Determinants of Credit Allocation for Photovoltaic Projects

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Determinants of Credit Allocation for Photovoltaic Projects

Research Outline and Preliminary Findings from Conjoint Experiments with German Financing Experts

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SUMMARY

An increasing concern for photovoltaic (PV) projects is a shortage of capital in the medium term. PV project financing is an urgent topic due to a fundamental lack of knowledge about how debt capital providers evaluate this class of infrastructure projects. Moreover, after recent turbulences on the financial markets it is unclear how the availability of capital for renewable energy projects will develop. In this context financing models are decisive especially for medium- and large-scale PV projects, since large shares of debt capital are needed: Practitioners assume debt ratios of up to 80% or even 90%.

As there is only limited academic research on project characteristics and their impact on credit allocations, the focus is on lenders' preferences for different project types. The explorative research approach therefore addresses the following question: Which types of PV projects do lenders prefer to finance? We try to answer this question by conducting an Adaptive Choice Based Conjoint experiment (ACBC) with German experts in renewable energy project financing (banks, savings banks, consultants, project developers). To get robust and relevant results we clearly define our research scope: medium- and large scale ground-mounted installations being subject to the German Renewable Energy Sources Act (EEG) as of 2009.

Initially, we supposed that from a lender's perspective two attributes might be of utmost importance: First, Debt Service Cover Ratio (DSCR), indicating the security of loan repayment. Second, a hardly discerned but assumingly important aspect is the project initiator who is the central stakeholder during project development. This attribute is conceptualized by referring to possible project initiators' business models. Examples are vertically integrated PV manufacturers, financial investors, service providers, and regional or multinational utilities. To provide for an as authentic as possible conjoint experiment, six attributes with 22 attribute levels in total were developed through literature studies and expert interviews. The six attributes are: DSCR, system capacity, brand/low cost technology, project initiator, maintenance concept, and equity ratio.

Our survey, taking place from January to March 2010, is still online as this working paper is being written; thus, results are preliminary. We report from a sample size of 1.240 choice tasks conducted by 30 interviewees; 40 to 50 experts are expected to participate in the end. So far, the empirical data do not support our assumptions regarding the outstanding importance of DSCR and project initiator. Instead, our preliminary results are suggestive of a "brand bias" in lenders' decisions.

Keywords: renewable energy, photovoltaic, business models, project financing, debt capital

1. INTRODUCTION TO PROBLEM AND RESEARCH APPROACH

Increasing concerns for photovoltaic (PV) projects refer to a possible shortage of capital in the medium term (e.g. Jäger-Waldau 2009; Schwabe et al. 2009). PV project financing is an urgent research topic due to a fundamental lack of knowledge about how debt capital providers evaluate this type of infrastructure projects in their credit allocation processes. Moreover, after recent turbulences on the financial markets it is somehow open how the availability of capital for renewable energy projects will develop (e.g. Böttcher 2009; Schwabe et al. 2009). This leads to fundamental uncertainties and risks for the development of renewable energies in general and PV projects in particular.

Financing models are decisive especially for medium- and large-scale PV projects since each venture has an individually optimal ratio of equity and debt capital. Most projects have in common a significant dependency on debt capital ("highly-geared" projects): Practitioners assume debt ratios of up to 80% or even 90%; whereas the optimum varies from case to case (e.g. Johnson 2009; Böttcher 2009). As there is only limited academic research on project characteristics and their relevance for credit allocations, the focus is on lenders' preferences for variant PV project designs. This research addresses an important gap: Today, information on the willingness to provide debt capital contingent on single project attributes is missing. Practitioners could use the expected insights to design projects and raise debt capital more effectively; an approach to mainstreaming investments in green energy technologies.

Against this background our investigation addresses the following research question: *Which types of PV projects do lenders prefer to finance?* To support robustness and relevance of results we clearly define our research scope from a technical, geographical and temporal point of view: our conjoint survey focuses on medium- and large scale ground-mounted installations being subject to the German Renewable Energy Sources Act (EEG) as of 2009.[1] We seek to answer this question by conducting an Adaptive Choice Based Conjoint experiment (ACBC) (Johnson et al. 2003; Johnson & Orme 2007) with German experts in renewable energy project financing (banks, savings banks, consultants, project developers). Our explorative research approach is based on a set of PV project attributes which were derived through extensive literature studies (taking into account both academic and practical resources) and expert interviews.[2] These attributes are used to simulate different PV projects which then have to be evaluated by experts during the conjoint survey.

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[1] All assumptions refer to the German legal and regulatory framework as of January 2010. When the survey was conducted the Federal Ministry for the Environment declared to reduce PV tariffs by April 2010. Meanwhile, the reduction was shelved to July 2010. Nevertheless, the German PV industry and associated sectors are in eager anticipation due to expected market changes.

[2] Mr Oliver Thominsky (Director of Finance and Administration), Mr Günther Störmer (Head of Corporate Strategy), both SunEnergy Europe GmbH, Hamburg, Germany; Ms Tanja Finke (Head of Project Financing), Windwärts Energie GmbH, Hannover, Germany. Interviews were conducted in December 2009 and January 2010.

Although conjoint experiments are widely used in marketing research (e.g. Louviere et al. 2003) and for exploring investment behaviour (e.g. Clark-Murphy & Soutar 2004), scholars in renewable energy financing apply this method lately (e.g. Oschlies 2007). For the first time this paper investigates debt capital providers' preferences and uses ACBC which combines Adaptive Conjoint Analysis and Choice Based Conjoint (Johnson et al. 2003; Johnson & Orme 2007).

Crucial to this approach is the exact definition of PV project attributes as these include a multitude of parameters such as capacity, module and inverter brand, maintenance concept, and different economic indicators. From a lender's perspective Debt Service Cover Ratio (DSCR) is of utmost importance. DSCR and related indicators are decisive economic "hard facts" indicating the economic viability of a project—these facts are central determinants of financing and investment decisions (e.g. Grosse 1990; Reuter & Wecker 1999). Going beyond commonly discussed attributes and indicators, a hardly discerned aspect is the project initiator. Examples are vertically integrated PV manufacturers, financial investors, service providers, and regional or multinational utilities. The underlying assumption is that initiators (characterized by their business models) can make a difference for lenders' decisions when confronted with different project proposals. Besides DSCR and project initiator further characteristics are supposed to determine credit allocation decisions. Since the definition of attributes and attribute levels requires extensive investigations and thoughtful argumentation, this working paper discusses these methodical and technical issues in some length.

We proceed as follows: First, the theoretical and conceptual background section evolves state-of-the-art knowledge on PV project financing and relevant project initiators (Chapter 2). Additionally, in Chapter 3 more technical and practical attributes are introduced and discussed. The result of both chapters is a thoroughly defined set of six PV project attributes with 22 attribute levels in total. Second, in the method section we discuss Adaptive Choice Based Conjoint as our chosen data collection method (Chapter 4). Third, in Chapter 5 we report from a sample size of 1.240 choice tasks that have been conducted by 30 interviewees as yet. 40 to 50 experts are expected to participate in the end. The conjoint survey is still online as this paper is being written, thus, results and discussion (Chapter 6) are preliminary.

