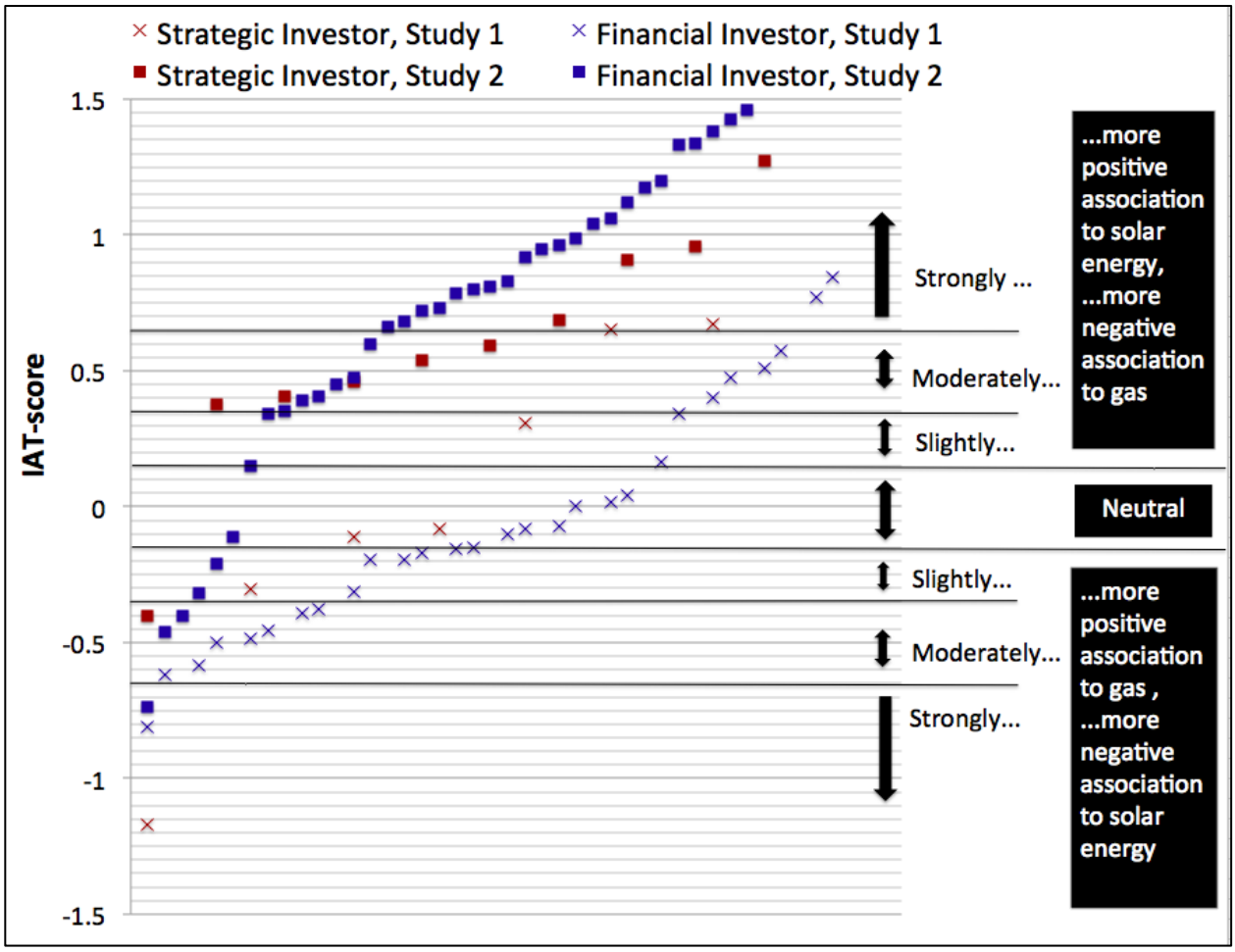
Table 6 IAT-scores of study 1 and study 2

IAT-test result		**Study 1 (N=43)**	**Study 2 (N=46*)**
Strongly...	...more positive association to gas, ...more negative association to solar energy	6	1
Moderately...		6	3
Slightly...		3	2
	Neutral	9	1
Slightly...	....more positive association to solar energy, ...more negative association to gas	7	2
Moderately...		9	11
Strongly...		3	26

* 21 out of 67 IAT-scores are omitted due to more than 11% errors in reaction tasks or more than 10% very fast reaction times, or missing final feedback message. This filtering procedure was recommended by Project Implicit.

Figure 3 shows all individual IAT-scores from both studies.

Figure 3 Individual IAT-scores from study 1 and 2



3.5 Discussion

On average, investors' implicit cognition on solar energy versus gas is either more positive towards solar energy or indifferent between the two energy sources. However, as already discussed in the analysis of the expert interviews in chapter 2, we also observe heterogeneity; while some investors perceive solar energy extremely more positive than gas, the IAT-score of others reveals the opposite. The most striking observation from the descriptive statistics presented in this chapter is the difference in average IAT-scores from study 1 versus study 2.

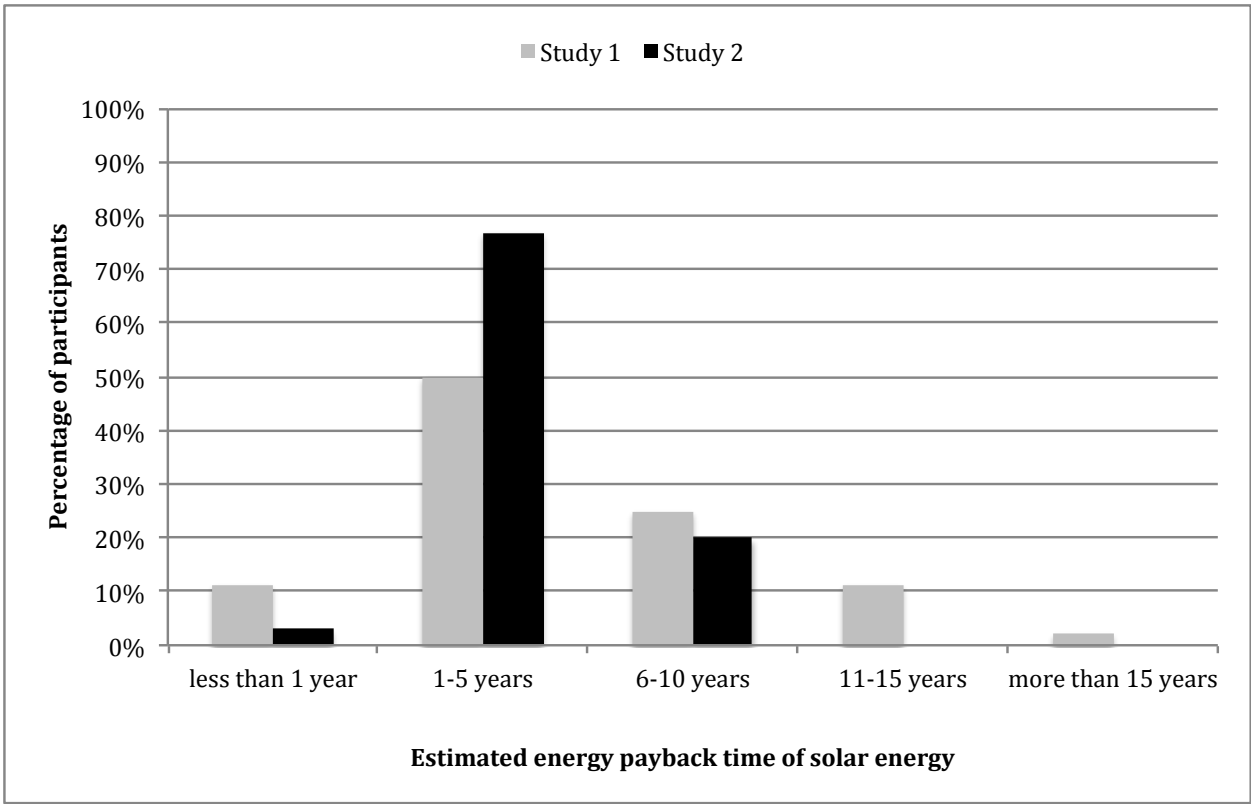
We suggest three explanations for the difference between study 1 and 2:

