Valuation of renewable energy investments: an explanatory mixed-methods study about applied approaches amongst practitioners

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Abstract: The purpose of this explanatory, sequential, mixed-methods study is to learn about the applied valuation processes for renewable energy investments to explore key value drivers, best practice approaches and improvements amongst Swiss and German investment professionals. The results demonstrate that both systematic and unsystematic risks are relevant. Risk preferences and subsequently valuation are clearly influenced by experienced materialisation of risk. Discounted cash flow (DCF)-based valuation is state of the art in this valuation, while encountered risks are adjusted either in the cash flows or in the applied discount rate. The internal rate of return (IRR) approach is most frequently applied, predominantly within a simplified flow to equity (FTE) valuation approach. Market participants surprisingly still use the weighted average cost of capital (WACC) of the investing company, mostly as a basis for defining hurdle rates. For assessing investments' value protection abilities and performing impairment tests, the less known but more consistent DCF-based certainty equivalent (CE) and adjusted present value (APV) approaches could be introduced.

Keywords: capital budgeting; cost of capital; risk assessment; risk mitigation; non-traded assets; private equity; renewable energy; practitioners; Switzerland; Germany.

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1 Introduction

In line with the international treaty to stabilise climate change (UNFCCC, n.d.),an effective means of transformation to a sustainable low-carbon economy (Jägemann et al., 2013; Skea, 2015) is based on facilitating the breakthrough of power plants producing electricity from renewable energy sources (RES-Es) (Reichmuth, 2013; Unteutsch and Lindenberger, 2016). These investments are typically asset-heavy, capital-intensive, highly immobile and long-term ventures[1] (Böttcher, 2009; Schmidt, 2014). In the current market environment, with historically low overall interest rates and economic challenges in several countries, many investors are attracted by subsidised RES-E projects with robust returns due to their absence of correlations with stock exchanges and their anticipated, favourable risk-return profiles (Warren, 2014; Monnin, 2015; Thakkar, 2015). However, many investors were forced to accept impairment losses in some of their RES-E investments (Shah, 2011). Therefore, the following question is to be answered: 'What are the optimal valuation methodologies to determine fair prices for sellers and acquirers of RES-E investments?'

While asset pricing research has extensively studied the relationship between risk and return on publicly traded companies (PTCs), including many theoretical publications about valuation (e.g., Brigham and Houston, 2012; Arnold, 2013) and several empirical studies about the application of methods (e.g., Graham and Harvey, 2001; Brounen et al., 2004), surprisingly little attention has been paid to the class of non-traded assets (NTAs) to which RES-E projects belong and to other, primarily qualitative factors that influence valuations and transactions. Even if this private equity[2] market is at least as important, in terms of size, growth, and the volume of acquisitions (Ang and Kohers, 2001; Moskowitz and Vissing-Jørgensen, 2002; Initiative-Europe, 2005; Capron and Shen, 2007), relatively little is known about its risk and return characteristics. Collecting data about this topic is challenging, since information is not publicly available for NTAs, and private investment firms are typically highly restrictive in providing corresponding information. For these reasons, applied asset pricing techniques, valuation processes and dynamics within negotiations for NTAs remain under-researched and poorly understood, in contrast to the research on PTCs (Petersen et al., 2006; Driessen et al., 2012; Ping et al., 2013). Furthermore, applied valuation methodologies – developed by researching PTCs (Damodaran, 2013) – do not appropriately consider all the specific characteristics of NTAs and RES-Es. Apart from having inadequate input data (Petersen et al., 2006) for NTA valuation, there is a lack of recognition of sector-specific characteristics (Brandt, 2002) and unsystematic risks (Damodaran, 2012). Other deficiencies are encountered regarding the lack of understanding and consideration of the correlation between project risk and within-firm and/or market risk (Ehrhardt and Brigham, 2016) and the prevailing subjectivity of many applied approaches (Cotner and Fletcher, 2000). Moreover, existing literature provides limited guidance for dealing with individual and cultural differences in risk perceptions and risk behaviours (Hofstede, 1983; Weber and Hsee, 1998; Weber et al., 2002) within such approaches.

This article reports on a performed explanatory, sequential, mixed-methods research (MMR) study conducted to better understand valuation processes in RES-E investments and to explore corresponding best and/or good practice approaches among investment professionals in Switzerland and Germany. The research is expected to make a valuable contribution to the asset pricing research for NTAs, specifically forRES-E investments. First, the research demonstrates which theoretical concepts[3] are applied in RES-E investment practice so that practitioners can learn how firms currently operate, assess risk and apply asset pricing techniques. Second, the research offers practitioners valuable insights into the organisational and cultural differences in the risk perception and risk behaviours of Swiss and German RES-E investors. Third, it contributes to the field of research and to managerial practice by suggesting improvements and complementary and alternative valuation methods for performing valuations in RES-E investments. Finally, the applied MMR is able to delve deeper into the subject than comparable studies with only a quantitative approach, for example by evaluating how risk mitigation measures and 'qualitative and strategic considerations' [Bierman, (1993), p.24] are taken into account in valuation, including the perspectives from the firm's and investor's level (Ehrhardt and Brigham, 2016). All these results could be the basis for the development of a conceptual model to valuate RES-E investments more efficiently and effectively.

Supplementary materials are available on request by emailing the corresponding author, or they can be obtained under https://www.researchgate.net/publication/323760123.

The paper starts with a presentation of the theoretical perspective, which includes a conceptual framework (Section 2). This is followed by the applied methodology (Section 3). The subsequent Section 4 presents the results and findings of the quantitative, qualitative and inference phases, before Section 5 concludes the paper.

2 Theoretical perspective

An extensive literature review[3] reveals that the majority of public theoretical approaches and empirical studies about valuation focus mainly on numerical methods and less on qualitative and judgmental approaches, even though the latter is at least as essential in valuation processes (Damodaran, 2012). From the perspective of numerical approaches, Table 1 presents an overview of the available valuation methodologies, of which discounted cash flow (DCF)-based ones and the economic added value (EVA) method are the most popular and essential approaches both in literature and in practice (Baker et al., 2010; Mielcarz and Mlinarič, 2014). Since the EVA approach is seldom applied for valuating RES-E investment projects[4], the focus of this research is on DCF-based approaches. The approach to choose from the latter's various forms depends on the information that is available, the applied financing policy[5], the considered argumentation for the optimal technique regarding the tax shield and the type of results required (Küting and Eidel, 1999; Fernandez, 2007b, 2007a, 2015, 2016; Drukarczyk and Schüler, 2009) (Figure 1). Even if all presented approaches, applied consistently, theoretically lead to the same results (Arnold, 2013; Fernandez, 2016), practical considerations determine their best applications. Within this research, three flow to equity (FTE) approach variations are of specific relevance: the simplified FTE[6], the adjusted present value (APV) and the certainty equivalent (CE)[7] approaches. Having selected the approaches, the appropriate type of discount rate is chosen. This rate typically considers both the time value of money and the involved risk (Robichek and Myers, 1966, 1968), which are derived from the still widely applied capital asset pricing method (CAPM) (Baker et al., 2010; Damodaran, 2012; Arnold, 2013; Britzelmaier, 2016). Ehrhardt and Brigham (2016) propose an integrated framework, combining numerical and judgmental aspects of risk assessment in valuation; it considers the effects of the investment in a new project on the investing company and the investor, based mainly on judgmental evaluations.

Table 1 Classification of different existing valuation methods

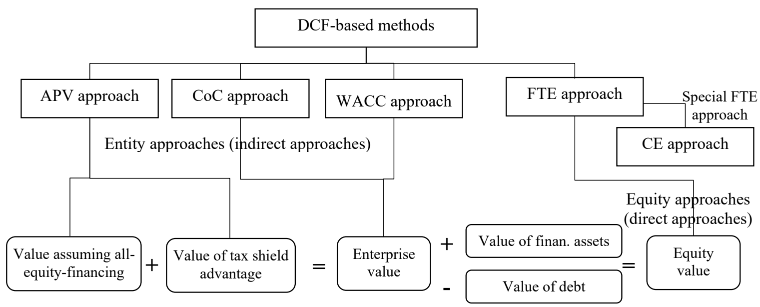
Classification of valuation methods					
Balance sheet-based methods	*Income statement-based methods*	*Mixed/good-will-based methods*	*Discounted cash flow-based methods*	*Value creation*	*Options*
Book value	Multiples per sales, EBITDA	Classic method	*Entity approach (free cash flow/free cash flow to entity)*	*Economic added value (EVA)*	Real option valuation
Adjusted book value	Other multiples (e.g., sales per production output)	Abbreviated income method	*Equity approach (equity cash flow/cash flow to equity)*	Economic profit	Black and Scholes
Liquidation value			Residual income valuation	Cash flow added	Investment options
Substantial value			Equivalent approaches (certainty equivalent, decoupled net present value)	Cash flow return on investment (CFROI)	Expand the project Delay the investment Alternative uses

Note: Main valuation methods according to Mielcarz and Mlinarič (2014) in italic letters.

Source: Adapted from Drukarczyk and Schüler (2009) and Fernandez (2016)

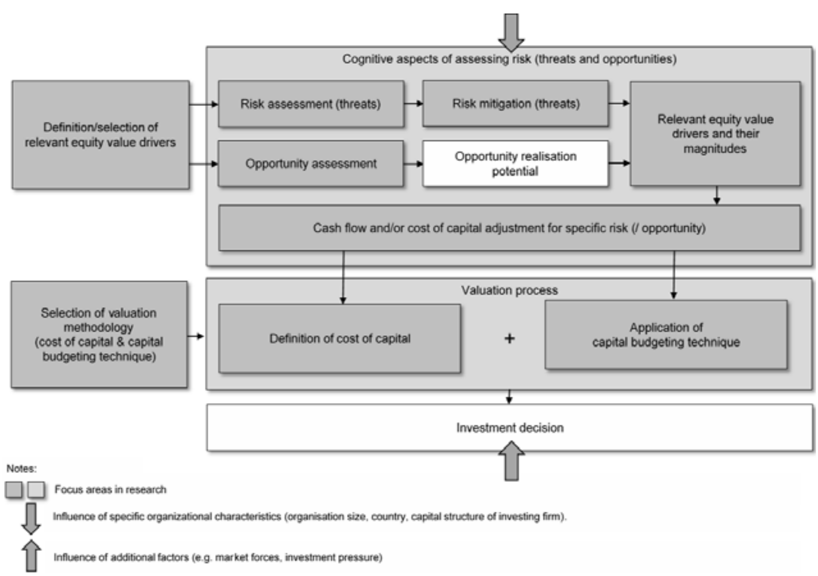
A conceptual framework (Figure 2) has been developed based on the learning's from the performed literature review to trying to understand how valuation is performed in practice, from a process point of view, and what determinants are relevant. This framework forms the basis for ultimate investment decisions as a function of the following: the definition of the relevant equity value drivers; a risk and opportunity assessment; the risk mitigation and opportunity realisation potential; the expected return [cost of capital (CoC)]; the chosen valuation methodology, as illustrated in Figure 1; and the corresponding adjustment possibilities for remaining business risks and opportunities. It also considers a variety of potential influence factors, which are mainly considered from a cognitive perspective. The framework serves as a scheme to develop the online questionnaire and the interview protocol.