2. THEORETICAL AND CONCEPTUAL BACKGROUND

2.1 Project Financing

Project financing is crucial for renewable energies (dena 2004; Böttcher 2009, 9-11). For two reasons: First, this industry is still determined by small and medium sized enterprises which need debt capital to realize more extensive ventures (Böttcher 2009, 15). Second, for decades project financing is an established method for one-time ventures such as infrastructure projects (e.g. Backhaus et al. 1990; Reuter & Wecker 1999). For the case of Germany, project financing is commonly applied for medium- and large-scale PV installations (Grell & Lang 2008, 37).

Advantages of this method are e.g. flexible combinations of different financial, personal and material resources, as well as risk sharing among the parties involved. A plurality of project parties is necessary due to multifaceted technical and economical project development tasks. "Projectizing" (Reuter & Wecker 1999, 9) combines challenges like facility development and installation, reliable revenue forecasts, thorough quality assurances, and as well complex project financing tasks.

In contrast to a firm a project is based on a singular and non-cyclical undertaking. It can have a limited lifetime, serve very specific project targets, and have separable financial, personal and material resources brought in by diverse project stakeholders (e.g. Backhaus et al. 1990; Reuter & Wecker 1990; Nevitt & Fabozzi 2000). These aspects often lead to the foundation of an independent, legally responsible and creditable project company—the so called "Special Purpose Vehicle" (SPV) (Grell & Lang 2008, 37). SPVs for renewable energies have to cope with technical complexities, political uncertainties, and have to be economically viable at the same time. These challenges have to be dealt with under circumstances of project development and project financing.

Three significant characteristics of project financing are often discussed in literature (e.g. Reuter & Wecker 1999; Nevitt & Fabozzi 2000; Böttcher 2009):

- Off-Balance-Financing, i.e. a financing method separated from the individual or corporate books of the financially involved project stakeholders;
- Orientation towards future project cashflows, these are the only source of economic performance and security;
- A complex network of project parties and a mesh of contracts to provide for broad risk sharing and risk reduction.

Off-Balance-Financing implies that financially involved project parties separate the PV project from their books and establish an SPV. Debt capital is brought to the SPV's books and thus does not influence the project parties' accounting and balance sheet indicators directly—this is also depending on accounting standards (Böttcher 2009, 21-22). Since the SPV does not possess further assets, debt capital providers have to rely on the expected economic performance solely. That is, in any case future project cashflows have to provide for debt service and returns on equity (*Cashflow Related Lending*) since a financial liquidation of a PV power plant is complicated and unprofitable (Grell & Lang 2008, 37; Böttcher 2009, 22-23). Lenders usually apply indicators such as Debt Service-, Loan Life- or Project Life Cover Ratio (Grosse 1990, 47-48; Grell & Lang 2008, 70) (see below). In a project constellation different degrees of recourse can be negotiated (Full-, Limited-, Non-Recourse Lending; Böttcher 2009, 34-35), which can lead to higher credit costs and necessitate broad risk sharing among project parties (*Risk Sharing*). Nevertheless, the main purpose of project financing is the acquisition of large shares of debt capital (Böttcher 2009, 19).

When developing a PV project and its financial concept at least two aspects have to be taken into account. First, renewable energies are politically determined and reliant upon legal and regulatory frameworks as well as supportive programs (dena 2004). Second, the credit crunch which peaked in late 2008 changed financial markets, their rules and related policies (e.g. Schwabe et al. 2009; Jäger-Waldau 2009). Böttcher assumes that the impact on renewable energy project financing is twofold (Böttcher 2009, 14-15): On the one hand, this asset class will continue to grow as it is independent from economic trends. Financing costs will increase, but simultaneously other investment costs will decrease due to falling commodity prices. That is, there is change but stability. On the other hand, projects with somehow higher risks will be rescheduled (e.g. technical, legal, regulatory risks). Moreover, project initiators and financiers will vary due to decreasing activities of pure financial investors and assumingly increasing activities of players like utilities. That is, the structure of project stakeholders will diversify.

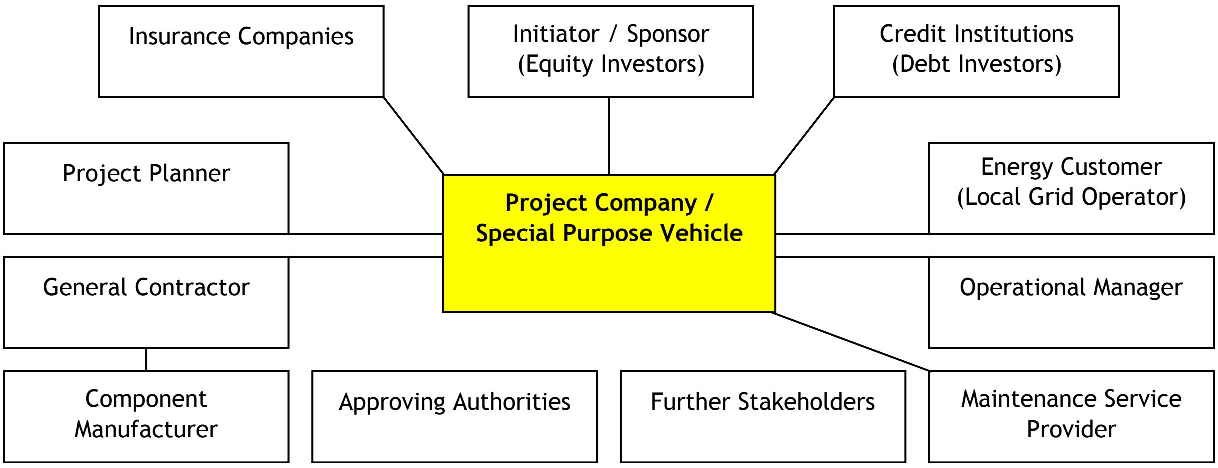

Figure 1: PV Project Stakeholders

Consequently, the task of "projectizing" is to design a PV project in a way that addresses the above mentioned complexities, market and policy changes, and allows for raising debt and equity capital. Moreover, manifold stakeholders have to be integrated into processes of project development and financing (Figure 1, based on Grell & Lang 2008). The initiator is the most important stakeholder at first (ibid).

2.2 Project Initiators

The project initiator comes up with the project idea, identifies further project parties, negotiates, concludes contracts, and thus actively designs the SPV. These activities also determine the value network which will surround the PV power plant (Frantzis et al. 2008). It can be assumed that the value network layout is directly influenced by the initiator's business model.