Experience. Comparing the samples from study 1 and 2 with regard to renewable energy investment experience (Table 5), we see that the sample of study 2 has on average 1 year more experience. This investment experience might have led to an overall improvement in perception of solar energy.

General knowledge on solar energy. Since summer 2012 when we conducted study 1, an intense public debate on energy sources and their potential to cover electricity needs took place in Switzerland. The study results suggest that this debate led to more knowledge on solar energy; in both studies, we asked participants to estimate the energy payback time of a solar energy power

plant. In study 1, answers were more dispersed, and the average estimated payback time was higher than in study 2. In study 2, three out of four participants gave the correct answer, in study 1 two out of four participants knew that the average energy payback time of solar energy is between one to five years (see Figure 4). The comparison of the yearly representative household survey on Swiss citizens' attitude on energy sources shows that the observed trend towards better solar knowledge from 2012 to 2013 corresponds to a similar trend in the general population (Chassot & Wüstenhagen, 2013).

Figure 4 Participant's estimated energy payback time of solar energy



Wording in the studies. Remember that study 1 measured how strongly investors associate solar energy and gas to "risk" and "return", whereas study 2 measured more generally how strongly investors associate solar energy and gas to the terms "negative" and "positive". We could not find earlier IAT-studies with financial and / or strategic investors. The two studies we did are early attempts to apply the IAT to this population. Further research could try different test specifications within the same sample. This would allow disentangling time effects due to a public debate from wording effects of the method itself.

In our case, we suggest that it is not the public debate alone that caused the difference, but also that study 1 captured a more finance-related perception of energy sources. It may be that due to recent turmoil in the photovoltaic industry, the association of photovoltaics to risk was relatively strong, whereas the overall perception of photovoltaics still tends to be more positive.

4 The effect of implicit cognition and organizational factors on investment decisions

Analyzing energy investments of portfolio managers, we have to bear in mind that these individuals act within an institutional context. Therefore, the management literature suggests to complement cognition, which is an individual-level factor, by organizational factors.

The most common organizational factors to look at are organizational capabilities and organizational incentives (Kaplan, 2008). In the following we develop hypotheses for each of the three factors – managerial cognition, organizational capabilities and organizational incentives.

4.1 The model and hypotheses

4.1.1 Implicit cognition

Broad empirical evidence from earlier applications of the IAT show that implicit cognition influences behavior; for example, Rachlinski et al. (2009) found that judges with implicit biases toward black people where more strict in their judgments of black defendants. Up to now, two applications of the IAT to energy sources are published; Siegrist et al. (2006) measured Swiss students' implicit association toward nuclear vs. hydro power. Truelove et al. (2013) conducted a similar study with american residents. Both studies conclude that implicit attitudes predict political support for energy sources. From the management literature discussed earlier, implicit cognition also has an influence on managerial decision making. With an empirical measure for managers' implicit cognition on renewable versus fossil energy, we therefore hypothesize that the more positive (negative) the implicit cognition on renewable energy, the more (less) a manager invests in renewable energies.

H1: There is a positive correlation of renewable energy investments with the degree of investors' positive implicit cognition on renewable energy.

Depending on the type of investor and the importance of the innovation to the company, the relevance of implicit cognition might differ. Grégoire et al. (2010) suggest that implicit cognitive processes are more influential for threat recognition than for opportunity recognition. Barreto & Patient (2013) find that the more an innovation relates to the core activities of a manager and unsettles the fundament of a company, the more intuitively a manager acts. Khatri & Ng (2000, p.78) confirm this result and argue that the high influence of intuition in unstable environments has a positive impact on financial performance of a company. In a survey of managers working for banks, computer companies and utilities, Khatri & Ng used an intuitive synthesis scale to measure how strongly the different managers rely on "pure judgment", "past experience", and "gut-feeling", and find that managers of computer companies rely the most on intuition, whereas those working for banks do so to a lesser extent and utility managers the least. The authors justify this result with the particularly unstable environment of computer companies. On the other hand, the more institutionalized the decision-making process is, the less influential is implicit cognition. For example Crossan et al. (1999, p.533) state that "institutionalization can easily drive out intuition. Intuiting within established organizations with a high degree of institutionalized learning requires what Schumpeter (1959) refers to as 'creative destruction' – destroying, or at least setting aside, the institutional order to enact variations that allow intuitive insights and actions to surface and be pursued."

In the context of the current energy transition, we argue that uncertainty in energy markets enhances the influence of implicit cognition among strategic investors, because energy investments relate to the strategic core of an electric utility. On the other hand, financial investors' investment strategies are defined in terms of asset classes. Our expert interviews focusing on financial investors' energy investments demonstrate that their decision making process is highly institutionalized in that sense (Beglinger, 2013), which is according to Crossan et al. (1999) a factor that drives out the influence of implicit thinking. Thus, we further hypothesize that

H2: The correlation of renewable energy investments and implicit cognition on renewable energy is stronger for strategic than financial investors.

4.1.2 Organizational capabilities

Organizational capabilities are "an essential driver of firm response to technical change" (Kaplan, 2008, p.672). Importantly, capabilities emerge from domain-specific prior experience, and not general experience of a company (Kaplan, 2008; Barreto & Patient, 2013). Whereas prior experience in the domain of the innovation enhances the company's success in response to the innovation, general experience or incumbency is rather a hampering factor, leading to path dependency (Lovio et al., 2011) or inertia (Benner & Tripsas, 2012; Tripsas & Gavetti, 2000). In the context of this study, we suggest that renewable energy-specific experience of the organization enhances (whereas the lack of capabilities hinders) renewable energy investments:

H3: There is a negative correlation of renewable energy investments with organizational lack of renewable energy experience.