Figure 1 Overview of the different DCF based methods



Source: Adopted from Steiner and Wallmeier (1999) and Schultze (2003)

Figure 2 Conceptual framework about valuation and its possible influence factors, based on literature review



Note: Author's own illustration

Source: Hürlimann and Bengoa (2017)

The following research questions (RQs), derived from the literature review and theoretical analysis, are addressed in line with an explanatory, sequential, MMR approach (Creswell and Plano Clark, 2018), including both quantitative (QUAN) and qualitative (QUAL) phases, which are then combined and integrated into the inference (INF) phase:

RQ1 What are the risk components to be considered, and how are they prioritised, processed and affected in the valuation of RES-E investments? [QUAN]

RQ2 What valuation techniques are applied in RES-E investment transactions, and what organisational characteristics influence these application choices? [QUAN]

RQ3 Why are certain methods applied in practice, and what deficiencies are encountered in valuation processes within RES-E investment transactions? [QUAL]

RQ4 What improvements in valuation can be introduced in practice to receive more adequate valuation results for RES-E transaction purposes? [INF]

3 Methodology

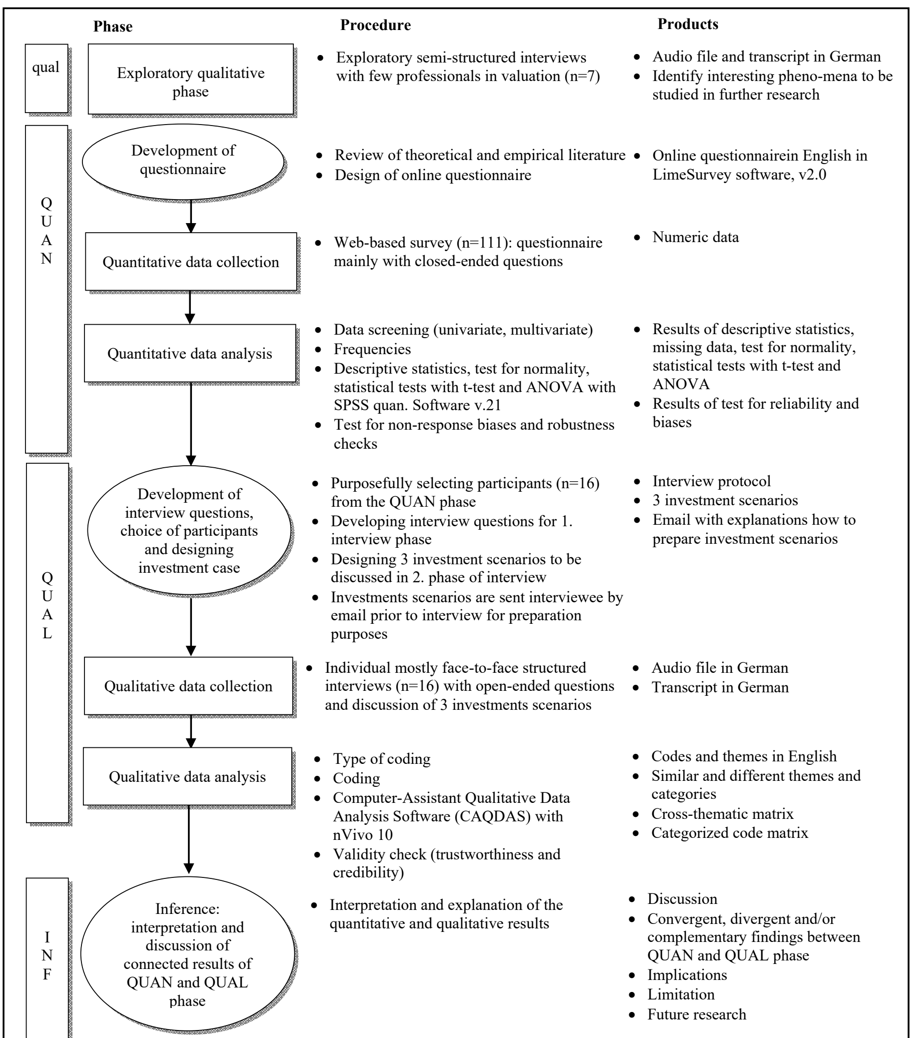
3.1 Study design

To answer the research questions, the researchers applied an MMR approach, which 'is an intellectual and practical synthesis based on qualitative and quantitative research; it is the third methodological or research paradigm (along with qualitative and quantitative research)' [Johnson et al., (2007), p.129]. Mixed-methods research is an approach for collecting, analysing and mixing both quantitative and qualitative data and analysis results at some research stage within the same study (Creswell, 1999; Creswell et al., 2003; Teddlie and Tashakkori, 2009; Creswell and Plano Clark, 2018).

The rationale for mixing both types of data is that neither type alone is sufficient for capturing the details of the studied phenomena, including the complexity and dynamics of valuation within transactions. The integration of data and analysis into MMR includes the combination of those elements in such a way as to not only optimally answer the research questions, but also achieve the project goals, thereby generating findings that are greater than the simple sum of MMR's single components (Bazeley, 2010) and providing a more complete picture of the research problem (Greene et al., 1989; Tashakkori and Teddlie, 1998; Johnson and Turner, 2003). The integration is not just a simple combination of qualitative and quantitative methods' […] they may indeed be more deeply intertwined' [Kane and Trochim, (2007), p.177] and this' […] frequently results in superior research' [Johnson and Onwuegbuzie, (2004), p.14]. Furthermore, the purpose of conducting an MMR approach (Saunders et al., 2009) is to apply an enhanced data collection procedure in order to gather data from a rich set of available sources, including a survey and subsequent interviews in this research. The use of follow-up interviews after responses to structured surveys is one of the most common data-gathering strategies applied within MMR (Bryman, 2006). A detailed outline of why and how to apply MMR is provided in supplementary materials.

Applying an explanatory, sequential, MMR design (Creswell et al., 2003; Hanson et al., 2005; Teddlie and Tashakkori, 2009; Creswell and Plano Clark, 2011), the research consists of four distinct, consecutive phases. The study began with initial exploratory interviews (qual phase). Then, the quantitative data collection (*QUAN phase*) took place; it is based on an online survey to examine which concepts from finance theory are applied, in relation to demographic data and/or other independent variables, to be subsequently evaluated with a quantitative data analysis based on statistical methods, as published in Hürlimann et al. (in press) (Section 4.3). The data collection of the subsequent qualitative phase (*QUAL phase*) was conducted as a follow-up to the QUAN phase on a more detailed level. This was done to help to explain the QUAN results and to explore additional issues and possible areas for improvement within the valuation of RES-E investments, being qualitatively analysed through a content analysis (Section 4.4). The inference phase (*INF phase*) followed as the final research phase (Section 4.5).

Figure 3 A procedural diagram about the various research activities with the applied explanatory sequential mixed-methods research approach



Source: Adopted from Ivankova and Stick (2007) and Moubarac et al. (2012)

Based on the notification system of Morse (1991), this study is termed a *qual → QUAN → QUAL → INF* research approach, where the applied sequence is demonstrated by arrows, and the primary research phases are indicated in capital letters. The initial *qual phase* explores the topics and forms an initial triage of interesting research questions (Figure 3). The subsequent *QUAN phase* presents an overview of the applied valuation methods in RES-E investments, demonstrating the differences based on organisational characteristics, while the *QUAL phase* provides the opportunity to dig dipper into the topic with thoroughly selected experts in the research field for the following purposes: to explain the results from the previous part; to receive a more profound understanding of the topic; and to discuss key value drivers, deficiencies, issues and possible steps for improvements. As such, the *qual* and *QUAN* phases inform the subsequent phases and the research questions, as outlined by Creswell and Plano Clark (2018). The primary QUAN and QUAL phases have equal priority in this research, as is evident by the use of capital letters for both. These two phases connect for the first time at the point when the interviewees are selected from the survey participants (Section 4.2). However, the INF phase, which is a primary point of integration within this research – indicated by capital letters – is the stage in which the connected outcomes of both previous phases are discussed and interpreted (Section 4.5).

3.2 Target population and sample

The target population in this research consists of active participants in the RES-E investment market in Switzerland and Germany who can invest both locally and globally. They are composed of equity investors in RES-Es, such as utilities, independent power producers (IPPs), project developers, fund managers, other financial investors and financial advisors exclusively mandated by investors, as well as debt financing institutes, i.e., banks, to obtain interesting insights and opportunities to compare with – even if questions of discount rate are difficult for banks to answer. All professionals hold senior positions within their organisations and are involved in multimillion-euro RES-E investment projects.

In the case of the initial qual phase, seven experienced professionals in valuation were purposively selected. For the QUAN phase, there was no need to create a sample for Switzerland, since the majority of the concerned population is known to the research team. In contrast, a study of the whole concerned German population would be impracticable and time consuming, and it would overrun the research budget, making sampling compulsory. Since an accurate probability determination of the selected participants was not possible, 'stratified random sampling' [Saunders et al., (2009), p.22] was applied to the German population in the QUAN phase. The sample was built by consulting the participant lists of several major RES-E conferences in Germany and social media platforms, complemented with snowball techniques based on the survey participants' networks. For the QUAL phase, 16 participants were purposefully selected to best match the criteria of the chosen MMR approach, to best answer the stated research questions and to provide necessary explanations for the QUAN results (Creswell and Plano Clark, 2018). The sample size was defined and reached in accordance with recommendations for the optimal participant numbers in purposive sampling and with the achievement of data saturation (Kuzel, 1992; Luborsky and Rubinstein, 1995; Guest et al., 2006; Mason, 2010; Fusch and Ness, 2015). In line with the requirements of the selected typology, namely the *explanatory, sequential, MMR approach*, the participants for the QUAL phase were identified from the pool of participants of the previous QUAN phase (Plano Clark and Ivankova, 2016; Creswell and Plano Clark, 2018). This was done by adopting 'heterogeneous sampling' [Saunders et al., (2009), p.239] whilst ensuring ethical and data privacy requirements in case of matching participants and their data between the different phases (Bazeley, 2010).

3.3 Quantitative phase

3.3.1 Data collection

For the data collection of the primary QUAN phase, an initial questionnaire was created based on the extensive literature review (Hürlimann and Bengoa, 2017) and findings identified in an exploratory interview phase (qual phase). It includes questions asked in the famous studies of Graham and Harvey (2001) and Brounen et al. (2004), since their questions and applied answer scales have proved their validity. However, each of the posed questions was adjusted and/or extended to match them to the research field. This survey was piloted with five experts in the research field and three scholars, all of whom provided valuable feedback that led to clarifications, a simplification of questions and the inclusion of additional brief explanations for certain questions.

The final questionnaire was prepared in English and sent to Germany and to all three language areas of Switzerland as an online survey, running on the LimeSurvey software. The developed online survey is composed of five groups of mainly closed-ended questions. First, general questions about RES-E investments were asked, including those regarding invested countries, technologies and entry phases in investment. The second group poses questions about risk, including the relevance of risk components in RES-E investments, materialisation and the mitigation of risk. Third, questions about how risk, return and its trade-off are understood within the organisations were asked. Finally, capital budgeting techniques were investigated, followed by questions about estimating the CoC, before concluding the survey with demographic and control questions. The answer options for those questions are usually Likert-type scales, expect for the assessment of risk mitigation and the adjustment for risk. We sent 328 questionnaires to Swiss and German investors in RES-E projects, and we obtained 111 responses. The overall response rate is then 32.8%, which is considered to be high, given the length and depth of our questionnaire; the required time to be able to seriously answer the stated questions, which were, in some cases, rather complex; and the restriction of some investment firms to participate for confidentiality reasons.