To define possible initiators' business models we refer to two recent studies (Frantzis et al. 2008; Schoettl & Lehmann-Ortega 2010). Somehow, both define business models with a conceptual reference to the business logic of "money-making", "profit earning" (Frantzis et al. 2008) and "the mechanisms enabling a firm to create value" (Schoettl & Lehmann-Ortega 2010). Generally, the business model serves practical purposes and helps managers "to capture, understand, communicate, design, analyze, and change the business logic of their firm" (Osterwalder et al. 2005, 19); but it also offers conceptual and theoretical perspectives for academic analyses (e.g. Amit & Zott 2001; Zott & Amit 2007; 2008). Since the business logic of money-making, respectively value creation, is a widely agreed on aspect of business models, we will follow these approaches and define a business model using a practically oriented definition: "A business model describes the rationale of how an organization creates, delivers, and captures value." (Osterwalder & Pigneur 2009, 14)[3]

Frantzis et al. (2008) discuss PV business models starting from the PV supply chain and value networks. Their analysis leads to models which differ in terms of ownership (end-user, third party, utility) and application context (residential, commercial, grid-sited). Due to fundamental differences in the regulatory frameworks in the US and Germany (Günnewig et al. 2008, 44-49; Bolinger et al. 2009) their business models cannot be used in this study. Nevertheless, their conceptual work serves as point of orientation. Thus, we start from the PV value chain to locate possible initiators from the PV industry; afterwards we introduce generic business models for the German market based on Schoettl & Lehmann-Ortega (2010).

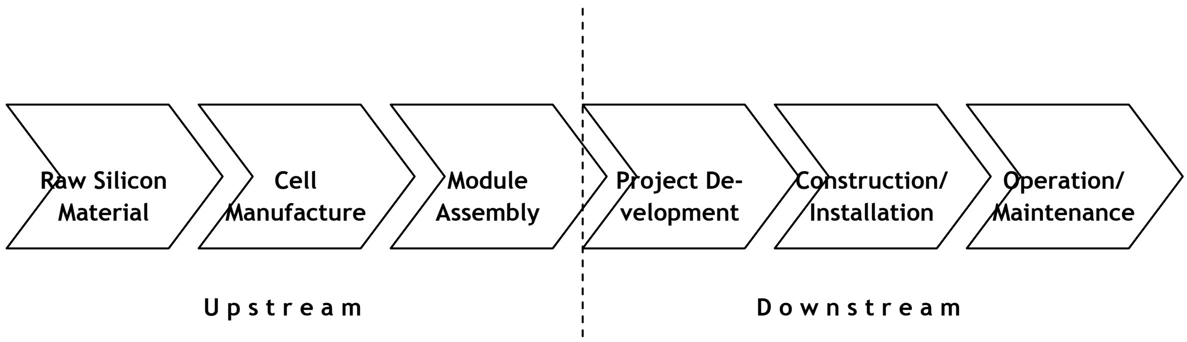

Figure 2: PV Supply Chain (Frantzis et al. 2008; Schoettl & Lehmann-Ortega 2010)

The latter authors deduce six generic PV business models by means of supply chain deconstruction (Schweizer 2005). Since our survey is limited to financing ground-mounted PV systems we focus on three generic models which directly relate to this system type (italics in Figure 3, Schoettl & Lehmann-Ortega 2010).

[3] Without discussing conceptual details in this paper, it has to be added that the business model's essence becomes clear when its constituent elements and differences to other business and management concepts are considered (e.g. Magretta 2002; Afuah 2004; Belz & Bieger 2006). However, according to Osterwalder (2004) or Ballon (2007) every business model is built on constellations of value proposition, customer interface, infrastructure, and cost and revenue streams.

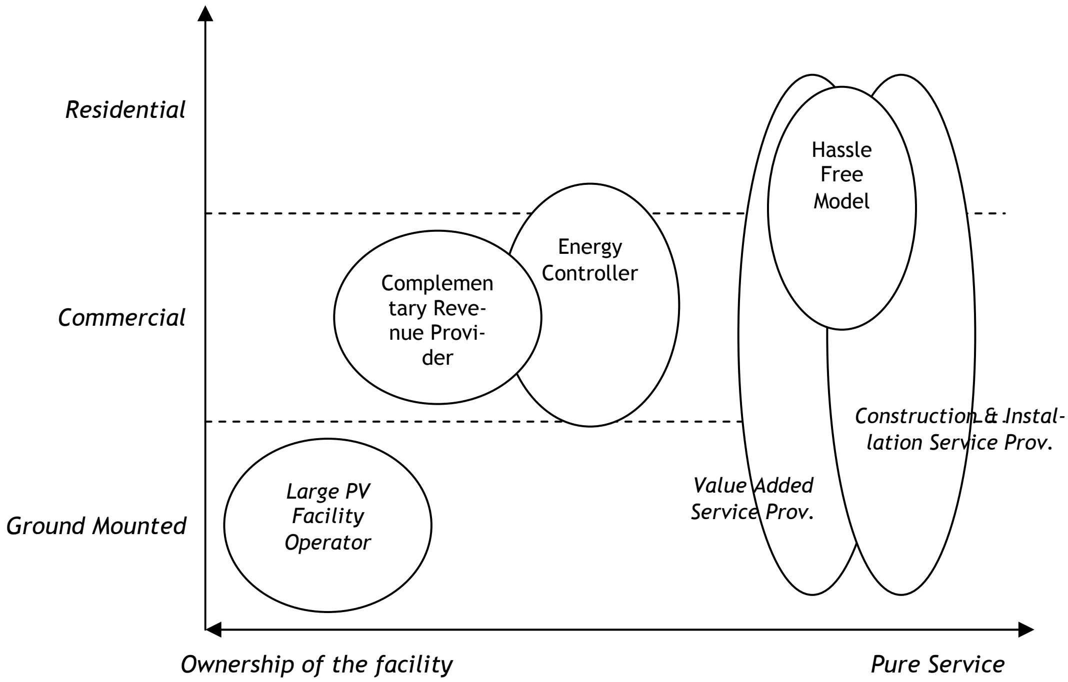

Figure 3: Six Generic PV Business Models

Similar to Frantzis et al. (2008) these models are defined by ownership and application; whereas ownership is a continuum of pure ownership and pure service (x-axis), and application is classed with residential, commercial and ground mounted (y-axis). We refer to the following three types (Schoettl & Lehmann-Ortega 2010):[4]

- Value Added Service Provider: “The player offers a value added service such as project development and consulting. He can be either specialized in one step in the value chain or act as an orchestrator, but he doesn’t own the facility.”
- Construction & Installation Service Provider: “The player offers a service with less added value as the [Value Added Service Provider]. He offers the construction and installation service to final customers or to orchestrators. The main competency is local project management.”
- Large PV Facility Operator: “The player owns the large PV facility: he is an energy producer. He has build the facility all himself or acted as an orchestrator. Main competencies are ability to deal with large projects and to raise cash to finance them.”

To get easy to handle and independent attributes for the ACBC experiment we distinguish two basic types being related to ground mounted systems: Service Provider and Large PV Facility Operator; i.e. in a first step we condense the service models and then simply differentiate *ownership* and *non-ownership.* Service Providers are non-owners according to their

[4] These models are not exclusive; i.e. a Large PV Facility Operator may also offer services of the other types.

business of providing value added services for projects. Large PV Facility Operators are basically defined as owners since their core business is energy production (Schoettl & Lehmann-Ortega 2010). Finally, due to latest discussions we identify four different initiators who can be owners and Large PV Facility Operators now and in the future. As fifth type we add a non-owner type comparable to Service Providers. These five initiator types and their business models possibly make a difference from a debt capital provider's perspective (Table 1).