4.1.3 Organizational incentives (or barriers)

Organizational incentives often relate to a company's customers. An example could be: market research has shown that the company's customers have high demand for the innovation, which creates an incentive for the company to invest. This would then be a *strategic* organizational incentive. In this study, we talk of organizational barriers rather than incentives. Collecting data in the context of the Swiss energy industry in 2012 and 2013, this seemed more appropriate since the discussion among many practitioners has been quite problem-oriented. An example for a strategic organizational barrier is either that renewable energy investments are considered irrelevant to the company's strategy, or contradictive to the company's strategy. We hypothesize

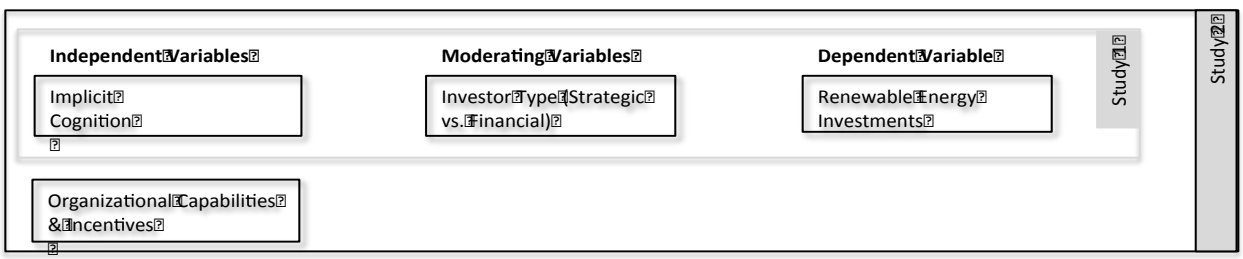
H4: There is a negative correlation of renewable energy investments with strategic organizational barriers.

Another type of organizational incentives or barriers relate to the policy framework a company acts in. Regulatory frameworks may incentivize investments in some areas (e.g. feed-in tariffs encourage investments in renewable energies), or impede them (e.g. the new financial market regulation Basel III implies more strict equity requirements for energy project finance, see also section 2.3.3). Regarding energy market regulations, policy makers have begun to adapt them to the market changes due to increasing renewable energy generation. However, this process is still ongoing. Thus, both strategic and financial investors claim to some extent that their respective investment regulations are not (yet) compatible with renewable energy investments.
Thus, we hypothesize that

H5: There is a negative correlation of renewable energy investments with regulatory barriers.

The core of the model focuses on the impact of implicit cognition on energy investments and the moderating effect of investor type. We tested this model in study 1 and study 2. In study 2, we added the organizational variables as explanatory factors to complement the picture on a manager's investment decision making within an organization.

Figure 5 Models of study 1 and 2, based on Kaplan (2008)



4.2 Variables

4.2.1 Measurement of organizational capabilities and incentives[1]

As Kaplan (2008), we measured capability in terms of organizational experience in renewable energy investments. However, as explained earlier, it seemed more appropriate to frame the questions as *lack of* experience and incentives. Similarly as Barreto & Patient (2013) and Denison et al. (1996), we used a seven point likert scale (1="irrelevant", 7="relevant") to assess organizational lack of experience. Specifically, participants had to indicate for each statement how relevant it was regarding their renewable energy investments. The item for lack of capabilities was "Our company does not yet have experience with renewable energy investments".

Organizational barriers can be strategic or regulatory. The respective item for strategic barriers was "We primarily have to generate return with our investments. The question in which energy source we invest is less important.", and for regulatory barriers: "Investment regulations are not designed for investments in this area."

4.2.2 Dependent variable energy investments

4.2.2.1 Study 1

We surveyed investments in energy sources in a detailed grid-item. Strategic and financial investors operate via different asset classes. The grid item included seven asset classes, and participants had to indicate via which particular asset class (private or publicly listed equity, real estate, bonds, project finance, commodities or other real assets) they invest in the respective energy source.

Just as the IAT-score is a relative measure of solar energy versus gas, the dependent variable in the model is *net* solar energy investments (we added the number of asset classes used to invest in solar energy and subtracted investments in natural gas). A positive number on the dependent variable indicates a relatively high exposure to solar energy; a negative number indicates relatively high exposure to gas. The dependent variable is the number of asset classes used to invest, since the expert interviews revealed that the number of asset classes is a proxy for a manager's involvement in renewable energy in the organizational context.

The most precise measure for energy investments would have been the precise investment amount in Swiss francs. However, the sizes of balance sheets of investors in our samples vary considerably between investor types. Therefore, there would have been systematic biases in our dependent variable. Furthermore, as these numbers are not publicly available, asking for the precise monetary amount invested would have required some research from our participants – or that they give imprecise answers.

4.2.2.2 Study 2

Again, participants completed a set of survey items after the IAT. Whereas study 1 asked for investments via seven different investment channels, we included four investment channels (project finance, shares, bonds) plus "others" in study 2 (in order to save time for participants we merged the three least relevant answer options). Participants indicated their investments in a grid that distinguished between solar energy and gas in the rows and investment channels in the columns. As in study 1, the final score is a *relative* measure of preference of solar energy over gas. Thus, we measure investments as the sum of investments in solar energy minus the sum of investments in gas (for more details and descriptive statistics on the dependent variable energy investments, see Appendix E).

[1] For a detailed description of measurement of implicit cognition, see chapter 3.

4.3 Results

4.3.1 Interaction effect of implicit cognition with investor type on energy investments

The final result of study 1 is that the IAT-score correlates with solar energy investments among strategic investors, but not among financial investors. A simple OLS-regression model shows the significance of the interaction effect of investor type with implicit cognition on energy sources, whereas the main effect is not significant (see Table 7).

Table 7 OLS regression results with interaction effect of IAT-score with type of investor

	Net solar energy investments	
VARIABLES	coefficient	robust standard error
IAT-score	-0.165	0.202
Strategic investor	-0.524	0.293
IAT-score*strategic investor	0.647**	0.221
Constant	0.424**	0.14
R-sqaured	0.210	
Prob > F	0.000	
Observations	35	

All variables are standardized

** p<0.01, * p<0.05, # p<0.1

The effect size of the interaction effect is 0.65, which is a rather large effect given the small sample. Alternatively, the model can also be estimated with ordered logit. We did this as a robustness check. The ordered logit regression shows the same significant interaction effect of investor type with the IAT-score on energy investments, whereas the main effects are not significant (see Appendix F for the regression table).