The exploratory interviews and the survey piloting were performed between April and September 2015, and the subsequent online survey occurred between December, 2015 and March, 2016.

3.3.2 Data analysis

The collected survey data were quantitatively analysed with parametric statistical tests, such as a univariate analysis of variance (ANOVA) and an independent samples t-test, using IBM SPSS statistics. The purpose of these analyses is to assess the significance of the empirical data about the applied valuation methodologies, the risk factors and their priorities, and other dependent variables in relation to demographical and organisational factors. In addition, non-response bias and the robustness of the results were checked with additional statistical tests, including the Pearson $\chi2$ test and Cronbach's alpha. The performed analyses reveal acceptable to good reliability, except for the group of questions about assessing general risk categories with low internal consistency, in contrast to the credible results about assessing single risk components.

3.4 Qualitative phase

3.4.1 Interview protocol development

For the primary QUAL phase, the content of the interview protocol is informed by the results of the previous QUAN phase. The object of the QUAL phase is to explore and elaborate on the statistical results (Creswell et al., 2003), the reason that certain methods are applied, the encountered deficiencies and subsequently possible improvements in valuation, as well as to search for explanations for specific QUAN results. The interview is structured as

1 a classic, semi-structured/unstandardised interview (David and Sutton, 2011)

2 a discussion of investment scenarios (Section 4.4.2).

The first interview component is based on a predefined list of open-ended questions, which contain themes to be covered during the interview, and the particular interview can be adjusted to both the organisational context and the course of the conversation by focusing on certain themes, omitting certain questions or changing the order of the questions (Saunders et al., 2009). To reflect the main results of the QUAN phase with the interviewee, five questions explore extra features and potentially controversial topics in capital budgeting methods and CoC approaches. Three additional questions explore the influence of uncertainty/risk, risk assessment and risk mitigation, and their integration into valuation and/or investment decisions. A specific question aims to understand the puzzling result from the QUAN phase about the risk component assessment in relation to project stages. Further questions investigate the effect of additional influence factors[8]– apart from organisation type, size, leverage, stock exchange listing and project stages asked in the QUAN phase – such as an existing portfolio of the investment company and the integration of synergies and/or opportunities within valuation and/or investment decision making. The last group of questions aims to find encountered problems in valuation processes. In this way, the issue of having the time value of money and the risk in one input variable, namely the discount rate, applied within valuation is presented and discussed, and the CE approach is introduced as a possible theoretical solution for this issue.

3.4.2 Investment scenarios

To collect an additional, rich set of data and even deeper insights into the topic, as well as to triangulate the answers of the first interview phase, the second interview part assesses the interviewees' judgements and decisions regarding three investment scenarios based on real investment cases. To challenge the interviewees' decisions and thoroughly explore valuation approaches in RES-E investments, three similar investments are presented. Prior to each prearranged interview appointment, the interviewee received an email with a description of the investment scenarios and some questions as preparation for the interview. The investment scenarios are based mainly on numerical key figures (descriptions and input data for the valuation) and the numerical results of the performed valuation based on the various methodological approaches (Appendix A1).

3.4.3 Data collection

The qualitative data collection was performed mainly (87.5%) via face-to-face interviews to gather the richness of each dialogue. This collection involved the following stepwise procedure:

1. providing each participant with a written declaration about ensuring data protection and anonymity prior to starting the interview
2. audio-taping each interview, which lasted approximately 50 to 70 minutes
3. a professional bureau transcribing the interviews verbatim, using the same transcriber, who is literate in financial matters, for all interviews
4. the main researcher checking the quality of each transcription, compared with audio material
5. uploading transcriptions to computer-assistant qualitative data analysis software (CAQDAS) to perform a content analysis, enriched with additional, collected demographic data, such as the type of investor, the highest education level and experience in transactions (amount and years).

3.4.4 Qualitative analysis

The applied qualitative data analysis goes a step further than merely sorting text responses to particular questions by a categorical variable with a spreadsheet and finding, for example, interesting quotes to be cited. Using CAQDAS, an optimal structural environment is provided to analyse complex responses in the most flexible way, thereby enabling detailed coding and even revised coding to additional categories while digging deeper into the responses (interview transcripts), allowing new and finer categories to emerge to be coded on and revealing new insights and concepts (Bazeley, 2010). A multiple coding process with an equilibrium between different coding types, including both manifest and latent as well as systematic and axial coding, has been applied in prior studies (e.g., Miles and Huberman, 1994; Ferraris et al., 2017). The CAQDAS enables "a richer and potentially more valid analysis […]. Variations in responses can be better understood, and anomalies and alternative explanations examined" [Bazeley, (2010), p.438]. The applied CAQDAS in this research is nVivo10, which is used for data storage, coding to both predefined and emerging categories, and the development of themes (Bazeley, 2010; David and Sutton, 2011).

The findings of the QUAL phase are illustrated in two-dimensional matrices (Table 4 to Table 9). They show the complete outcomes about the detected common themes and similarities, being able to present whether mutual applications are applied by the same participants, with regard to the answers of each of the QUAL participants. Here, only the main findings are discussed. Detailed findings, including illustrative quotes from the participants, are available in supplementary materials.

3.5 Inference phase

As outlined in Section 4.1, the final research phase of integrating, interpreting, explaining and discussing the connected results of the QUAN and QUAL phases is regarded as the primary stage of integration in this study. This stage is also referred to as the *inference* (INF) phase. Furthermore, it is regarded as *primary* because it delivers the main research outcomes. Due to the chosen explanatory research purpose, it is key that, within the integration process and the interpretation of the inference outcomes, the QUAL phase provides additional explanations and is able to increase and deepen knowledge about the found results of the previous QUAN phase.

Apart from providing explanations, three possible outcomes can arise when integrating the results of the QUAN and QUAL phases (Chesla, 1989; Erzberger and Prein, 1997; Erzberger, 1998; Kelle and Erzberger, 1999; Erzberger and Kelle, 2003):

1. Convergence of results, i.e., the QUAN and QUAL results lead to the same conclusions.
2. Complementary results, i.e., the QUAN and QUAL results supplement each other.
3. Divergence of results, i.e., the results of the QUAN and QUAL phases are divergent and contradictory.

3.6 Quality, validation and credibility of research

Ensuring the quality of the performed MMR is a key topic in studies, as Curry and Nunez-Smith (2015, p.183) noticed: 'It is essential that the chosen study design is well suited to generate quantitative, qualitative and integrated data that are directly relevant to answering the study questions'. Quality also refers to validation processes ensuring the rigor of the applied methodological procedure (Plano Clark and Ivankova, 2016). In other areas of assessing and ensuring the MMR quality, there are various debates amongst scholars, such as the way in which a quality assessment should be performed (Bryman et al., 2008) and whether quality assessment standards or the time in the research to perform quality assessments should be defined (Creswell and Plano Clark, 2011; Plano Clark and Ivankova, 2016). Within MMR, scholars (Dellinger and Leech, 2007; Greene, 2007; Teddlie and Tashakkori, 2009; Creswell and Plano Clark, 2011) agree that the quality of each strand directly affects the quality of the inferences. As such, a recommendation is to assess the quality of the research –the data and results of the quantitative and qualitative phases – with the typical processes applied for each of those two strands as the basis for reaching a high quality of the inferences (Greene, 2007; Teddlie and Tashakkori, 2009; Creswell and Plano Clark, 2011; Curry and Nunez-Smith, 2015; Ivankova, 2015). In addition to differentiating between the quality standards applied in the quantitative and qualitative phases, Greene (2007) suggests assessing the quality of the inference phase separately. Moreover, the approaches to ensure MMR quality are directly interlinked with decisions about defining the MMR design and processes (Plano Clark and Ivankova, 2016). As such, three interlinked levels are differentiated within MMR quality assessments: the quality of

1. the individual quantitative and qualitative stands
2. the generated inference

3 the specifically applied MMR design, its features and implementation (Plano Clark and Ivankova, 2016).

These lead to the development of a straightforward quality assessment framework, as presented in Table 2.

Table 2 Quality assessment framework within this MMR

Phase and/or level	*Approach*	*Brief description*	*Source*
1a: Quantitative strand	Established statistical methods to ensure internal (causal validity) and external validity (generalisation)	• Choice for powerful and robust methods, including Chi-square-test, t-test and ANOVA, test for type I error, test for various bias types • Checking for threats in terms of internal and external validity	Ivankova (2015) and Plano Clark and Ivankova (2016)
1b: Qualitative strand	Ensuring trustworthiness and credibility to ensure internal (causal validity) and in particular descriptive, interpretive and theoretical validity	• Checking for threats in terms of internal (and if possible external) validity • Ensuring consistency, transparency and authencity in coding with only one transcription expert and the researcher's personal coding (descriptive validity) • Ensuring trustworthiness and credibility with appropriate strategies including data triangulation and peer debriefing (interpretive validity) • Ensuring plausible data analysis outcomes by the researcher's developed theoretical concepts. This is ensured by discussing the found results rigorously with the available literature. (theoretical validity)	Lincoln and Guba (1985), Maxwell (1992, 1996), Onwuegbuzie and Johnson (2006), Bazeley (2010), Creswell and Plano Clark (2011), Ivankova (2015) and Plano Clark and Ivankova (2016)
2: Inference	Integrative framework for inference quality	• Ensuring inference quality by engaging in dialogues with stakeholders, such as practitioners, and by rigorously judging how inferences contributes to an improved understanding of the research topic in literature and practice • Continuous evaluation of applied procedures with feedback loops to ensure the consistency of research objectives and the outcomes of the inferences. • Application of coding software to facilitate the integration, coding and interpretation process (overall quality)	Onwuegbuzie and Johnson (2006), Greene (2007) and O'Cathain (2010)

Table 2 Quality assessment framework within this MMR (continued)

Phase and/or level	*Approach*	*Brief description*	*Source*
3: Design and implementation	Emphasis on the consistency of the applied methods and processes with the research design	Design and implementation quality is ensured with • Design suitability • Design fidelity • Within-design consistency • Analytical adequacy • Justification for the design choices and transparency how to perform the research (planning quality) • Performing rigorous data collection and analysis procedures	Teddlie and Tashakkori (2009), Creswell and Plano Clark (2011)

4 Results and findings

4.1 Quantitative phase

This section contains a summary of the performed research – the detailed results of the QUAN phase are published elsewhere (Hürlimann et al., in press).