Table 1: PV Project Initiators' Business Models

Initiators' Business Models		**Reasoning**
Owner	**Regional Utility**	Utilities' roles in renewable energy supply chains (in the PV industry in particular) is one of the most dynamic topics with regard to their future strategies and business models (e.g. AT Kearney 2007; Accenture 2008; Frantzis et al. 2008; PWC 2009; Schoettl & Lehmann-Ortega 2010).
	Multinational Utility	Undoubtedly, with increasing market shares of renewables utilities as market players will more and more influence and shape this green industry. Following Böttcher (2009) utilities will soon be important project stakeholders. Lenders might perceive project credibility differently if the utility is an international "big player".
	Financial Investor	The US market faces significant shifts in equity investments: "In early 2009, approx. four to six traditional investors remain active [of twenty]. The new deals getting financed are the best projects with solid management teams … New investors could emerge." (Schwabe et al. 2009) Böttcher (2009) assumes similar developments for Germany.
	Vertically Integrated PV Manufacturer	Initiators often come from the downstream PV supply chain segments (e.g. project developers), but also from related and other industries like the above mentioned utilities and financial investors. Recently, market players from the upstream segments (e.g. cell or module manufacturers) act as project initiators, respectively sponsors; i.e. they integrate the PV supply chain.
Non-Owner	**Service Provider**	This initiator is not an owner of the finally realized PV power plant. He offers a value added service such as project development, consulting, construction and/or installation. He can either be specialized in one step in the supply chain or act as an orchestrator.

3. TECHNICAL CHARACTERISTICS OF PHOTOVOLTAIC PROJECTS

3.1 Technical Aspects

The generator is the heart of each PV facility. It consists of an amount of PV modules which are made from solar cells based e.g. on crystalline silicon or different kids of thin film materials. This generator produces direct current (DC) which has to be transformed into alternating current (AC) by the DC-to-AC inverter which feeds the electricity into the grid. The third basic component is the mounting system which has to guarantee for stability in cases of stress, e.g. caused by wind or snow. Moreover, the mounting can be used as tracker system to follow the sun's eclipse.

These components' quality is decisive for a PV facility's performance in terms of efficiency, effectiveness and long-term reliability. Therefore, brands, certificates, producers' references and long-term experiences are indicators for technological quality (Grell & Lang 2008; Böttcher 2009). Thus, for projects we find two generic possibilities. First, one can choose technology (e.g. modules and inverters) of superior quality and pay a price premium for that technology. This option may be operationalized as *premium brand.* The second option is to save the price premium and integrate *low cost* technology (accepting the risk of additional costs of inferior quality).

3.2 System Capacity

Capacity is a crucial physical characteristic of PV systems, determining not only investment volume but also efficiencies of scale and thus cost effectiveness. Within this survey we seize on different capacity ranges which should be of relevance for financing ground mounted PV systems in Germany. We therefore refer to Lenardič's classification of PV power plant sizes (Lenardič 2009).[5] For his annual review he defines seven classes (Table 2).

Another clue for ACBC attribute construction might be the German funding scheme according to the Renewable Energy Sources Act 2009 (EEG). The EEG distinguishes systems which are ground mounted (lower tariff[6]) from those being attached to buildings (e.g. integrated or roof installations) (higher tariff[7]). For the latter the EEG defines feed-in tariffs depending on system capacity, whereas for ground mounted PV plants a general tariff is applied. That is, the EEG does not incite decisions for special capacities of ground mounted systems.

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[5] pvresources.com is a database of the 1,000 largest installations worldwide, ranging from 1 to 60 MWp capacity.

[6] EEG 2009 Section 32 (1) defines the tariff as follows: (1) The tariff paid for electricity from installations generating electricity from solar radiation shall amount to 31.94 cents per kilowatt-hour. (Note: All tariffs are subject to the degression rules of section 20. That is, the tariffs mentioned are only valid for installations which are put into operation in 2009.)

[7] EEG 2009 Section 33 (1) structures the tariff as follows: 1. 43.01 cents per kilowatt-hour for the first 30 kilowatts of output, 2. 40.91 cents per kilowatt-hour for output between 30 and 100 kilowatts, 3. 39.58 cents per kilowatt-hour for output between 100 kilowatts and 1 megawatt, and 4. 33.0 cents per kilowatt-hour for output over 1 megawatt.

Table 2: Capacity Classes of PV Power Plants / Distribution of German Plants

Large-scale classes	Size (peak power)	Number of German plants (end of 2008)*	Class description
Class VII	> 20 MW	2	power plants in classes IV to VII tend to be exclusively ground mounted, majority of is located in Spain
Class VI	10 MW – 20 MW	4	
Class V	5 MW – 10 MW	19	
Class IV	3 MW – 5 MW	36	
Class III	1 MW – 3 MW	177	including ground mounted power plants, installations of such size are common in Spain and Germany, also including some of the largest roof mounted power plants
Class II	500 kW – 1 MW	n. av.	including the majority of large-scale flat roof mounted power plants
Class I	200 kW – 500 kW	n. av.	mostly owned by single investors or small sized companies

* Own calculations based on Lenardič 2009 and pvresources.com, 25 August 2009

We follow Lenardič's classification in a slightly modified way. Our system capacity attribute classes medium- and large-scale ground mounted PV systems with four categories: *200 kWp-1 MWp, 1 MWp-5 MWp, 5 MWp-10 MWp, > 10 MWp.*

3.3 Quality Assurance

Following Grell & Lang (2008), an extensive quality assurance is the most important prerequisite for financing PV projects since its end is to assure cashflows. Elements of quality assurance are revenue forecasts, performance assessments, inspections, monitoring and operations control.

Revenue forecasts are the core of planning a PV facility technically as well as financially. While technical planning has to develop a system which suites local conditions and thus optimizes relative energy yield (e.g. in terms of size, cell type, inverter concept, mounting), the planning task from a financial point of view is to assure the desired rates of return (for initiators, sponsors and further equity investors) and coverage ratios (for debt investors). Consequently, revenue forecasts are fundamental to every PV project. A thorough quality assurance concept includes further measures to back this fundament.

Producers refer to Standard Test Conditions (STC) to declare nominal module capacity. Since technical and financial performance of a project is directly linked to the modules' effectiveness and reliability, independent reviewers should assess declarations and variances of actual capacities. Moreover, performance assessments of installed and activated systems are necessary since PV power plants work under empirical circumstances different from STC. Mandatory for inspection purposes is the availability of documentaries and protocols to check planning and real data when the system has been installed. Such inspections can be improved by means like thermal imaging to identify deficiencies such as damaged modules, wrong wiring, or insufficiently calibrated inverters. At least, a quality assurance concept needs permanent monitoring and automated operations control to monitor the actual Performance Ratio (PR) and to recognize malfunctions immediately. Thus, aspects of quality assurance (like *system inspection* and *system monitoring*) should be considered within a conjoint experiment.

3.4 Economic viability

According to the idea of project financing (Off-Balance-Financing, Cashflow Related Lending, Risk Sharing) credibility depends on the project itself and its cashflows. That is, with regard to negotiated recourse (Full-, Limited-, Non Recourse) project cashflows are the main security for debt capital providers. Therefore, to evaluate a project from a lender's perspective special indicators are used to estimate different coverage ratios.