4.3.2 The final model

Table 8 shows the results of the OLS regressions for study 2. The regression is based on only 32 observations, due to missing values on some of the variables: As briefly discussed in section 3.4, 21 IAT-scores were omitted. This filtering is based on Project Implicit's recommendation to not rely on IAT-scores of a participant, if the participant in more than 10% of all tasks showed extremely fast reaction times or committed errors. Of the remaining 46 participants, between 40 to 46 answered each of the other variables included in the regression reported below. However, it was not always the same participants who did not answer one specific question, but in total 14 out of the remaining 46 who have some missing data. This leads to the final 32 observations for the regression model. For a comparison of the subsample used for the regression with the omitted subsample, see *Appendix D* Testing for selection bias in study 2. As in study 1, that the main effect of implicit cognition is not significant. However, implicit cognition in combination with strategic investor has a significant effect on energy investments; being a strategic investor and having positive (negative) implicit associations to solar energy implies ceteris paribus more (less) net solar energy investments (see model 2). With 0.633, the effect size is similar to that of study 1 (0.647). The regression coefficients express elasticities; a 1% increase in positive implicit cognition on solar energy implies a 0.633% increase in net solar energy investments.

The ordered logit model (see Appendix F) confirms the interaction effect with higher significance than in the OLS-model. The fact that the interaction effect appears in both samples with ordered logit as well as OLS (even though in study 2, the coefficient in the OLS-model is only significantly different at the 10%-level), and the very similar effect size in both samples demonstrates the robustness of the interaction effect.

The main effect of regulatory barriers is significant at the 10%-level and has a negative impact on solar energy investments – a 1% increase in regulatory barriers implies a 0.384% decrease in net solar energy investments. As for organizational capabilities, neither the main effect nor the interaction effect has a significant effect. Regarding the control variables age, type of investor and position of the manager, age has a significantly negative effect in both models. As an example for interpretation of the coefficient for age of -0.608, one can imagine two investors being exactly identical in all explanatory variables except that investor A is 1% older than investor B. Let's say A is 50 years old and B 50 years and 6 months. Our results suggest that investor A's net investments in solar energy are 0.608% higher than B's investments. As we measured investments as number of asset classes and not in terms of invested Swiss francs, we cannot quantify the meaning of the regression coefficients in a monetary unit.
A brief discussion of these results follows in the next section.

Table 8 OLS regression results study 2

	Net solar energy investments	
VARIABLES	coefficient	robust standard error
Strategic barriers	-0.252	0.169
Regulatory barriers	-0.384#	0.209
Lack of capabilities	0.364	0.282
IAT-score	0.113	0.161
Strategic barriers * strategic investor	-1.053	0.694
Regulatory barriers * strategic investor	0.548	0.360
Lack of capabilities * strategic investor	-1.097	1.452
IAT-score * strategic investor	0.633#	0.338
age	-0.608*	0.221
Bank	-0.334	0.981
Institutional investor	-0.087	0.989
CEO or member of the board	-0.213	0.439
Chief financial or investment officer	-0.599	0.534
Portfolio manager	-0.806	0.566
Constant	0.346	1.140
R-sqaured	0.703	
Prob > F	0.000	
Observations	32	

All variables are standardized
** p<0.01, * p<0.05, # p<0.1

4.4 Discussion

With the analysis presented in chapter 4 we addressed the following research questions:

(4) What is the impact of investors' implicit cognition on energy investments?
(5) How does implicit cognition and its influence on renewable energy investments differ between managers of financial versus strategic investors?
(6) How do organizational capabilities and incentives influence energy investments?

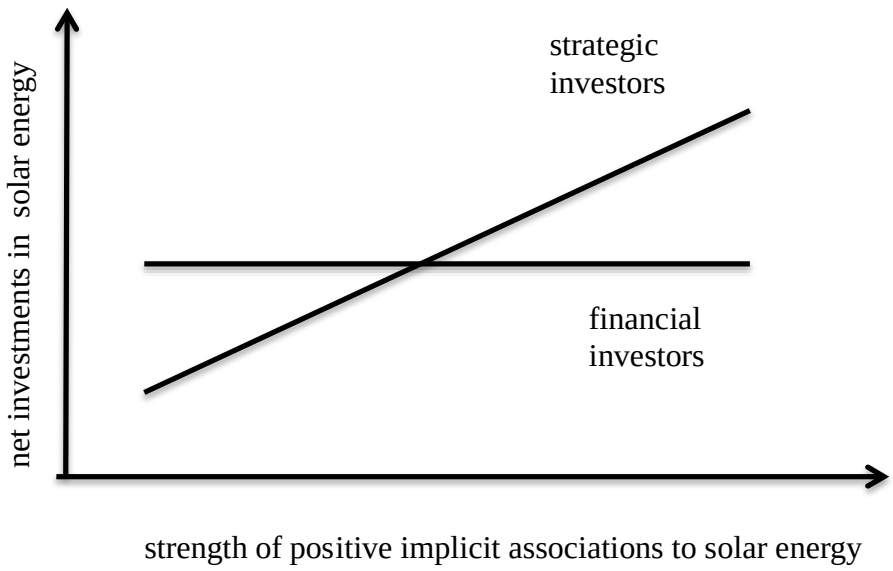
The main results of the two IAT-studies – implicit cognition on renewable vs. fossil energy has an effect on energy investments of strategic investors – is in light of the sample sizes surprisingly large and robust across samples and model specifications (even though the coefficient is only significantly different form zero at the 10%-level in the final OLS-regression). For a qualitative illustration of this result, see Figure 6.

For strategic investors in the energy industry, the decision which energy source to invest in is a matter of high involvement and lies at the core of the business strategy of an electric utility company. As the IAT-score predicts solar energy investments for strategic investors, this study indicates that when managers face an innovation, implicit cognition is more influential if the innovation relates to the core business of a company. Financial investors on the other hand have a more pragmatic approach to energy investments – they seek investment objects that fit into their established asset classes framework.

Regarding organizational factors, regulatory investment barriers have a negative effect on investments; however, the effect is only significant at the 10%-level. After the discussions in the expert interviews, we would have expected a larger negative effect. Overall, the significance of coefficients in the final OLS model is low. The ordered logit model (Appendix F) indicates the same effects more significantly. Nevertheless, we report the OLS regression in the main text because this model specification poses less restrictive assumptions on data distribution.

In all models where age is included, it has a significantly negative effect. The older an investor who participated in our test is, the less he or she invests in solar energy. This links back to the discussion during expert interviews at the beginning of this project, where one interviewee of a electric utility talked about the change of mentality that decentralized renewable energies imply. Older managers who grew up in the traditional Swiss energy system with hydropower and nuclear seem to be more susceptible to path dependence, in that they are less open to exploring new energy generation technologies than their younger colleagues.