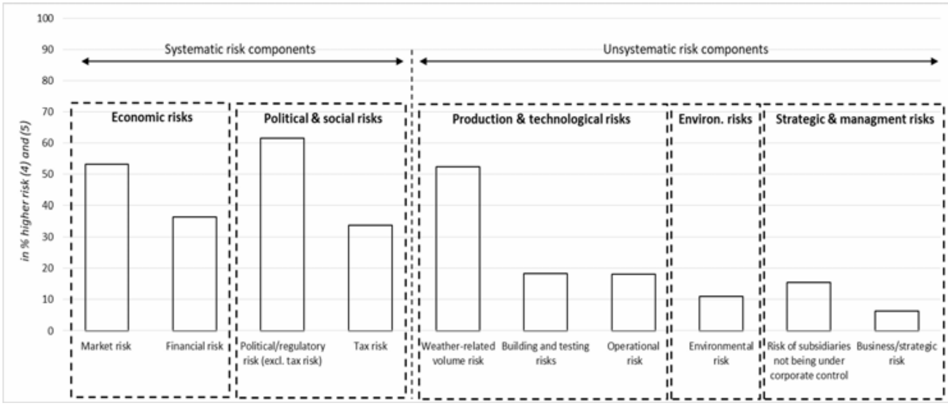
4.1.1 Demographic information

Most participants in the survey are from Switzerland (68%), and the remaining 32% are from Germany. Power utility companies have the highest survey participant numbers (43%), while financial advisors (8%) and banks (5%) comprise the lowest number of survey participants. In addition, the survey sample consists of more small organisations[9] (58%), and onshore wind is the main investment technology focus (41%).

4.1.2 Assessment of risk components

The results (Figure 4) demonstrate that three risk categories are considered to be the riskiest in RES-E investments: political/regulatory (61.5%),market risk (53.2%) – both of which are systematic risks – and weather-related volume risk (52.3%), which is an unsystematic risk that can potentially be decreased with appropriate diversifications (Hürlimann and Bengoa, 2017). The results are quite homogenous if examining the responses conditional on the firm's characteristics and domicile. Significant differences were found in tax risk, in relation to organisation types (utility and institutional investors with higher ratings); in political/regulatory risk, which the German sample considered to be more severe; and in weather-related volume risk, which low leveraged companies and firms not listed on the stock exchange assessed as riskier. Listed companies considered operational risk to be significantly higher. Furthermore, the results indicate that, in many cases, risk categories were scored as riskier if participants reported that the same risk had already materialised in their RES-E investments.

Figure 4 QUAN results about assessment of risk component[1] in RES-E investments, illustrated in relation to systematic and unsystematic risk



Note: [1]Answer options: scale of 1 to 5 (risk rating: 1 meaning very low risk, 5 meaning very high risk).

Source: Adopted from Hürlimann et al. (in press)

4.1.3 Managing for risk

Risk mitigation measures – essential procedures during project valuation and investment transactions – were evaluated. The majority of the respondents perform internal and external due diligences (83.0% and 75.0% respectively), reduce operational risks with appropriated maintenance contracts (81.0%), arrange for machine failure insurances (69.0%) – in contrast to less frequently applied weather protection insurances (9.0%) – reduce market risks with feed-in tariffs or long-term power purchase agreements (68.0%) and standardise procedures (62.0%). The results reveal that there is a change of behaviour when considering, refusing, reacting to and mitigating potential risk if risk materialisation has been experienced.

Apart from avoiding and transferring risk during risk mitigation processes, the alternative option with risk adjustment in project valuations is done either within the applied discount rate for DCF-based methods (44.6%) or directly within the appropriate case flows (34.0%) and then by a risk adjustment of both cash flows and discount rates (21.4%). The application rate differs between the two options depending on the considered risk component.

4.1.4 Valuation techniques

The results (Table 3) indicate that most respondents select an internal rate of return (IRR) and/or an NPV as the most frequently applied capital budgeting technique (92.7% and 70.8% respectively). This also demonstrates the popularity of both equity and project return rates (65.0% and 62.7% respectively) and the hurdle rate concept (63.9%). Furthermore, the payback period (PB) method is still widely applied (44.4%); this is an interesting and controversial result that is investigated in more depth in the QUAL phase (Section 5.2.4). As most popular basic approaches to determine CoC, the weighted average cost of capital (WACC) of their company (67%), that discount rates are at least as high as defined hurdle rates (59.0%) and formal risk analysis (57.3%) are predominantly applied. More particularly, most participants define a specific discount rate for the considered country (65.9%), the applied technology (60.0%) and/or the considered project stage (52.2%). A scenario analysis and a sensitivity analysis are the primary risk assessment approaches within RES-E investments (79.4% and 75.7% respectively).

Table 3 Summary of the quantitative results of capital budgeting techniques, CoC approaches and risk assessment procedures

Techniques	*% almost always (4) and always (5)*[1]
Capital budgeting techniques	
Internal rate of return (IRR)	92.4
Net present value (NPV)	79.8
Estimate cost of equity capital of project (equity return rate)	65.0
Hurdle rate of return	63.9
Estimate total cost of capital of project (project return rate)	62.7
Payback period (PB)	44.4
Basic approach to determine cost of capital (CoC) or discount rate	
Weighted average cost of capital (WACC) of our company	67.0
Discount rates are at least as high as defined hurdle rates	59.0
Formal risk analysis	57.3
Benchmarking approaches with comparable companies or comparable investments	43.2
Capital asset pricing model (CAPM, the beta approach)	35.3
Certainty equivalent (CE) approach	9.2
Specific approach to determine cost of capital (CoC) or discount rate	
A specific discount rate for the considered country (country discount rate)	65.9
A specific discount rate for the applied technology/concerned industry	60.0
A specific discount rate for the concerned project stage (e.g., planning/designing, financing, building, operating)	52.2
A risk-adjusted discount rate for this particular project (RADR concept)	44.4
Risk assessment approaches	
Scenario analysis (e.g., base case, worst case, best case)	79.4
Sensitivity analysis	75.7
Simulations (e.g., Monte Carlo simulations)	12.2

Note: [1]Answer options: 1 = never; 2 = Almost never; 3 = Sometimes; 4 = Almost always; 5 = Always.

Source: Adopted from Hürlimann et al. (in press)

4.2 Qualitative phase

4.2.1 Investment scenarios

The discussion of real investment scenarios during the interviews proved to be a valuable approach for revealing key insights (Table 4). All participants actively and even enthusiastically engaged in this part of the study, presumably because they felt highly confident in this area, which is similar to the valuations they perform at work. The outcome of the discussion regarding the investment scenarios was successfully used to triangulate the findings of the first interview component with the open-ended questions, as presented below.

Table 4 Categorised code matrix with the findings about the applied valuation methods, found in the discussion of the provided investment scenario

No.	*Themes/categories*	*Participant no.*															
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
1	Internal rate of return (IRR) approach	+	+	+		+	+/–	+	+	+	+	+	+	+	+	+	+
2	Net present value (NPV) approach		–				+/–			–			–				+
3	Equity return rate	+	+	+	+	+	+	+	+	+	+	+/–	+	+	+	+	+
4	Project return rate/total cost of capital	+	+	+	+	–	–	–	–			+	–		–	+	
5	Comparing expected return rate to set hurdle rate	+		+			–			+				+		+	
6	Payback period (PB) method		–	+	+	–	–			+	+				+	+	
7	Certainty equivalent (CE) method	0	–	–	0	0	0	–	–	0	–	–	–	–	–	–	–
8	Profitability index (PI)			0	0		–						–				
9	Multiples, specifically for RE projects		+	+		+/–						+		+/–	+	+	
10	Covenant profile	+	+	+	+				+		+						
11	Distribution profile to equity investors	+								+							
12	Risk assessment (sensitivity and scenario analysis)	+	+	+	+	+		+	+	+	+		+	–	+	+	+
13	Considering opportunities	+	+		+	+		–					+/–			–	
14	Considering synergy potential															–	

Note: + Applied, – not applied; +/–: applied in some cases, sometimes not applied, 0: interesting, but not applied.

4.2.2 Numerical approaches in capital budgeting

Both interview parts clearly demonstrate that the DCF-based approach, in particular the IRR method (Table 5, pt. 2.1) with a leveraged equity return rate (Table 6, pt. 2.1), is the main applied approach in RES-E investments. The related NPV method was reported to be not as suitable as the IRR method for RES-E investments. On the one hand, the calculated discount rate with the IRR method is an optimal approach for communicating with the market (pt. 02.4) and for comparing different investments (pt. 02.6), particularly of various sizes and with regard to a set hurdle rate (a minimal discount rate) (pt. 02.5). The calculated enterprise or equity value with the NPV method, on the other hand, is regarded as more appropriate than the IRR method for the valuation of RES-E projects under development and for impairment tests of operating RES-Es (pts. 02.3, 03.1 and 03.2). Only one participant (pt. 02.2) mentioned issues regarding the consistency and subsequent restriction of the application of the IRR approach, which are also reported in financial theory (Arnold, 2013; Hürlimann and Bengoa, 2017). The majority do not differentiate between the IRR and NPV approaches from a theoretical understanding; instead, they erroneously regard them as the same approach, and they simply start the calculation from different angles. The majority of participants consider the FTE, after having paid all expenses, including debt service expenses and tax, to be a relevant cash flow level in valuation (pt. 04.1), while some consider the entity approach, such as the WACC approach, to be inappropriate (pt. 04.2), since the WACC approach is not able to correctly consider the changing debt structure of a typical, autonomous, financing policy[5]. In addition, the majority of participants consider the distribution potential to the equity investors to be relevant (pt. 05.1), and only one participant reported applying it consistently within valuation processes (pt. 05.2). Several participants mentioned planning the implementation of an *output-IRR* (pt. 05.4); this discounts the distributable cash flows to equity investors after having considered all restrictions due to accounting standards and tax regulations, which consider the repayment potential and the corresponding risk involved in distributing funds. Similarly, approximately one third of the participants consider the simplistic and rather outdated PB approach to be a complementary approach (pt. 06.2), focusing particularly on the period length until the investment is repaid to its investors and subsequently evaluating the *investment repayment time at risk* (Section 5.2.4).

Table 5 Categorised code matrix regarding the application of capital budgeting techniques for valuation of RES-E investments

No.	*Themes/categories*	*Participant no.*															
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
1	Discounted cash flow (DCF)-based approaches																
1.1	DCF as state of the art approach for RE project investment valuation																
1.2	DCF as established method based on agreement between valuation and accounting domain																
1.3	DCF applied for project specific valuation and known project details																
1.4	Different DCF approaches available and applied																

Note: Grey cells: applied/agreed with.

Table 5 Categorised code matrix regarding the application of capital budgeting techniques for valuation of RES-E investments (continued)

No.	*Themes/categories*	*Participant no.*															
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
2	Suitability of IRR																
2.1	IRR as main valuation method	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
2.2	Awareness of restrictions of the IRR method										■						
2.3	IRR not appropriate for project developers					■											
2.4	IRR optimal for market communication					■			■		■	■					
2.5	IRR suitable to compare with hurdle rate	■		■						■			■	■	■	■	
2.6	IRR as optimal tool to compare investments												■	■			
2.7	Transparency of assumption within valuation									■							
3	Suitability of NPV																
3.1	NPV applied by project developers					■	■										
3.2	NPV suitable for impairment tests																■
4	Relevant cash flow levels																
4.1	Focus on equity approach (FTE)	■			■	■			■	■	■		■	■	■	■	■
4.2	Entity approach, such as the WACC approach, not optimal	■		■													
4.3	Combination of equity and entity approach		■	■		■					■						
4.4	Valuating an entity approach with an artificial all-equity-project								■								
4.5	Focus on entity approach, before equity approach											■					
5	Distribution potential to equity investors																
5.1	Distribution potential considered as relevant		■	■		■	■		■	■	■	■	■	■		■	■
5.2	Output-IRR already applied								■								
5.3	Output-IRR calculation is not relevant					■											
5.4	Output-IRR implementation is planned													■		■	■
6	Payback period																
6.1	Known concept	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
6.2	Applied as risk measurement				■	■		■		■	■		■			■	

Note: Grey cells: applied/agreed with.