Table 3: Coverage Ratios for Project Evaluation from a Lender's Perspective

Indicator		Interpretation
LLCR =	<u>NPV of Cashflows of Loan Lifetime</u> Outstanding Debt	• Loan Life Cover Ratio • refers to the ability of debt service *during the life of loan*
PLCR =	<u>NPV of Cashflows of Project Lifetime</u> Credit Amount	• Project Life Cover Ratio • refers to the ability of debt service *during the project lifetime*
DSCR =	<u>Cashflow of Period + Interest Payment</u> Repayment + Interest Payment of Period	• Debt Service Cover Ratio • refers to the ability of debt service *on an annual basis*

Basically, a ratio of 1.0 indicates exact coverage of debt service. If cashflows are sufficient the ratio exceeds 1.0; if not, it falls below. The coverage ratios mentioned in Table 2 differ in the periods they take into account (Grosse 1990, 47-48; Böttcher 2009, 129-130): LLCR focuses on debt service during the life of loan. PLCR asks for cashflows during the project's lifetime. DSCR refers to the relation of gross cashflow and debt service on a yearly basis and thus varies with different project phases. To prevent annual shortages this indicator has to be applied in any case; it is even acceptable to use DSCR alone (Böttcher 2009, 126). For renewable energy projects Böttcher (2004) as well as Grell & Lang (2008) refer to a minimum DSCR of 1.3; i.e. lenders always charge a minimum contingency reserve.

Practical examples of PV project calculations illustrate the range of DSCR from roughly 1.0 to 3.0 and above (Grell & Lang 2008; Böttcher 2009). Therefore, to create a DSCR attribute for the ACBC experiment we apply three average DSCRs to offer different degrees of overall credibility (*1.2, 1.5, 1.8*).

4. METHOD

4.1 Adaptive Choice Based Conjoint

Which types of PV projects do lenders prefer to finance? To answer our research question we conduct an online Adaptive Choice Based Conjoint experiment with bank managers from Germany who are responsible for providing debt capital for PV projects.

Conjoint experiments have been widely discussed earlier and we refer to corresponding literature for an overview (Louviere et al. 2003; Train 2003). With its roots in marketing research conjoint experiments are used for exploring investment behaviour as well (Clark-Murphy & Soutar 2004; Oschlies 2007; Riquelme & Rickards 1992; Shepherd & Zacharakis 1999). Recently, scholars in renewable investment start to apply conjoint experiments for elaborating on renewable energy investors' preferences (e.g. Oschlies 2007). For the first time this paper investigates debt capital providers' preferences and uses the Adaptive Choice Based Conjoint tool from Sawtooth Software to perform choice tasks. Being available lately, ACBC combines advantages of Adaptive Conjoint Analysis (ACA) and Choice Based Conjoint (CBC) methods (Johnson et al. 2003; Johnson & Orme 2007).

Important advantages of ACBC compared to CBC are "a more stimulating experience that will encourage more engagement in the interview than conventional CBC questionnaires, [the possibility] to screen a wide variety of product concepts, but focus on a subset of most interest to the respondent, [and finally the possibility to] provide more information with which to estimate individual partworths than is obtainable from conventional CBC analysis" (Johnson & Orme 2007, 4). An additional benefit from increased information is that ACBC is especially beneficial for small sample sizes (Johnson & Orme 2007, 18) and therefore fits our requirements. We analyse the choice results by calculating Hierarchical Bayesian (HB) analysis estimation which allows for calculating data on an individual level (Otter 2007).

The basic idea within choice experiments is that survey participants seek to choose the alternative with the highest utility. Each alternative within the experiment is described by attributes and attribute levels which are the sources of utility: Utility of an alternative a: Ua = Va + εa.[8]

[8] V_a = systematic utility (function of observable variables), ε_a = Random utility component (not observed influences)

Conjoint experiments display partworths, i.e. values which indicate a distinct attribute's contribution to the total utility of an alternative. In our experimental set-up we ask debt capital providers to consider different PV projects which are comparable but differ in some aspects (these are our attributes and levels). In the *Build Your Own* section we ask to design the PV project the interviewee would be most likely to finance. In the *Screening* section different projects have to be evaluated as being "A possibility" or "Won't work for me". Finally, in the *Choice Task* section varying projects are presented of which only one can be chosen (see Appendix). Depending on participants' choices we then are able to bring out the partworths debt capital providers allocate to certain PV project attributes and levels.

Based on the specifics of PV project financing as presented in the theoretical and conceptual section and the selected technical characteristics we are able to derive six attributes and 22 corresponding levels for the ACBC experiment (Table 3). The experiment is restricted to fictitious medium- and large-scale ground mounted PV facilities being subject to the German Renewable Energy Sources Act (EEG) as of 2009. These restrictive assumptions and our clear focus help increase the degree of rigor.

Table 4: ACBC Attributes and Attribute Levels

Attribute	Levels
Debt Service Cover Ratio (Average)	1.2 1.5 1.8
Capacity	200 kWp-1 MWp 1 MWp-5MWp 5 MWp-10 MWp > 10 MWp
Brand	Low Cost Solar Cells and Low Cost inverter Low Cost Solar Cells and Premium Brand inverter Premium Brand Solar Cells and Low Cost inverter Premium Brand Solar Cells and Premium Brand inverter
Initiator's Business Model	Vertical Integrated Manufacturer Regional Utility Multinational Utility Financial Investor Service Provider
Maintenance Concept	System Inspection Constant System Monitoring System Inspection and System Monitoring
Equity	10 % 20 % 30 %

4.2 Sample

Our sample consists of institutions from the conventional finance industry, from the field of sustainable finance, free financial advisors and renewable energy project companies. The intended sample size is about 40-50 experts who attend the experiment via an online questionnaire. We reached out for the participants first by phone and via e-mail. Initially, we found about 140 relevant institutions in Germany; in about 50 cases experts could be identified by name and were asked personally to participate. Our survey is still open, i.e. we are in the process of data collection. We therefore report from a sample size of 1.240 choice tasks that have been conducted by 30 interviewees as yet.[9] The sample size is small due to the participants' high scope. Nevertheless, this high scope contributes to consistency and is beneficial for our findings.

Some socio-economic data describe our current sample: Within the last three years 23% of the respondents' companies financed PV projects exceeding €500 Million total volume. A volume of €100-500 Million was financed by 27%; 50% of respondents' companies financed PV projects with a total volume of up to €100 Million Euros within the last three years. 37% of the companies operate in Europe. 40% operate in Germany, Austria and Switzerland only; 23% operate within a global context. Nearly all companies have their headquarters in Europe (one is located in the USA). The interviewees work in various positions in renewable energy project financing (e.g. Executive Director Renewable Energies, Head of Project Financing, Project Manager, Structured Finance Specialist). Most respondents show more than 5 years of personal experience in renewable energy financing (53%). 27% have 2-4 years, and 20% have less than 2 years of experience.