Figure 6 Qualitative illustration of the interaction effect of implicit cognition with investor type on energy investments

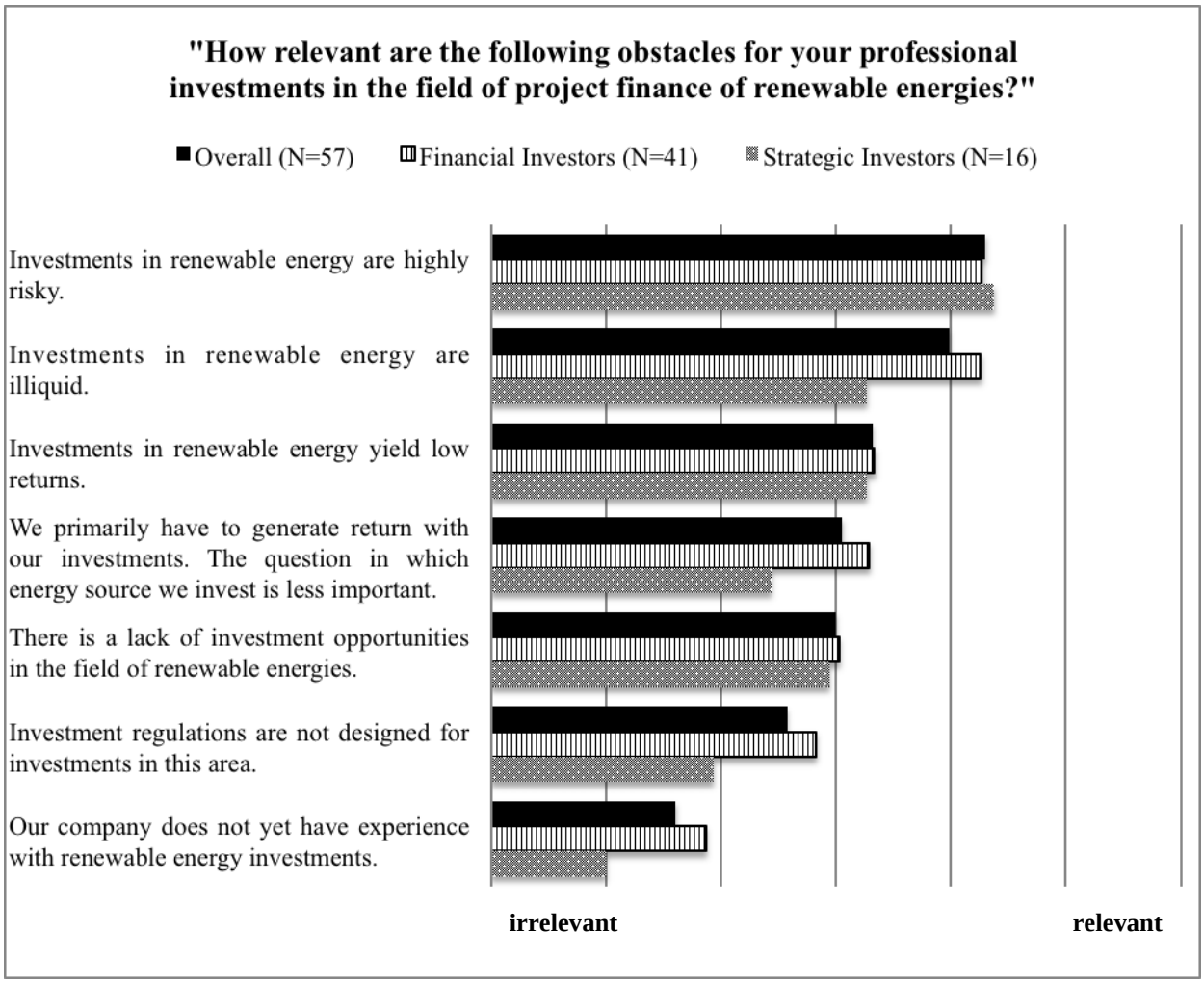


5 Regulatory risk as explicitly stated investment obstacle

5.1 Investment obstacles

For a broader understanding on what may hinder investments for the specific case of renewable energy project finance, we asked the participants of study 2 to rate the relevance of seven investment obstacles. Figure 7 shows that perceived risk is the most relevant obstacle for the entire sample. We find the only significant difference by investor type for liquidity of investments; this obstacle is on average more relevant for financial investors. Illiquidity of investments is overall the second most relevant investment obstacle. Low returns and lack of strategic incentives are third and fourth, followed by lack of investment opportunities. The least relevant are according to the participants' rating regulatory barriers and, finally, lack of organizational capability.

Figure 7 Investment obstacles by investor types (significance of differences were tested with t-tests, *p<0.1)



5.2 Risks associated with investment in photovoltaics

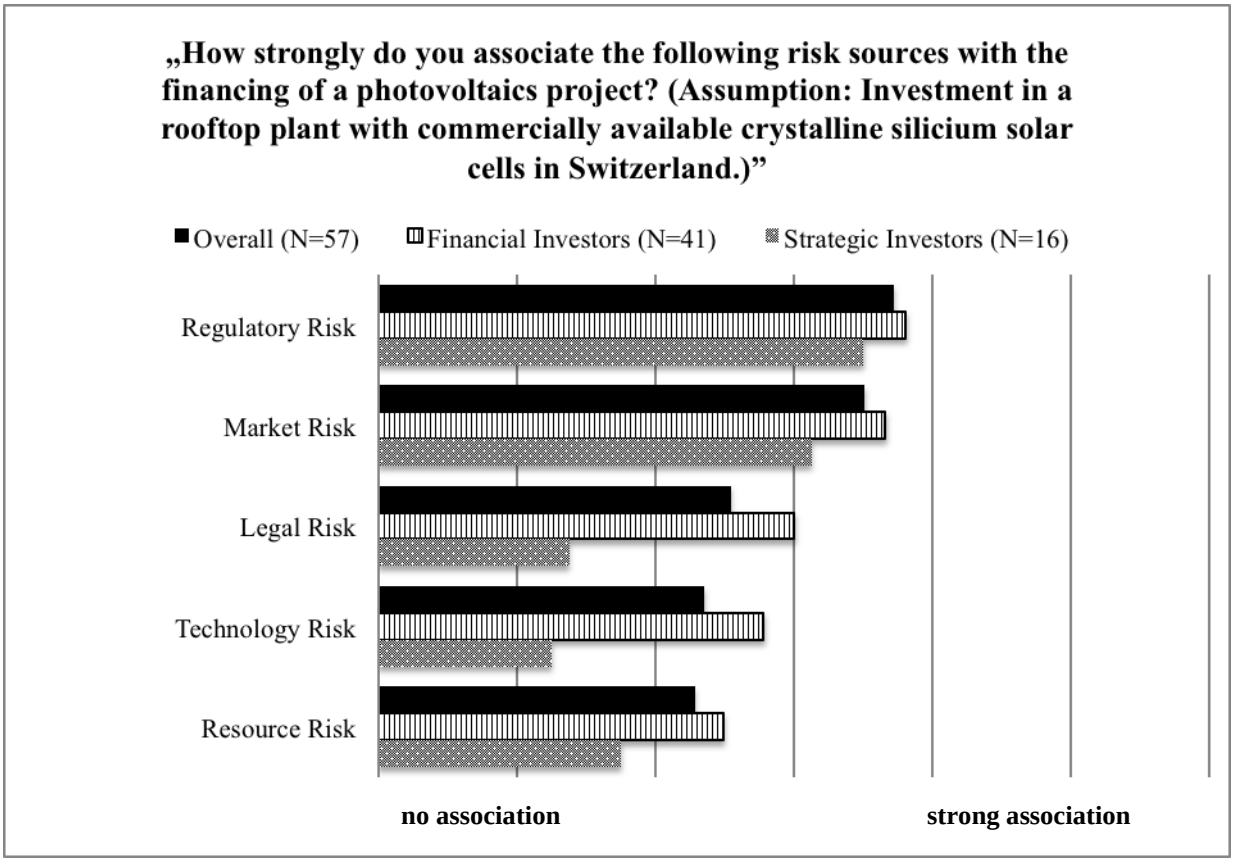
Figure 8 shows what types of risks in particular investors associate photovoltaics with. The question in the survey-part of the study was: „How strongly do you associate the following risk sources with the financing of a photovoltaics project? (Assumption: Investment in a rooftop plant with commercially available crystalline silicium solar cells in Switzerland.)". To make sure that answers are comparable and relevant across investor types, the question explicitly asked about photovoltaics *project finance*, which is a potential investment channel for financial and strategic investors alike.