4.2.3 CoC approaches

Discount rates are considered either as indicators of being compensated for taking risks (pt. 01.2, Table 6) or as measures for defining what can be earned for a comparable project (pt. 01.1), and as market price indicators (pt. 01.03). Some participants stated the necessity of matching the discount rates with the appropriate cash flow streams and their certainty levels (pt. 01.4). Most of the participants focus their valuations on leveraged equity return rates (pt. 02.1), while only one participant computes a virtual, equity-only (or unleveraged equity) return rate to be able to compare investments without valuation distortion by financial leverage effects (pt. 02.2). As an alternative, others focus on the total CoC (or project return rates) to bypass this distortion of the leverage (pt. 02.3).

Table 6 Categorised code matrix regarding the application of CoC approaches for valuation of RE project investments

No.	*Themes/categories*	*Participant no.*															
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
1	Discount rate																
1.1	Discount rates indicate what can be earned in the market for a comparable projects									■							
1.2	Discount rates as indicator for being compensated for taking risk					■	■										
1.3	Discount rates are market price indicators		■														
1.4	Necessity of matching discount rate with certainty level of cash flow streams						■					■					
2	Equity and/or total cost of capital (CoC)																
2.1	Leveraged equity return rate	■	■	■	■	■	■	■		■	■	■	■	■	■	■	■
2.2	Equity-only return rate or unleveraged equity return rate								■				■ **				
2.3	Project return rate/total cost of capital	■ *	■ *	■ *	■ *							■ *				■ *	
3	Setting discount rates																
3.1	Setting discount rates based on theoretical concepts (CAPM, Beta factors and Pure-Plays)											■					
3.2	Setting discount rates based on theoretical concepts (CAPM, Beta factors and indirect approach)											■					
3.3	CAPM is not regarded as applicable for RES-E investments since it ignores relevant unsystematic risks					■	■										
3.4	Setting discount rates with market sounding	■		■		■	■		■			■	■				
3.5	WACC of investing company is not relevant for discount rates setting of RES-E investments	■		■						■	■						

Note: Grey cells: applied/agreed with *encountered while discussing the investment scenarios, **reports observation, i.e., not applied by participant.

Table 6 Categorised code matrix regarding the application of CoC approaches for valuation of RE project investments (continued)

No.	*Themes/categories*	*Participant no.*															
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
4	Hurdle rate																
4.1	Hurdle rate as hard cut-off line	■		■			■					■	■	■			
4.2	Hurdle rate as reference value						■			■ **		■ **			■	■	
4.3	Hurdle rates by country, technology and/or project stages, and/or business units															■	■
4.4	Only one single hurdle rate								■					■			
4.5	Hurdle rate application: equity IRR must be greater than hurdle rate	■		■				■		■ **				■			
4.6	Hurdle rate application: hurdle rate plus puffer													■			
4.7	Hurdle rate set by corporate bond													■			
5	Risk-adjusted discount rates (RADR)																
5.1	RADR as supplementary approach to hurdle rates							■					■				
5.2	Application of RADR instead of hurdle rates									■							
5.3	Necessity to define appropriate RADR for relevant unsystematic risks						■										
5.4	Base with market sounding plus certain risk premiums												■				
6	Static to dynamic discount rates																
6.1	Static discount rate as predominant applied approach					■								■			

Note: Grey cells: applied/agreed with *encountered while discussing the investment scenarios, **reports observation, i.e., not applied by participant.

While defining an appropriate required return rate, hurdle rates and/or RADR are applied. A hurdle rate is stated to be either a minimum discount rate for future acquisitions or a benchmarking or reference value for an applied discount rate.[10] There are various companies that set hurdle rates for different company divisions, and only one company does not define hurdle rates but rather RADR, which considers project-specific risk components. Some participants reported the application of both.

More specifically, it was reported that the setting of discount rates for RES-E investments is based mainly on market sounding (pt. 03.4) without following a specific numerical approach, such as the CAPM. But on the other hand, he CAPM is, in general, still the mostly applied CoC approach in valuation. Having been developed for PTCs, the CAPM focuses only on systematic risk (pt. 03.3) and subsequently ignores unsystematic risks – the latter is, however, specifically relevant for single RES-E investments (Hürlimann and Bengoa, 2017; Hürlimann et al., in press). Nevertheless, as reported, the CAPM with a levered Beta seems to be appropriate for application to defining the equity return rates of RES-E projects with many-year-long production cycles and natural resource experience and therefore low resource uncertainties (pt. 03.1).

In practice, the static discount rate is the predominately applied method within the *simplified FTE approach*, independent of the involved financing policy. There were indications only from one practitioner that different discount rates are applied to specific, distinct periods (dynamic discount rates) for RES-E projects with typically decreasing amounts of debt over time. These findings are contradictory to financial theory, which suggests that to receive consistent results, a dynamic discount rate should be applied in cases of valuations of autonomously financed projects with predefined redemption schedules only – typically encountered in RES-E projects – in contrast to projects with value-oriented financing policies (Hagenloch, 2007; Drukarczyk and Schüler, 2009; Hawawini and Viallet, 2011; Deloitte, 2014; Mielcarz and Mlinarič, 2014). This demonstrates a clear gap between theory and practice. Moreover, none of the participants reported this point as a particular issue, nor did they discuss the application of constant or dynamic discount rates.

4.2.4 Risk consideration in valuation

With regard to considering risk in the valuation of RES-E investments (Table 7), risk mitigation standardises project structures (pt. 01.01), and it is a widely and broadly applied approach in RES-E projects (pt. 01.2). It is regarded as beneficial for valuation purposes because it allows for better planning, and it helps to decrease the complexity within valuation by providing long-term cost reliability for certain components (pt. 01.3). However, risk mitigation also decreases the chance of benefiting from available opportunities. There is no scientific approach to apply risk mitigation measures. As stated, it can also potentially be the root cause of intensive discussions between sellers and acquirers in the case of earn-out[11] models, which are defined in financial transaction documents, since such a provision can be difficult to enforce because many factors can come into play during the earn-out period.

In addition to assessing the way in which valuation adjustments are performed for risk in the QUAN phase (Section 5.1.3), the QUAL phase indicates that the foci of risk adjustment within project valuation are mainly on cash flows (pt. 02.2) and on ensuring high cash flow quality (pt. 02.1). With regard to risk components, natural resources are considered to be some of the main value drivers of RES-E investments (pt. 03.1). Various participants also outlined the necessity of taking into account the time component of risk (pt. 03.2), including the potential temporal shifts in the volatility of the risk magnitude, future changes in encountered risks and the possible emergence of new future risks. Furthermore, they differentiate between unsystematic and systematic risk (pt. 03.3), and they are aware of the diversification potential of unsystematic risk components (pt. 03.4),while a few implement portfolio diversification strategies (pt. 03.5).

For most participants (pt. 04.1), the risk assessment, either with a sensitivity or a scenario analysis, is an integrated method in valuation approaches. The consideration of the repayment potential (pt. 04.2) is widely applied, for instance with a distribution profile or a PB (Section 5.2.2). Only one participant assesses risk with benchmarking approaches (pt. 04.3), while formal risk analyses are not performed by the interviewees (pt. 04.4).

Table 7 Categorised code matrix about risk considerations in valuation

No.	*Themes/categories*	*Participant no.*															
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
1	Risk mitigation in valuation																
1.1	Risk mitigation according project structure standardisation					■								■	■	■	■
1.2	Risk mitigation measures implemented	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
1.3	Risk mitigation is regarded as beneficial for valuation processes					■										■	
1.4	Specific issues with risk mitigation measures within valuations								■		■						
2	Valuation adjustments for risk																
2.1	Focus on quality of cash flows		■		■												
2.2	Risk is predominantly considered in cash flow streams							■	■					■			
3	Risk components																
3.1	Natural resources considered as one of the main value drivers	■ *	■ *	■ *	■	■ *	■	■ *	■ *	■ *			■ *	■ *	■ *	■ *	■ *
3.2	Time component of risk					■		■									■
3.3	Differentiation between systematic and unsystematic risks			■		■	■	■	■	■				■		■	
3.4	Diversification potential of unsystematic risk			■						■						■	
3.5	Portfolio diversification applied				■					■				■			
4	Risk assessment																
4.1	Scenario and sensitivity analysis and simulations	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
4.2	Repayment potential (e.g., distribution profile, payback period)			■	■	■	■	■		■	■		■			■	
4.3	Benchmarking									■							
4.4	Formal risk analysis																
5	Understanding risk and risk preferences																
5.1	Risk-averse investor and focus mainly on down-side risk									■				■			
5.2	Defining risk appetite in executive committees														■		■
5.2	Different risk considerations between seller and acquirer					■											
5.3	Discount rate being compensated for taking risk, but only the ones still available					■											

Note: Grey cells: applied/agreed with.

A few insights into understanding risk and risk preference could be collected. It was reported that the risk a version of investors and a focus mainly on downside risk prevail (pt. 05.1), that applied risk appetite in transactions is defined in executive committees (pt. 05.2) and that sellers and acquirers consider risk differently (pt. 05.3). Furthermore, it was outlined that a discount rate is about being compensated for taking risks, but only those that are still available (pt. 05.4).

4.2.5 Judgmental approaches in valuation processes

In addition to the numeric valuation approaches described in Section 5.2.2, a wide variety of specific judgmental valuation approaches and considerations are taken into account and applied (Table 8). These judgmental approaches consider the assessment of specific factors that are difficult to assess with numerical methods. They are predominantly applied in a complementary way to the numerical approaches and never as sole approaches, and they are detected when comparing the applied judgemental assessments (Table 8, pt. 01.1) to the above-mentioned applied numerical methods (Table 5) of the same participants.

Table 8 Categorised code matrix regarding the application of judgmental considerations (i.e., applied methods and factors considered) in valuation of RES-E project investments

No.	*Themes/categories*	*Participant no.*															
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
1	Evidence for judgmental considerations in RES-E valuation																
1.1	Judgement assessment applied	■	■	■	■	■ *	■ *	■	■	■	■	■ *	■	■	■ *	■	
1.2	No explicit application of qualitative assessment methodology reported									■	■						
1.3	Assessment method for risk and qualitative factors developed		■				■ *		■								
2	Due diligence and transaction process																
2.1	Due diligence results must be available to grasp the investment challenges qualitatively											■ *					
2.2	What-if method applied for assessing due diligence results qualitatively		■														
2.3	Probability of investment success as valuable qualitative information in transactions			■ *	■ *	■ *	■ *		■ *	■ *		■ *	■ *				
2.4	Past experience of sellers and acquirers				■		■			■ *				■			

Note: Grey cells: applied/agreed with; *encountered while discussing the investment scenarios.