5. PRELIMINARY RESULTS

5.1 Estimation of Utilities

The questionaire is still online and the ACBC experiments are conducted presently. Hence, results are preliminary. Average utilities of attributes and attribute levels are estimated based on a sample size of 1.240 choice tasks completed by 30 interviewees.

Referring to the cumulated results for attributes (without the single levels' utilities) we see that DSCR as assumed economic "hard fact" is of lowest importance for credit allocations, followed by the project initiator as second weakest attribute. Instead, the premium brand/low cost attribute is of primary importance, followed by capacity and equity share (Figure 4).

Zooming in on the values of attribute levels we learn about details of debt capital providers' preferences for PV projects (Figure 5). Positive values indicate positive utilities and, thus, a positive impact on lenders' decisions, whereas negative values point to aversion to attribute levels.

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[9] We target a final sample size from about 1.600 to 2.000 tasks performed by 40 to 50 experts and expect to reach this sample size and close the survey by March 31, 2010.

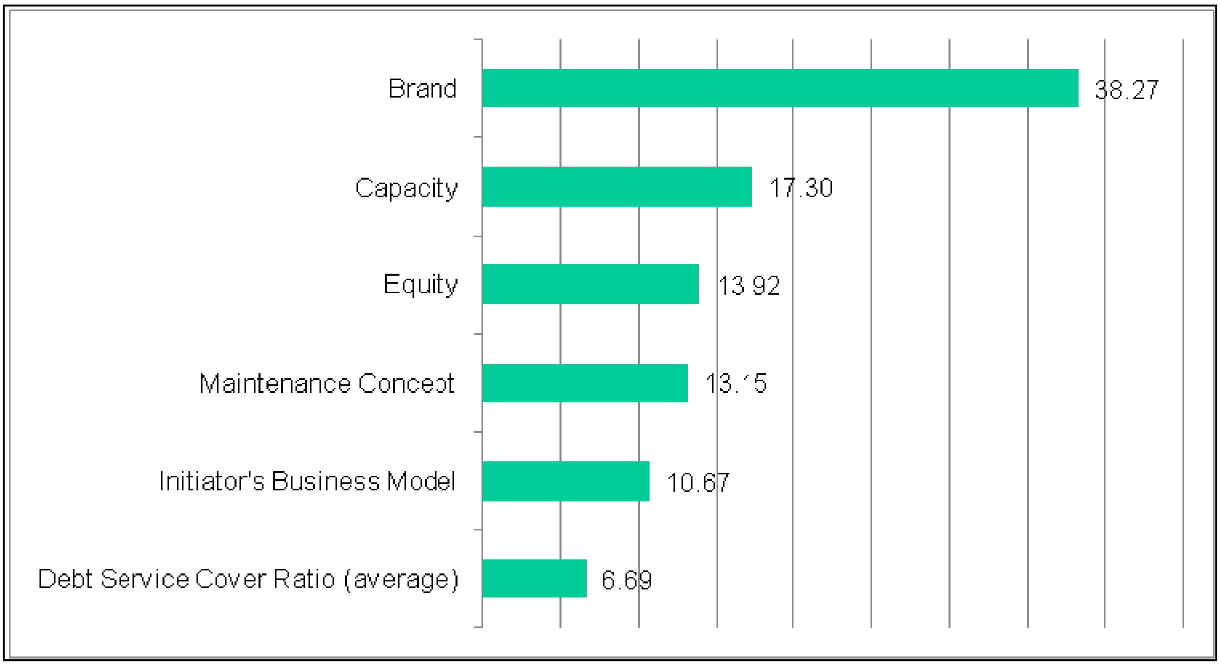

Figure 4: Average Utilities (Zero-Centered Diffs)

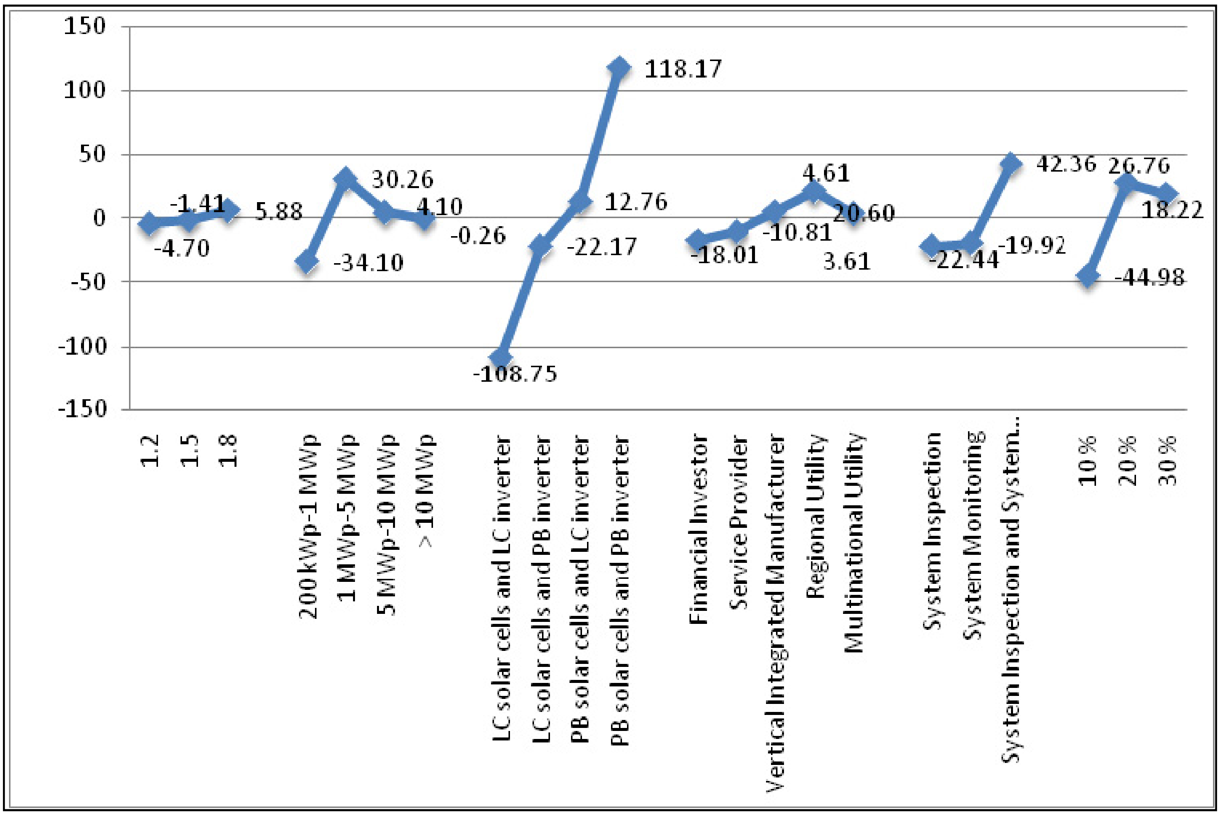

Figure 5: Zero-Centered Diffs (Attribute Levels)

Table 5 summarizes the main results as average utilities based on HB estimates. The relatively high standard deviation reflects the temporarily small sample size.