For five sources of risk, respondents had to indicate on a seven-point likert scale how strongly they associate photovoltaics to that risk. The types of risk were defined as follows in the survey:

(1) Regulatory risk: Relates to changes in the relevant regulatory framework, e.g. change of the feed-in tariff.
(2) Market risk: Relates to changes in the energy market, e.g. market entrance of a renewable energy supplier.
(3) Legal risk: Relates to risk of delays due to legal inquiries.
(4) Technology risk: Relates to technological development that might lessen competitiveness of the technology, or technology suffers from unforeseen deficits.
(5) Resource risk: relates to price changes of resources that are necessary to build the photovoltaics power plant.

The sequence of the five risk types was randomized in the survey. Figure 8 shows that the top risk is regulatory risk, followed by market risk. The investors associate photovoltaics to a lesser extent to legal risk, resource risk and technology risk.
Regarding differences in risk perceptions of strategic and financial investors, the figure below shows significant differences for legal and technology risk; a significantly larger fraction of financial investors associates photovoltaics to these risk sources. Adding the risk associations for each risk source shows that overall, financial investors expressed more risk associations in the survey than strategic investors (20.73 vs. 16, p-value of t-test 0.004).

Figure 8 Explicit risk associations to photovoltaics based on survey item (significance of differences were tested with t-tests, ***p<0.01)



6 Final discussion

6.1 Implications for policy makers

One research question we set out in the beginning of this report remains;

(7)What are the implications for designing effective energy policies in Switzerland?

In this research we addressed renewable energy investment decision making of strategic and financial investors. After 20 expert interviews with investment decision makers from electric utility companies, pension funds, banks and insurance companies, we identified managers' implicit cognition on energy sources, as well as organizational capabilities and incentives as relevant factors to explains these investors' energy investments. In order to measure managers' implicit cognition on energy sources, we then developed two different versions of the Implicit Association Test (IAT). The IAT allowed us to capture managers' implicit preference of solar energy versus natural gas in two separate empirical studies with Swiss strategic and financial investors. We complemented the IAT with some survey questions.

The methodological diversity of this research strengthens the robustness of some main results:

- *perceived risk of renewable energy investments is a major concern of strategic and financial investors.*
- *regulatory risk is the predominant source of perceived risk.*
- *for financial investors, risk as an investment obstacle could be overcome by creating an investment vehicle with a low-risk profile.*
- *for strategic investors, fast thinking on energy sources influences investments. Overcoming investment obstacles goes together with a more fundamental change of mentality.*

Implications for Swiss energy policies are manifold.

First of all, electric utilities, banks, pension funds and insurance companies are all (potential) renewable energy investors. They already explore renewable energy investments – passively through research and observing or actively with investments. Electric utility companies face a political imperative to adjust to the revised national energy strategy. Some electric utilities have a respectable renewable energy portfolio already, although these investments are largely located abroad. Among financial investors, a few banks have taken a leading role and develop renewable energy investment funds. Financial investors seek long-term investment opportunities with low risk and stable cash flows. Before the subprime and the Euro-crisis, real estate investments and bonds would have sufficiently fulfilled these criteria. In today's financial markets, long-term investment opportunities are scarce.

Another commonality of strategic and financial investors is the most relevant investment obstacle risk, in particular regulatory risk, such as a change in the feed-in tariff as observed in neighboring European countries in the past and as currently discussed in Switzerland. Ensuring a reliable and predictable regulatory framework is an important component of reducing investors' risk perceptions. Strategic and financial investors are potential co-financing partners, as experience from abroad shows. Where Swiss utilities have participated in such co-investments so far, they have chosen to collaborate with foreign rather than Swiss financial institutions. Lack of expertise among Swiss financial investors is one reason. The most straightforward way to bring renewable energies closer to financial investors is to package them into long-term low risk investment vehicles – in particular bonds. Adaptations of financial market regulations that ease investments in renewable energy projects should also be considered.

An interesting aspect of our findings is that the strict regulation of financial investors seems to have crowded out the space for investors' intuition, which – as our results show – is often rather positive towards renewables. In the specific context of renewable energy investments, this may imply that investment decisions that would correspond to common sense and help to achieve societal objectives are prevented – an effect that could even counteract the regulators' original intention of reducing risk in the financial market. While simply relying on pension fund

managers' gut feeling may not be the solution, it might be worth for further research to explore how the positive aspects of intuition could be brought back into the investment decision process.
Many strategic investors on the other hand actively explore renewable energies. For those who hesitate, incompatible mentalities – or what we call implicit cognition and measured with the IAT – appears to have some influence on their decision-making. Investigating long-term changes in implicit cognition would be an interesting topic for further research.