(■ = grey cell)

Table 8 Categorised code matrix regarding the application of judgmental considerations (i.e., applied methods and factors considered) in valuation of RES-E project investments (continued)

No.	*Themes/categories*	*Participant no.*															
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
3	Production site and applied technology																
3.1	Quality of resource assessment									■			■				
3.2	Attractiveness of production site and applied technology				■					■	■						
3.2	Attractiveness of production site and applied technology				■					■	■						
3.3	Experience at production site and with type of technology									■				■			
4	Service providers and suppliers																
4.1	Quality of contracts and quality and reliably of partners	■				■*		■		■	■	■					
5	Country risk																
5.1	Assessment approach of country and regulatory risks			■													
6	Financial structure (leverage/gearing)																
6.1	Assessment of return rates in relation to leverage			■													
7	Synergies, upside potential, existing portfolio and diversification																
7.1	Assessment of synergies mainly in the investment screening process		■					■									
7.2	Assessment of synergies in the detailed valuation process possible	■				■							■			■	■
7.3	Assessment of upside potentials (opportunities)	■	■										■	■	■	■*	■
7.4	Experience/influence of existing portfolio														■	■	■
7.5	Influence of diversification	■															

Note: Grey cells: applied/agreed with; *encountered while discussing the investment scenarios.

The discussion of the investment scenario demonstrates that the probability assessment of investment success is used as valuable qualitative information within transactions (pt. 02.3). Past experiences of sellers and acquirers are regarded as crucial within due diligence and transaction processes. With regard to the judgmental assessment of the production, many participants consider the quality of the resource assessment (pt. 3.1), the attractiveness of the production site and applied technology type (pt. 3.2) and the experience at a production site with technology (pt. 3.3) to be key input factors in valuation and investment decision making. Additional judgmental assessments are performed for quality assessment of relevant service providers and suppliers (pt. 04.1), country and regulatory risk (pt. 05.1) and the return rate with regard to the financial structure or leverage (pt. 06.1).

In addition, upside potentials (opportunities) are only considered by a handful of participants (pt. 07.3). Several participants reported that, if necessary, synergy potential can be considered in project valuation, for example at the point of performing investment target screening (pt. 07.1) or by considering the potential positive effects of the targeted project within the existing portfolio (pt. 07.2).

4.2.6 Implementation of alternative valuation concepts

Having discussed alternative concepts for valuation, such as the CE method (Table 9), within the investment scenarios, some of the participants understand the need for improvements. However, they stress the fact that the CE method could not be used as a sole concept in transactions, since both the decision-making body and the seller would not be willing to implement or understand it. Nevertheless, it could be a complementary concept, used internally, to compare different investments and build the basis for investment preferences when valuating several possible investment targets.

Table 9 Categorised code matrix about applying the CE concept

No.	*Themes/categories*	*Participant no.*															
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
1	Certainty equivalent (CE) method																
1.1	Known concept	■			■	■			■			■					
1.2	Critical view		■						■		■		■				
1.3	Regarded as interesting concept	■			■	■	■		■	■							

Note: Grey cells: applied/agreed with.

4.3 Inferences

This section presents the findings from the inference analysis drawn by combing and integrating the two applied primary research phases with regard to the three different outcomes of inferences – convergent, divergent and complementary findings – while also indicating where the QUAL phase provides additional in-depth explanation for the QUAN results.

4.3.1 Inferences within capital budgeting approaches

Convergent outcomes confirm DCF as the main applied method in RES-E investment valuation (pt. 01.01, Table 10). It is complemented with the finding from the QUAL phase that, more specifically, the *simplified FTE approach* (pt. 01.02, Section 5.2.3) is the main accepted method within the RES-E transaction market. It can be regarded as the current *business standard* – a simplification and/or compromise within business – that has been implicitly agreed on between sellers and acquirers. When asked about the issues that are known or encountered within the used valuation methods, most participants did not seem to be aware of the limits and restrictions of this specific DFC method during its application. Other converging results include that FTE and IRR are the preferred methods applied, while new insights emerged regarding the application of a virtual, all-equity case for testing the investment attractiveness (pt. 01.04) and the APV (pt. 01.08) as an optimal and complementary method for impairment tests. As demonstrated in the QUAN phase, the IRR method is more frequently applied than the theoretically more consistent NPV method (pt. 01.05), while both equity IRR and project IRR are relevant, as presented in the QUAN phase, but in variation of their priority, as indicated in the QUAL phase (pt. 01.06). Other complementary results from the QUAL phase revealed that the distribution potential to equity holders should be considered in DCF-based valuation (pt. 01.07), that MAs are applied for initial investment screening and/or a second opinion (pt. 01.09) and that the PB method is particularly relevant for investments in risky countries (pt. 01.10). The QUAL phase proved to be worthy of being the optimal research approach for investigating the application possibility of the promising CE method in more depth (pts. 01.11 and 01.12), providing additional explanations for how to apply it. The QUAL results demonstrate that investors increase their know-how by performing ex-post valuations of previous investments (pt. 01.13).

Table 10 Inference findings of numerical capital budgeting techniques, CoC approaches and risk assessment, risk mitigation and adjustments for risk in RES-E investment valuations

No.	*Statement*	*Applied inference rule*	*Additional explanation by QUAL phase*
1	Applied capital budgeting techniques/approaches for RES-E investments		
1.1	DCF is the main method applied for RES-E investments since it is the accepted method in transaction by sellers and acquirers	Convergence	-
1.2	More specifically, the simplified FTE approach is the main DCF method applied for RES-E investments accepted by the transaction market	Complementary	Additional explanation
1.3	Flow to equity (FTE) method is the preferred DCF method for RES-E investments	Convergence	-
1.4	A virtual all-equity case is applied for testing project attractiveness	Complementary	-
1.5	Within the FTE method, IRR is more frequently applied compared to NPV	Convergence	-
1.6	Both equity IRR and project IRR are relevant, but in variation of their priority	Convergence and complementary	-
1.7	Distribution potential to be considered in DCF based valuation	Complementary	-
1.8	APV approach is suggested as an optimal and complementary method for impairment test	Complementary	-
1.9	Multiples are applied for initial investment screening and/or second opinion	Complementary	-
1.10	Payback period method is only relevant for investment in risky countries	Complementary	-
1.11	Certainty equivalent method is almost unknown/not used	Convergence	-
1.12	Certainty equivalent method might be a complementary, valuable concept in valuation	Complementary	Additional explanation
1.13	Increasing know how of investors by performing ex-post valuations of previous investments	Complementary	-

Table 10 Inference findings of numerical capital budgeting techniques, CoC approaches and risk assessment, risk mitigation and adjustments for risk in RES-E investment valuations (continued)

No.	*Statement*	*Applied inference rule*	*Additional explanation by QUAL phase*
2	Cost of capital (CoC) or discount rate		
2.1	CAPM applied as basic concept for defining the expected return rates	Convergence	-
2.2	Using CAPM with a pure-play Beta factor might become interesting in the future as soon as more RES-E portfolios (preferably differentiated by technology) are traded on stock exchanges	Complementary	Additional explanation
2.3	WACC is still a principle technique to determine CoC requirements	Divergence	Additional explanation
2.4	Unsystematic risk are relevant in setting required return rates	Convergence	-
2.5	Hurdle rates are widely applied in CoC processes	Convergence	-
2.6	Required return rates are compared to the market	Convergence	-
2.7	Return rate requirements/hurdle rates are often distinguished between countries, technologies/industries and sometimes also project stages	Convergence	-
2.8	Sellers often set discount rates depending previous transactions and/or information from a market sounding to maximise profit	Convergence	-
2.9	Required discount rates are set in relation to exit strategies in case of investors with a defined investment period	Complementary	Additional explanation
2.10	Setting required return rates/hurdle rates are predefined by central organisation	Complementary	Additional explanation
2.11	Both equity return rates and project return rates are applied, but in different frequency in Germany and Switzerland	Convergence	-
2.12	Application of project specific RADR	Convergence	Additional explanation
3	Risk assessment, mitigation and adjustment		
3.1	Political/regulatory, market and weather-related risk are the key risk components in RE investments	Convergence	-
3.2	Risk assessment of different risk components in relation to project stages	Complementary	Additional explanation
3.3	Risk mitigation measures are widely applied and have to be considered in valuation	Convergence	-
3.4	Adjustment for risk in valuation processes is widely applied, considering systematic and unsystematic risk components	Convergence	-
3.5	Risk attitudes and/or individual risk preferences are clearly influenced by having experienced materialisation of the same risk, being influenced with the prevailing risk-aversion of the investors with their main focus on securing downside risk	Complementary	Additional explanation
3.6	Scenario and sensitivity analysis are mostly applied, simulations less frequently, but more often by Germans	Convergence	-

In the case of judgemental considerations in capital budgeting approaches, the QUAL phase provided particularly valuable insights in the form of complementary findings (Section 5.2.5),which would have been almost impossible to collect in a quantitative phase.

4.3.2 Inferences with CoC approaches

Although the findings between the QUAN and QUAL phases regarding the application of the CAPM in CoC approaches in RES-E investment valuations are, in general, considered to be convergent (pt. 02.01, Table 10), a more in-depth analysis in the QUAL phase revealed that most interviewed participants are not involved in setting required return rates and eventually applying the CAPM. Some of them are not even well-versed in how to apply the CAPM and what its features and restrictions are. As complementary findings, there are some QUAL phase participants who reflected on the application of the CAPM and suggested deriving a pure-play beta factor (Section 5.2.3) based on corresponding traded securities on stock exchanges (pt. 02.02). Convergent findings were detected for the relevance of unsystematic risk components in setting discount rates in RES-E investment valuations (pt. 02.04). In the QUAN and QUAL phases, it was found that hurdle rates are widely applied in CoC processes (pt. 02.05),and a complementary finding from the QUAL phase is that the required return rates or hurdle rates are predefined by a central organisational department (pt. 02.10). Both equity return and project return rates are applied, while cultural differences are found in their application rates (pt. 01.11). Additional convergent results were found for the application of RADR while providing additional explanations for how to apply it (pt. 01.12).

The application of the WACC approach in RES-E investments provides a differentiated picture (pt. 02.03). On the one hand, many corporate on the buying side consider it to be a principle technique, not to set a company-wide required return rate, but rather as a basis to derive return rate requirements or hurdle rates that are distinguished between countries, technologies/industries and sometimes also project stages (pt. 02.07). On the other hand, some participants, in particular many sellers reject the WACC concept for setting required return rates, hurdle rates or RADR (divergent finding). Instead, they propagate the idea of defining CoC requirements without referring to the acquirer's WACC, as finance literature proposes (Hürlimann and Bengoa, 2017), by considering the results from previous transactions, performing market sounding (pt. 02.08) and/or taking into account the exit strategies that are already present at the time of acquisitions (pt. 02.09).

4.3.3 Inferences within risk assessment, risk mitigation and adjustments for risk

Convergent findings between the QUAN and QUAL phases were found for the relevant risk components in RES-E investment valuations (pt. 03.01,Table 10) and the wide application of risk mitigation measures (pt. 03.03). Similarly, in the case of adjustment for risk (pt. 03.04), a scenario and sensitivity analysis, and simulations (pt. 03.06), no contradictions to the QUAN outcomes were encountered during the QUAL phase. Moreover, the QUAL phase provided complementary, explanatory results (pt. 03.02) for the puzzling QUAN results regarding the risk assessment outcomes for the different risk components in relation to project stages: the QUAN results of the risk component assessment in relation to the different project stages must be understood as a comparison between the considered risk component and other relevant risk components in the concerned project stage. In other words, the relevance of a considered risk component (e.g., natural resources) can change due to the elimination of other risk components from one stage of a project life cycle to another (e.g., from green field to ready-to-build phase), even if the relevance of the considered risk component should objectively remain equal. While the QUAN phase indicates that risk attitudes and/or individual risk preferences are clearly influenced by having experienced materialisation of the same risk, the QUAL phase complements this result and provides a possible explanation for the prevailing risk-aversion of the investors, with their main focus on securing downside risk (pt. 03.05).