Table 5: HB Average Utilities (Zero-Centered Diffs)

Attribute Levels	Average Utilities (HB)	Standard Deviation
1.2	*-4.47*	*20.08*
1.5	*-1.41*	*19.77*
1.8	*5.88*	*17.06*
200 kWp-1 MWp	*-34.10*	*53.14*
1 MWp-5 MWp	*30.26*	*18.41*
5 MWp-10 MWp	*4.10*	*35.63*
> 10 MWp	*-0.26*	*38.88*
Low Cost solar cells and Low Cost inverter	*-108.75*	*28.60*
Low Cost solar cells and Premium Brand inverter	*-22.17*	*34.34*
Premium Brand solar cells and Low Cost inverter	*12.76*	*25.99*
Premium Brand solar cells and Premium Brand inverter	*118.17*	*42.23*
Vertical Integrated Manufacturer	*4.61*	*21.13*
Regional Utility	*20.60*	*18.25*
Multinational Utility	*3.61*	*26.35*
Financial Investor	*-18.01*	*15.87*
Service Provider	*-10.81*	*22.33*
System Inspection	*-22.44*	*23.18*
System Monitoring	*-19.92*	*21.93*
System Inspection and System Monitoring	*42.36*	*21.94*
10 %	*-44.98*	*41.10*
20 %	*26.76*	*20.71*
30 %	*18.22*	*28.49*

5.2 Preference Simulations

The chosen attributes and attribute levels allow for designing different fictitious PV projects. To measure lenders' preferences for variant project layouts common market simulation software can be used to process the observed utilities (Sawtooth Software package). Each simulation compares two project layouts which comprise different combinations of attribute levels. Theoretical preferences for selected combinations are simulated below.

Simulation 1: project with low cost components vs. project with premium brand components

Both projects are equal in all attributes (e.g. DSCR, capacity etc.) but differ in terms of brand. The first project has low cost modules and low cost inverters; the second project applies premium brand modules and premium brand inverters. The simulation shows that lenders would clearly prefer the premium brand project: 97.4% would choose this project.

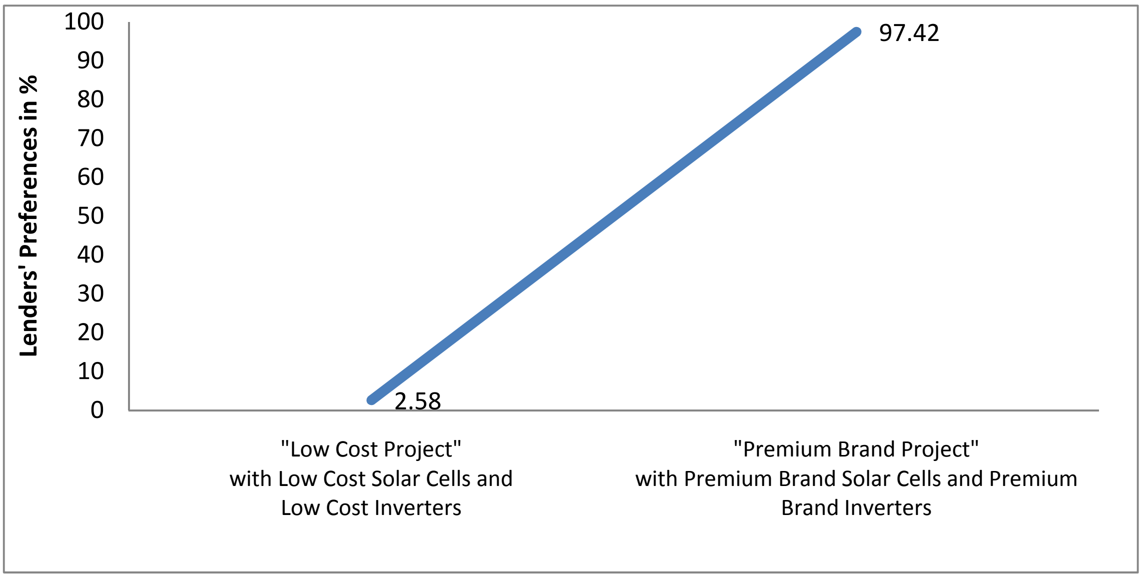

Figure 6: “Low Cost Project” vs. “Premium Brand Project”

Simulation 2: project with low cost components and superior DSCR vs. project with premium brand components and inferior DSCR

The project with low cost components offers a high coverage ratio (1.8); the one with premium brand components is a low DSCR project (1.2). As soon as premium brand components are integrated (e.g. premium brand modules), 93.9% of lenders would allow a credit for the low DSCR project. The supposed rational choice for highest DSCR seems to be biased.

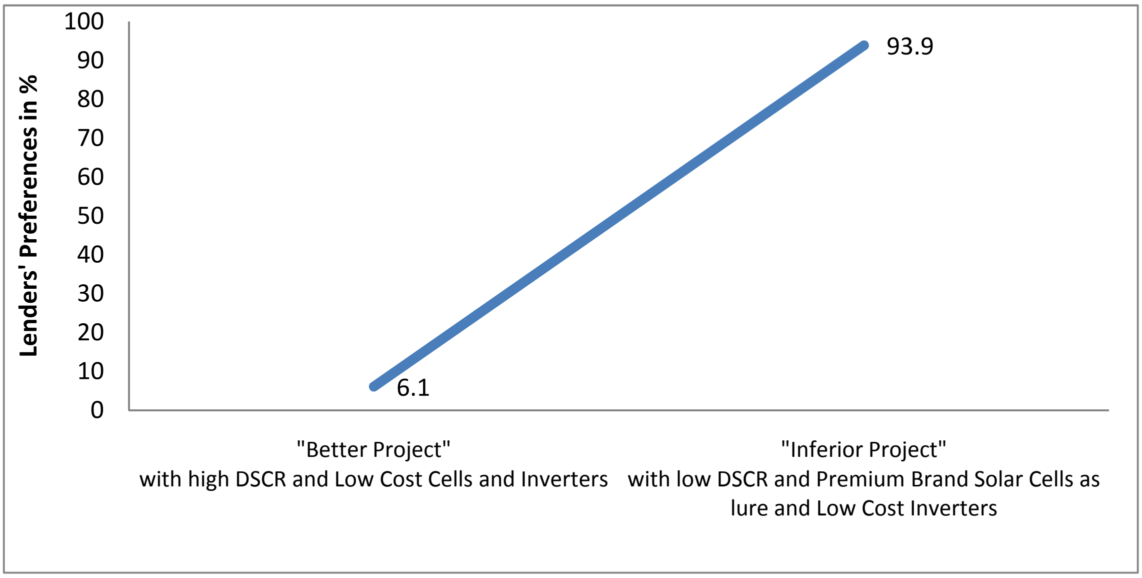

Figure 7: “High DSCR Project” vs. “Low DSCR Project”

Simulation 3: project with low cost components, superior DSCR and "low risk" vs. project with premium brand components, inferior DSCR and "high risk"

The first project uses low cost components and offers highest DSCR (1.8). Remaining attributes are combined to simulate a "low risk" design: the initiator is a multinational utility which supposedly accounts for securities of loan defaults and also promises energy buy-off (we assume that lenders may associate such or comparable advantages with utilities). Moreover, this project has an all-in maintenance concept to reduce operating risks. Finally, a high equity ratio serves as additional security (30%). The second project with a premium brand component (premium brand module/low cost inverter) is designed to evoke an association of comparatively higher risk: DSCR 1.2, financial investor as initiator, system monitoring only, 20% equity. The result of this simulation is that nearly 63% of lenders would grant a credit for the assumed "high risk" project.