6.2 Limitations and further research

This exploratory research project was the first to use the implicit association test (IAT) in the context of energy investments. We empirically investigated real investors, and our objective was to relate professional investors' implicit thinking to their energy investment decisions. The exploratory nature of this research project implies a series of limitations that can represent a starting point for further research.
First, there is a trade-off of accuracy of measurement of variables and quality of the sample; we emphasized accurate measurement of implicit cognition on energy, but this implied for our participants that each of them had to conduct about 180 reaction tasks. Therefore, in order to establish a good sample of Swiss investors, we had to rely on simplified operationalization of other variables. The most accurate measure of energy investments for example would have been the exact amount invested in each energy source in Swiss francs. However, such data is not readily available, especially for financial investors, and in many cases this would have required substantial research from our respondents themselves, and the time required to complete the survey would have gone well beyond the usually acceptable 15-20 minutes.
Another approach how some scholars solve the trade-off of measurement accuracy and quality of the sample is to conduct a study in the laboratory and invite students to participate. The quality of a sample is two-dimensional; one dimension is the size, the other dimension is to get the relevant people to participate. For this research, the second dimension was more important, we wanted to do this study with investors who actually manage portfolios and are in a position to invest substantially in renewable energy. In sum, while the „real-world"-sample and the accurate measurement of implicit cognition is the novelty and the strength of this research, we took a more pragmatic approach to the measurement of other variables such as energy investments, and the sample size would of course have been larger with a student sample.
Secondly, study 1 was conducted in English, study 2 in German. While we have no indication that this would have affected validity of the results of each study, for comparisons across the two studies it is not possible to disentangle potential language effects from other possible explanations. In study 1, the associations were framed for the finance world with the terms „risk" and „return"; in study 2, the associations were as in the classic version of the IAT „negative" and „positive". Further research who could disentangle wording from language effects.
Thirdly, given the empirical evidence from this project, it is not possible to test potential explanations for the interaction effect of investor type with implicit cognition on energy investments. The literature discussed earlier offers two explanations; Grégoire et al (2010) and Barreto & Patient (2013) would probably argue that strategic investors from electric utility companies rely more on implicit cognition because strategic investors might perceive renewable energies as a threat to their current business model, and because the „shock" distance to the renewable energy revolution is smaller. Crossan et al (1999) on the other hand would argue that financial investors' decision making process is so highly institutionalized, and that this is the reason that implicit cognition, the „gut feeling" of investors, has no room anymore. Our own prima facie evidence from the expert interviews suggests that the highly technical, complex investment decision making process of financial investors rules out any influence of „gut feeling". However, neither study 1 nor study 2 included any questions that explicitly addressed

the influence of the institutional context, in particular the nature of the investment decision-making process.
Fourthly, in order to really understand what motivates and what hinders renewable energy investments, it is important to get as close to the investment decision as possible. The data for investments in this study is self-reported. Observing investment decision-making in real time would certainly be an interesting complement to rule out any omitted variable issues. Further research that captures the decision processes of energy investors in real time would be highly valuable.
Beyond the challenges of measuring implicit cognition, another reason why earlier research on managerial cognition used letters to shareholders rather than interview data as a source for managerial cognition, is that this approach makes the effort for longitudinal studies manageable. Longitudinal studies rule out potential reverse causality of managerial action on cognition. However, the research tradition on implicit cognition in psychology emphasizes the long-term stability of implicit cognition. Thus, while investment experience with an innovation may influence implicit cognition in the long term, this is not yet the case when the innovation just appeared on the market. Changes of implicit associations happen very slowly and only after "repetitive and intense experience" (Epstein, 1994, p.711). While reverse causality is a potential shortcoming of a lot of research that links managers' investment decisions to attitudes, using an IAT is a more robust method when confronting this issue than for example CEO letters to shareholders or other documents of corporate communication. Nevertheless, longitudinal studies on the development of implicit attidues on energy would be a promising avenue for further research. Given the currently significant changes in some energy markets, implicit cognition may also change over time. Tracking these changes, mapping what type of people change their implicit cognition due to which factors, would be of high relevance and also theoretically advance the field.

7 Acknowledgements

We acknowledge third-party funds from the Swiss National Science Foundation, project PBSGP1_146901, „Renewable Energy Policy Design Informed Through Economic Psychology".
With regard to contents, we acknowledge the reviewers' feedback of the International Association for Research in Economics & Psychology (IAREP) at the SABE / IAREP / ICABEEP conference in Atlanta, 25-29 July, who awarded this research with the Elsevier Student Paper Award 2013.
Furthermore, the items to assess investment obstacles were developed in cooperation with First Climate, a renown independent asset manager focusing on climate change and renewable energy energies.
Last but not least, this research project profited from feedback from employees of the Swiss Federal Office of Energy in various occasions. We appreciated their interest and feedback.

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Appendix A Guideline for expert interviews

Please see separate file „BFE Schlussbericht Interview Guideline“

Appendix B Survey of Study 1

Please see separate file „BFE Schlussbericht Survey Study 1“

Appendix C Survey of Study 2

Please see separate file „BFE Schlussbericht Survey Study 2“

Appendix D Testing for selection bias in study 2

	Sample for regression (N=32)	**Omitted for regression (N=35)**	**p-value of t-test of differences in mean between subsamples**
Dependent variable	0.1875	0.1538	0.8935
Explanatory variables			
IAT-score	0.723	0.427	0.0894
Strategic barriers	3.875	4.269	0.4424
Regulatory barriers	3.531	3.636	0.859
Lack of capabilities	2.594	2.619	0.964
Control variables			
Electric utility company (N)	8	8	Pearson Chi Squared-Statistic for test of different distribution: 0.340, p=0.844
Banks (N)	13	12	
Institutional Investors (N)	11	14	
Age	42.0313	42.917	0.7467

Appendix E Dependent variable energy investments

As Figure 6 shows, we collected very detailed information about participants' investments in different energy sources. In order to reflect the environment of both strategic and financial investors adequately, we included different asset classes as possible investment channels as well as „others". Furthermore, we distinguished between investments the participant conducts himself in his daily business, investments of his or her company, and we were also interested in privately conducted investments.