5 Conclusions and outlook

5.1 Discussion of the results

In assessing risk and the corresponding adjustments in valuation, the QUAN results demonstrate that both *systematic* (with political/regulatory risk due to the high exposure of government-guaranteed, predominantly issued feed-in-tariffs to RES-E-based generation units, and with market risk) and *unsystematic* risk components (with weather-related volume risk) are key value drivers, as McMahon and Stanger (1995) and Damodaran (2012) proposed. Adjustment for risk in valuation is as common in RES-E investments as it is in other sectors (e.g., Payne et al., 1999; Gitman and Vandenberg, 2000; Graham and Harvey, 2001; Brounen et al., 2004). The ranking of relevancy for such adjustments is specific to each sector; in RES-E investments, this ranking isled by market risk, followed by weather-related volume risk, operational risk, interest rate risk and political/regulatory risk. Adjustment for risk is mainly conducted in project cash flows, except for political/regulatory risk, which is predominantly adopted in the discount rate.

Clear evidence is found regarding participants' experience in *materialised risk*, which influences their subjective risk perception and increases risk awareness, as Baumann and Sims (1978) also reported for certain climate risk. This in turn translates into a higher frequency of employed risk mitigation measures, supported by the findings of Botzen et al. (2009), and of adjustments for risk in valuation. Even though all concerned participants and entities are objectively exposed to risk (Petrolia et al., 2013), risk assessment, risk mitigation processes and valuation adjustment for risk remain subjectively affected due to the involved judgmental considerations. Having said that it can be demonstrated that risk assessment with prioritisation of different risk components for a particular object and time or stage is always set in relation to the other available and known risk components.

The findings also indicate that valuation and pricing mainly consider risk components with knowledge of the probability of the risk occurring and/or the consequences. Valuating and pricing *latent uncertainty* with no knowledge of probability and consequences or with high improbability is hardly ever performed, i.e., strictly latent uncertainty does not seem to be compensated for by the financial market. Moreover, it can be concluded that experiencing and perceiving risk are crucial within valuation processes. This is also applicable in terms of the involved members in transaction teams and their experience, as well as in terms of making the optimal trade-off between implementing risk mitigation measures, accepting an appropriate level of risk taking and defining the appropriate return expectation.

Apart from mainly considering the downside dimension of risk, the results with regard to the upside dimension of risk illustrate that RES-E investors do not consistently consider the value of opportunities and/or synergy effects within valuation processes. These previous topics as well as risk mitigation measures tend to be neglected in theoretical and empirical financial research in the context of valuation approaches, even though they are considered to be key components in a coherent valuation approach.

With regard to capital budgeting approaches, the following inference results are reassuring: in RES-E investments, *DCF-based valuation* methods continue to be the dominant underlying investment-evaluation techniques, as reported by practitioners and supported by academic literature (e.g., Fernandez, 2015) and previous empirical surveys (e.g., Burns and Walker, 1997; Graham and Harvey, 2001). An interesting result is that the *IRR* approach is more popular than the NPV approach due to its ease in terms of comparing and communicating, although the former approach has more theoretical deficiencies than the latter (Mauboussin, 2002; Baker et al., 2010; Arnold, 2013; Ehrhardt and Brigham, 2016), while most QUAL participants are not aware of the IRR's methodological restrictions.

As a fundamental QUAL finding, it is demonstrated that market participants, both sellers and acquirers, apply the *simplified FTE approach* in RES-E investments, as reported by Deloitte (2014). Considering the typically changing capital structure within RES-E projects, this practice reduces valuation complexity by applying a constant single discount rate instead of the more consistent periodic-specific discount rate adjustment. However, most participants are not aware of the approach's limitation – compared to only a few participants who possess the knowledge in finance theory that there are other, more consistent DCF methods that are still practical enough to be applied in RES-E investments, such as the APV and the CE approach. This low level of knowledge about those two approaches is also illustrated in empirical studies (e.g., Petty et al., 1975; Graham and Harvey, 2001; Brounen et al., 2004).

5.2 Conclusions and contribution

Even though the RES-E transaction market remains reluctant about or even ignores DCF methods other than the simplified FTE approach, the QUAL findings reveal that the APV and CE approaches can be applied as complementary methods:

1 the *APV approach* can be applied as a valuable method for impairment test processes due to its optimal separation of operating and tax deducting cash flow

2 the *CE method* can be applied as a powerful tool to evaluate an investment project's value protection ability.

In line with the work of Espinoza (2014, 2015), a valuation using a traditional DCF approach with RADR (focus on discount rate adjustment for risk), complemented with a CE-based valuation (focus on cash flow adjustment for risk), is an optimal and promising procedure for the analysis of potential RES-E investment opportunities. This type of valuation decreases the issue of inconsistency of the applied simplified FTE approach, and it provides inputs and is particularly powerful for comparing mutually exclusive investments. Based on the discussion of the investment scenarios, two interesting questions remain: how can the encountered difference between the NPV calculation based on the conventional method (higher value) and the CE method (lower value) be understood, and can the difference be regarded as an option price, for instance for a future repowering, retrofitting and prolongation of a project's lifetime, which is not directly included in the valuation?

These findings with only few cultural differences between the investigated Swiss and German subgroups (Hürlimann et al., in press) indicate that there is still a considerable gap between theory and practice in RES-E investment valuation processes. This corresponds to findings obtained in previous studies among practitioners in other areas (e.g., Gitman and Mercurio, 1982; Graham and Harvey, 2001; Brounen et al., 2004).

The paper contributes to the body of knowledge and to practice in various ways. This empirical research clearly demonstrates how valuable and powerful MMR is to evaluate the current gap between theory and practice and to find detailed explanations for the encountered situation in practice. Furthermore, it illustrates the current status of applying capital budgeting techniques, CoC approaches and risk consideration concepts in practice. Newcomers and experienced investors alike can use this study's findings in their RES-E project investments. In doing so, practitioners would be provided with valuable insights into how their peers apply the different techniques and approaches in tabular form in the QUAN results. After having performed INFs with the QUAL results to explain the QUAN results, and with regard to the theoretical concepts in the literature review, these QUAN results can also be considered as the current status of applied approaches in line with 'good/best practices'.

5.3 Limitations and further research

With regard to possible research limitations, the QUAN phase was limited to a relatively small sample of German RES-E investors. Therefore, it might be not representative of and generalisable to the whole population. However, by applying triangulations, the subsequent QUAL could confirm the found results. As within similar studies (Graham and Harvey, 2001; Brounen et al., 2004), there is an essential reservation to be made. The research assumes that the participants act as agents of their companies, without verifying whether their responses regarding their views and opinions are translated into actions; however, this particular research limitation was decreased by discussing investment decisions based on realistic investment scenarios. Since the QUAN phase focused on scanning the whole spectrum of methodological applications, it was not able to collect differentiated data for specific cases, such as specifically applied approaches in relation to technology, project stages, investment country and project leverage. This simplification was somehow equalised by the in-depth discussions about applied approaches within the three provided specific investment scenarios in the QUAL phase. Moreover, this research does not focus on the valuation of high leveraged companies with corporate financing in which option valuation methods (e.g., McNulty et al., 2002) might become more relevant as valuation approaches. Even thought his discussion of the investment scenario tried to investigate not only orally explained knowledge but also knowledge expressed in behaviour, there was still certain knowledge of the participants that could not be expressed and therefore analysed. This understanding is in line with Polanyi's (1966) widely noted quote: 'We can know more that we can tell'. According to him, knowledge that can be expressed in words and numbers only represents the tip of the iceberg of the entire body of possible knowledge.

To improve valuation approaches in RES-E investments, the ongoing research should concentrate on finalising the following three concepts specifically developed for the concerned sector:

1 the assessment of influencing factors on valuation and the development of an equity value driver and influencing factor model to understand the relevant determinants

2 an uncertainty/risk consideration model to be able to appropriately manage the different uncertainties and risks

3 an integrated equity value creation and value protection model, including the CE approach, to assess the value protection dimension and to perform a coherent valuation by considering the diversification level of the investing firm and the investor.

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Notes

1 Renewable energy sources (RES) projects are enterprises that transform a replenishable primary natural resource, such as biomass, hydro power, wind power, solar radiation, gravitation, isotope decay and residual heat in the earth's interior into secondary energy forms, such as electricity, heat or fuel (BMU 2006, cited in Peter and Fischedick, 2007). The abbreviation RES-E stands power plants producing electricity from renewable energy sources (Unteutsch, 2016); these could be hydro power plants, wind farms, photovoltaic plants or geothermal power plants. They are typically private equity investments, either structured as completely private investments of a company on their own balance sheets or as special purpose vehicles (SPVs) with project financing (Steffen, 2018). An SPV is a business entity that is initialised by a firm for the purpose of conducting a clearly-specified activity (Gorton and Souleles, 2007; Böttcher, 2009; Chang et al., 2009), such as developing, building and operating RES-E projects.

2 Private equity refers to an asset class that consists of equity securities and debt in an operating company that is privately owned and hence not publicly traded on a stock exchange (Jegadeesh et al., 2009). These investments are considered to be illiquid and long-term (Zimmermann et al., 2005, Sorensen, 2013, 2014). Market data for private equity are not directly accessible (Nielsen, 2011; Driessen et al., 2012), only if securities that are investing in private equity companies are publicly traded (Ljungqvist Richardson, 2003). Such securities could be funds (Ljungqvist and Richardson, 2003) or specific companies (Zimmermann et al., 2005; Jegadeesh et al., 2009). Private equity can, for example, be categorised in private equity investment trusts, venture capital trusts, public to private, management buy-outs or management buy-ins, venture capital or business angels (Arnold 2010), or SPVs for operating specific projects.

3 A detailed literature review is reported elsewhere (Hürlimann and Bengoa, 2017).

4 Compared to EVA, DCF-based methods are more appropriate for handling projected cash flows over the whole project period, without applying a determination value, and for significant distributions to equity holders in later project years.

5 Financing policy: In relation to valuations, there are two ideal types of financing policies, namely the autonomous financing policy and the value-oriented financing policy (Richter, 1998; Drukarczyk and Schüler, 2009; Meitner and Streitferdt, 2012). Both of them are based on simplified assumptions about real, existing financing policies. In the case of the autonomous financing policy, which is also known as the determined financing policy (Drukarczyk and Schüler, 2009), the future amount of borrowed capital is given. Such a situation is encountered in credit agreements in which the complete redemption schedule is terminated until the complete repayment, which is frequently applied in project financing credit agreements for RES-E investments. As such, the debt-equity ratio – the leverage – is variable. The resulting tax benefits are precisely predictable, and the tax shield can thus be regarded as safe, apart from the insolvency risk (Pawelzik, 2012). In contrast, the value-oriented financing policy, which is also known as the breezing financing policy (Drukarczyk and Schüler, 2009), defines a certain debt financing level or debt ratio as the target value. This could either be constant over the observed period or determined in a periodic-specific manner (Dierkes et al., 2009). The amount of debt capital – both the corresponding amount of interest and tax shield – consequently varies in relation to the equity value. As a result, the tax shield cannot be regarded as safe in this circumstance; instead, it is subject to the same risk of future payment surpluses or free cash FTE (Kruschwitz and Lorenz, 2011).