Figure 9 Investment channels to invest in energy sources and energy efficiency. Percentages indicate how many investors use the respective asset class

"Please indicate for each energy source, via which asset classes you yourself invest in them in **your professional daily life**. (Multiple answers per energy source allowed.)"																			
	project finance				**publicly listed equity**				**bonds**				**other**				**no investments**			
	Overall (N=58)	Financial Investors (N=42)	Strategic Investors (N=16)	p-value of pr-test	Overall (N=58)	Financial Investors (N=42)	Strategic Investors (N=16)	p-value of pr-test	Overall (N=58)	Financial Investors (N=42)	Strategic Investors (N=16)	p-value of pr-test	Overall (N=58)	Financial Investors (N=42)	Strategic Investors (N=16)	p-value of pr-test	Overall (N=58)	Financial Investors (N=42)	Strategic Investors (N=16)	p-value of pr-test
Energy efficiency	22%	14%	44%	0.016	36%	50%	0%	0.000	17%	21%	6%	0.171	22%	19%	31%	0.319	24%	21%	31%	0.435
Photovoltaics	24%	14%	50%	0.005	36%	48%	6%	0.003	9%	10%	6%	0.691	21%	16%	31%	0.220	28%	29%	25%	0.786
Gas	14%	5%	38%	0.001	29%	40%	0%	0.002	17%	21%	6%	0.171	12%	17%	0%	0.082	45%	38%	63%	0.095
Wind energy	29%	12%	75%	0.000	38%	50%	6%	0.002	9%	12%	0%	0.149	10%	12%	6%	0.527	29%	33%	19%	0.275
Nuclear energy	2%	0%	6%	0.102	12%	17%	0%	0.082	16%	19%	6%	0.229	7%	5%	13%	0.299	71%	69%	75%	0.656
"This question addresses **your company's** investments. Please indicate for each energy source, via which asset classes your company has invested so far. (Multiple answers are allowed.)"																				
Energy efficiency	33%	29%	44%	0.271	36%	48%	6%	0.003	16%	19%	6%	0.229	24%	19%	38%	0.140	26%	24%	31%	0.563
Photovoltaics	34%	26%	56%	0.031	33%	43%	6%	0.008	12%	14%	6%	0.401	21%	17%	31%	0.220	28%	31%	19%	0.353
Gas	22%	17%	38%	0.089	29%	36%	13%	0.083	19%	21%	13%	0.438	10%	14%	0%	0.110	48%	45%	56%	0.453
Wind energy	38%	24%	75%	0.000	38%	48%	13%	0.014	10%	14%	0%	0.110	9%	7%	13%	0.516	28%	36%	6%	0.025
Nuclear energy	5%	5%	6%	0.819	24%	29%	13%	0.201	21%	26%	6%	0.094	2%	2%	0%	0.534	64%	60%	75%	0.273
"This question addresses your investments as **citizen.** Please indicate for each energy source, via which asset classes **you privately** invest. (Multiple answers are allowed.)"																				
Energy efficiency	16%	10%	31%	0.041	17%	19%	13%	0.555	3%	5%	0%	0.374	14%	17%	6%	3.040	59%	62%	50%	0.411
Photovoltaics	14%	14%	13%	0.860	16%	21%	0%	0.044	3%	5%	0%	0.374	7%	2%	19%	0.028	66%	64%	69%	0.749
Gas	2%	2%	0%	0.534	17%	21%	6%	0.171	0%	0%	0%	n.a.	2%	0%	6%	0.102	79%	76%	88%	0.342
Wind energy	0%	0%	0%	n.a.	12%	17%	0%	0.082	2%	2%	0%	0.534	3%	2%	6%	0.470	86%	83%	94%	0.304
Nuclear energy	0%	0%	0%	n.a.	3%	5%	0%	0.374	2%	2%	0%	0.534	0%	0%	0%	n.a.	95%	93%	100%	0.272

In order to summarize the detailed data on energy investments from for further analysis (e.g. regression analysis), we provide the number of asset classes a participant uses as investment channels below (here only for investments the respective participant conducts herself in her professional

life). In the subsequent analysis we focus on investments in photovoltaics and gas only, because our IAT also contrasted these two energy sources. The dependent variable we use to analyze the data of study 2 is given in Figure 12; it is the sum of asset classes a participant uses to invest in photovoltaics, *minus* the sum of asset classes a participant uses to invest in gas. We use *net* solar energy investments because

- *we mirror the setup of the IAT, which is also a measure of relative preference of one energy source over the other;*
- *it allows us the cancel out the effect of systematically different investment patterns of financial versus strategic investors; as shown in Figure 13, there is no significant difference in the dependent variable between strategic and financial investors.*

Figure 10 Number of asset classes for photovoltaics and gas only. Percentages indicate how many investors use the respective number of asset classes to invest

Number of asset classes used as investment channel in professional daily life for photovoltaics and gas separately (ordinal)				
Energy source	Number of asset classes	Overall (N=58)	Financial Investors (N=42)	Strategic Investors (N=16)
Photovoltaics	0	28%	29%	25%
	1	55%	55%	56%
	2	17%	17%	19%
Gas	0	45%	38%	63%
	1	38%	40%	31%
	2	17%	21%	6%

Figure 11 Sum of asset classes participants use to invest in photovoltaics and gas, respectively; t-test for significance of difference between strategic versus financial investors.

Computed sum of asset classes used in professional daily life for photovoltaics and gas				
	Overall (N=58)	Financial Investors (N=42)	Strategic Investors (N=16)	p-value of t-test
Photovoltaics	0.900	0.881	0.938	0.776
Gas	0.724	0.833	0.438	0.070

Figure 12 Net solar investments

Net solar investments (number of asset classes for PV minus number of asset classes gas; dependent variable study 2)			
	Overall (N=58)	Financial Investors (N=42)	Strategic Investors (N=16)
-1	26%	26%	25%
0	41%	50%	19%
1	22%	17%	38%
2	10%	7%	19%

Figure 13 Average net solar investments with t-test for significant differences between strategic versus industrial investors

Average net solar investments			
Overall (N=58)	Financial Investors (N=42)	Strategic Investors (N=16)	p-value of t-test
0.172	0.048	0.500	0.102

Appendix F Results of robustness checks

Table (Appendix) 1 Regression results study 1, ordered logistic regression model

	Net solar energy investments	
VARIABLES	coefficient	Robust standard error
IAT-score	-0.767	0.893
Strategic investor	-1.683	1.069
IAT-score*strategic investor	2.223*	1.094
Pseudo R2	0.173	
Prob > Chi2	0.006	
Observations	35	

All variables (except dependent variable) are standardized, ** p<0.01, * p<0.05, # p<0.1

Table (Appendix) 2 Regression results study 2, ordered logistic regression model

	Net solar energy investments	
VARIABLES	coefficient	roubst stanard error
Strategic barriers	-1.022	0.647
Regulatory barriers	-2.012**	0.772
Lack of capabilities	2.235	1.581
IAT-score	0.495	0.64
Strategic barriers * strategic investor	-5.748*	2.435
Regulatory barriers * strategic investor	4.207*	1.797
Lack of capabilities * strategic investor	-7.612	5.25
IAT-score * strategic investor	3.33*	1.361
age	-3.375**	1.252
Bank	-0.779	3.376
Institutional investor	0.234	3.057
CEO or member of the board	4.144*	1.889
Chief financial or investment officer	4.04*	1.754
Portfolio manager	1.138	2.526
Pseudo R2	0.489	
Prob > Chi2	0.000	
Observations	32	

All variables (except dependent variable) are standardized, ** p<0.01, * p<0.05, # p<0.1

Appendix G Who invests in renewable energies? An investor typology for Switzerland

Please see separate file “BFE Schlussbericht KEV-Report”