6 For reasons of simplification, the FTE approach is often applied with a constant discount rate, even if an autonomous financing policy is implemented which would require the application of dynamic discount rates. This so-called simplified FTE approach is the most frequently used valuation method in pricing RES-E projects. It has the advantage of being easy to implement, understand and communicate. However, it comes with the drawback of being overly simplified and inaccurate due to its negligence of changing risks and capital structure over time (Deloitte, 2014).

7 This method was first proposed by Robichek and Myers (1966, 1968) as an alternative to traditional RADR approaches, and it is regarded as theoretically superior to them because of the applied separation between the time value of money and risk (Hamada, 1977; Sick, 1986; Gitman, 1995; Megginson, 1997; Halliwell, 2001; Ryan and Gallagher, 2006; Zeckhauser and Viscusi, 2008; Cheremushkin, 2009; Espinoza and Morris, 2013), i.e., a single discount rate as a risk measure is not an adequate approach (Espinoza, 2014). Although the CE method has partially the same drawbacks as the other traditional methods, since it is based on the same philosophy as the CAPM (Wolffsen, 2012), it is the preferred method for addressing risky cash flows (Zeckhauser and Viscusi, 2008). The CE method involves an adjustment of the numerator within the present value equation [equation (2)] with a deduction for risk to assure CE cash flows, while the applied hurdle rate in this case should equal the risk-free rate (Baker et al., 2010) to calculate the project's present value.

8 The complete results of this part (additional influence factors on valuation, including key value drivers) will be presented in a separate paper in connection with the developed equity value driver model for RES-E investments (Section 6 regarding further research).

9 Small organisations defined as those organisations with less than 501 employees.

10 Following an IRR approach, this calculated IRR is compared to the set hurdle rate, while in the case of an NPV approach, e.g., for impairment tests, the hurdle rate is applied as the discount rate.

11 Earn-out is a provision written into a financial transaction document (e.g., a share purchase agreement) whereby the seller of a business will receive additional payments after a defined earn-out period based on the future performance (e.g., actual production data compared to forecasted production data) of the business sold. Within a reverse earn-out provision, a certain amount is paid back to the acquirer.

Appendix

A1 Assessment of investment scenarios in wind onshore in Germany and France

- Approach:
  - a Please assume that your company for which you work pursues the *objective* to build a *200 MW* portfolio of power plants based on renewable energies in the next 4 years (the 'portfolio'). Your company starts from scratch, i.e., currently 0 MW. Your company plans to invest about 125 MEUR in equity.
  - b You are an *investment manager* working for the Renewable Energy division of this company. You are heading a team experienced in valuation and due diligence in renewable energy technologies (the 'valuation analysis team'). You are responsible for building this portfolio. The investment decision is taken internally by a separate decision-making body, composed of members of the board of directors of your company (including CEO and CFO).
  - c Your valuation analysis team presents to you following *three investment opportunities* in onshore wind. Your team provides you a summary of key figures and of the analysis results (Tables A1 and A2).
  - d Based on these key figures and valuation results, you have to *present to your decision-making body* the three investment opportunities and your proposal in which investment (only one of the 3), the company should try to invest. Your decision has to be justified based on the provided figures and used methods.
- Additional information:
  - a All three investments are project financed by German banks.
  - b Your company invests in the equity portion to acquire the project while taking over the project financing without changing it.
  - c The WACC of the investing company (i.e., your company) is 3.0%.
  - d The financial department defines annually a country specific hurdle rate (minimal return rate) for its various divisions in order to consider the specific risk of the projects of the different divisions. For this year, the hurdle rate of the concerned renewable energy division for Germany is *3.5%* and for France is *4.1%.*
  - e The applied risk free rate (governmental bond 10Y of concerned country) are 0.19% for Germany and 0.50% for France.
- Questions:
  - a Are you able to present your investment proposal to your decision-making body based on the provided information (Tables A1 and A2)?
  - b On what basis (figures and analysis results, Tables A1 and A2) do you justify your proposal?
  - c Are certain key figures and analysis/used methods missing?
  - d Which key figures, used methods and analysis results are not necessary to make the proposal and take a decision?

e Do you consider additional circumstances which are not based on valuation and figures in your investment proposal?

Table A1 Details about the investment opportunities

Projects	*1*	*2*	*3*
Technology	Onshore Wind	Onshore Wind	Onshore Wind
Location	Saxony-Anhalt, Germany	Mecklenburg-Western Pomerania, Germany	Picardie, France
Commissioning date	June 2016	Oct. 2014	Jan. 2016
Installed capacity	27.6 MW	14.4 MW	11.5 MW
Hub height	137 m	141 m	98 m
Rotor diameter	126 m	117 m	82 m
Annual production (@P50)	76.8 GWh/a	41.3 GWh/a	28.7 GWh/a
Full load hours (@P50)	2763 h	2868 h	2489 h
Wind assessment – average wind velocity	6.7 m/s	6.9 m/s	7.2 m/s
Wind assessment – standard deviation	12%	13.4%	11.5%
Feed-in tariff (FiT)/FiT period	8.69 ct/kWh for 20 years (fixed)	8.83 ct/kWh for 20 years (fixed)	8.56 ct/kWh for 15 years (indexed)
Direct marketing fee	–0.65 ct/kWh for 10 years	–0.69 ct/kWh for 5 years	Not known yet
Power prices after FiT end (assumption)	4.0 ct/kWh, indexed with 1.5%/a (base year 2014)	4.0 ct/kWh, indexed with 1.5%/a (base year 2014)	4.0 ct/kWh, indexed with 1.5%/a (base year 2014)
Lease agreements	25 + 5 years	25 + 5 years	25 + 5 years
Project financing	78% leverage Tenor: 10 years Interest rate (first 10 years): 1.8%	70% leverage Tenor: 10 years Interest rate (first 10 years): 1.9%	68% leverage Tenor: 10 years Interest rate (first 10 years): 2.6%
Management contracts (technical and commercial)	Contract term: 20 years	Contract term: 10 years	Contract term: 5 years
O&M agreement	15 full maintenance contract (all components included)	10 full maintenance contract (all components included)	5 full maintenance contract (all components included)
Stake in target to be sold	100%	100%	100%

Table A2 Valuation results

Projects	*1*	*2*	*3*
DCF methods			
Valuation period	25 years	23 years	25 years
Base case:			
Equity return rate (equity IRR) (incl. all tax) vs. P value	6.52% @P50	5.23% @P50	5.48% @P50
	4.28% @P75	2.87% @P75	3.75% @P75
	3.04% @P90	1.34% @P90	2.16% @P90
Project return rate (total/project IRR) (incl. all tax) vs. P value	3.64% @P50	3.37% @P50	3.87% @P50
	2.85% @P75	2.23% @P75	3.01% @P75
	2.03% @P90	1.03% @P90	2.20% @P90
Total enterprise value (@P50)	71.5 MEUR	37.2 MEUR	20.7 MEUR
Equity value (@P50)	15.9 MEUR	11.2 MEUR	6.7 MEUR
NPV @5.0% cost of equity	16.8 MEUR	11.5 MEUR	7.0 MEUR
Certainty equivalent method* (based on risk free rate = governmental bond 10Y of concerned country)	14.1 MEUR @0.19%	7.9 MEUR @0.19	4.7 MEUR @0.50%
Profitability index (PI)** (@4.0% cost of equity)	1.142	1.119	1.143
Discounted payback period	17.5 years @3.0%	17.9 years @3.0%	17.2 years @3.0%
	18.6 years @4.0%	19.4 years @4.0%	19.2 years@4.0%
	21.9 years @5.0%	23.0 years @5.0%	22.0 years@5.0%
Non-DCF methods			
Payback period	15.2 years	14.0 years	15.3 years
Enterprise value/capacity	2.59 EUR/MW	2.58 EUR/MW	1.80 EUR/MW
Enterprise value/annual production (P50)	0.93 EUR/GWh	0.90 EUR/GWh	0.72 EUR/GWh
Additional assessment			
Probability of investment success according to valuation team	50%	60%	70%

Notes: P value (P50, P75, etc.): It is a probability measure, e.g., P50 is defined as 50% of estimates exceed the P50 estimate, in case of P90, 90% of the estimates exceed the P90 estimate.

*Within the CE method, expected cash flows are adjusted to reflect project risk and discounted by the appropriate risk-free rate to obtain project's NPV.

**Profitability index (PI) is the present value of the project's cash inflow per currency unit of its initial investment.

***Worst case and best case: adjustment of +/– 20% production, O&M costs: +/– 30% end of contract, interest rate: +4%/–0.5%, market prices after end of FiT: + 100%/–50%.

Table A2 Valuation results (continued)

Projects	*1*	*2*	*3*
Risk and opportunity assessment			
Sensitivity analysis – wind risk	(See equity IRR and total IRR above for different P values)	(See equity IRR and total IRR above for different P values)	(See equity IRR and total IRR above for different P values)
Sensitivity analysis – market risk: –10% market prices after FiT end: (all other variables constant)	Equity IRR: 6.31% Total IRR: 3.55%	Equity IRR: 5.04% Total IRR: 3.25%	Equity IRR: 5.03% Total IRR: 3.62%
Sensitivity analysis – O&M risk: +10% O&M costs at the end of contract (all other variables constant)	Equity IRR: 6.43% Total IRR: 3.59%	Equity IRR: 5.18% Total IRR: 3.36%	Equity IRR: 5.21% Total IRR: 3.73%
Sensitivity analysis – interest rates (project financing) risk: +1% higher interest rate after 10 years (all other variables constant)	Equity IRR: 6.44% Total IRR: 3.65%	Equity IRR: 5.07% Total IRR: 3.40%	Equity IRR: 5.39% Total IRR: 3.78%
Scenario analysis*** – worst case:	Equity IRR: 2.21% Total IRR: 0.51%	Equity IRR: 0.10% Total IRR: –0.15%	Equity IRR: 0.51% Total IRR: 0.12%
Scenario analysis*** – best case:	Equity IRR: 8.76%	Equity IRR: 9.57%	Equity IRR: 11.82%
	Total IRR: 4.95%	Total IRR: 6.31%	Total IRR:8.13%
Opportunities	Almost no opportunities	New negotiation of O&M and management contract > 11 years	New negotiation of O&M and management contract > 5 years; maybe additional revenues for direct marketing

Notes: P value (P50, P75, etc.): It is a probability measure, e.g., P50 is defined as 50% of estimates exceed the P50 estimate, in case of P90, 90% of the estimates exceed the P90 estimate.
*Within the CE method, expected cash flows are adjusted to reflect project risk and discounted by the appropriate risk-free rate to obtain project's NPV.
**Profitability index (PI) is the present value of the project's cash inflow per currency unit of its initial investment.
***Worst case and best case: adjustment of +/– 20% production, O&M costs: +/– 30% end of contract, interest rate: +4%/–0.5%, market prices after end of FiT: + 100%/–50%