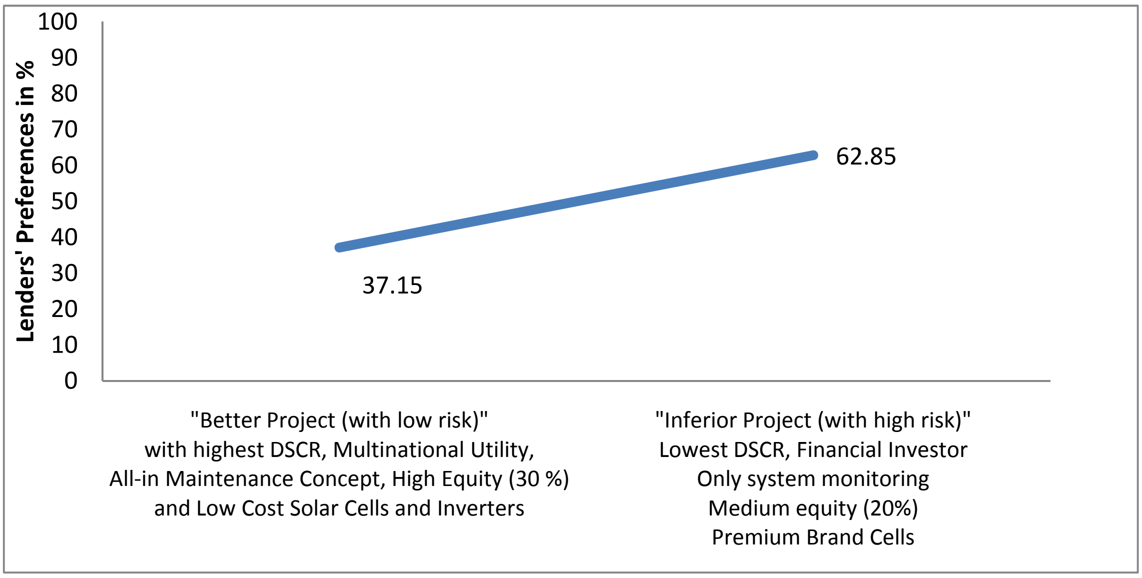

Figure 8: "Low Risk Project" vs. "High Risk Project"

6. DISCUSSION

In the last section we discuss our preliminary results and try to figure out some determinants of credit allocation for photovoltaic projects; but first of all some limitations have to be addressed.

The temporarily small sample size gives rise to some analytical constraints (e.g. on analyzing differences between expert groups like CIOs, Specialists in Renewable Energy Investments or Portfolio Managers). Moreover, we find a central limitation in the experimental set-up. Experiments reduce real-world complexities drastically. Especially in the context of decision-making this is not unquestioned. We know that various aspects which have not been included might also determine lenders' choices. For instance, important aspects are discussed in behavioural economics and refer to phenomena like group-dynamic determinants of decision-making (e.g. "herding"). Being aware of these limitations we want to state some recommendations for future work.

Referring to the cumulated results for attributes we see that DSCR as assumed economic "hard fact" is of lowest importance for credit allocations, followed by the project initiator as second weakest attribute. Both results are contrary to our initial assumptions regarding the importance of DSCR and project initiator. Instead, the premium brand/low cost attribute is of primary importance, followed by capacity and equity share. Zooming in on the values of attribute levels we learn about details of debt capital providers' preferences for PV projects. In a nutshell: lenders seem to be extremely risk averse. Their surprisingly clear preference for premium brand components is only one hint. Additionally, they appreciate all-inclusive maintenance concepts with system inspection and system monitoring, and they opt for project initiators who provide for disposal of the generated electricity. Hence, they prefer regional and multinational utilities to be involved in projects. Project initiators like service providers, vertically integrated manufacturers and financial investors even deter debt capital providers. Regarding capacity we learn that project sizes of 1 MWp-5 MWp are most attractive, followed by projects with above 10 MWp. Small projects of 200 kWp-1 MWp and projects between 5 and 10 MWp have negative impact on choices. Finally, we see an inverted U-curve relationship for the optimal equity ratio peaking between 20% and 30%, but being slightly closer to a ratio of 20 % equity.

Several practical conclusions can be drawn, even from these preliminary results. On the one hand, realizing photovoltaic installations based on a "Special Purpose Vehicle" allows for flexibly combining financial, personal and material resources; if risks and financing structures are handled in a smart way, PV ventures can obtain large shares of debt capital. On the other hand, the technical and economical characteristics of photovoltaic along with the task of "projectizing" bear significant challenges. Consequently, the most important one is to simultaneously meet equity investors' and lenders' expectations (e.g. in terms of internal rates of return and DSCR). Therefore, project developers might want to design projects which propose low risk. In particular they could decide to integrate premium brand components rather than using low cost technology. Moreover, we encourage project developers to co-operate with regional or multinational utilities in the project development phase. We argue that the involvement of utilities might improve fundraising success due to aspects of financial and technical security. Finally, we encourage project developers to "projectize" PV ventures with a capacity that meets lenders' preferences. In this regard there seems to be potential for projects with a capacity between 1 MWp and 5 MWp.

We want to draw some more attention to the project initiator attribute. As discussed above, the initiator is the most important stakeholder at first. He comes up with the project idea, identifies further project parties, negotiates terms, concludes contracts, and thus actively designs the SPV. Therefore, these activities determine the value network and the stakeholder constellation surrounding the PV project. Due to current changes in political settings (new German government) and funding schemes (severe reduction of PV tariffs) lender's preferences might shift from costly premium brands to cost-conscious system components. According to the idea of project financing, other risk sharing and assurance concepts besides "trust in premium brands" will have to be developed. A tendency of "trust in utilities" might result. Regional as well as multinational utilities and their business models of energy production and distribution might play a role for PV project development in the near future. But for the moment our assumption of project initiators being an important determinant for credit allocation is not clearly supported. Instead, the "brand bias" was surprisingly dominant in our market simulations. This aspect has to be analyzed more thoroughly in the near future. Approaches from the fields of behavioural economics and marketing psychology could help to better understand this bias and its interplay with economic indicators like DSCR.

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APPENDIX

Screenshot 1: Build Your Own Section

Please consider different PV projects that are equal and comparable but differ in the following aspects.

Select the PV project you'd be most likely to finance. For each feature, select your preferred level.

Feature	Select Feature
Debt Service Cover Ratio (average)	○ 1.2 ○ 1.5 ○ 1.8
Capacity	○ 200 kWp-1 MWp ○ 1 MWp-5 MWp ○ 5 MWp-10 MWp ○ > 10 MWp
Brand	○ Low Cost solar cells and Low Cost inverter ○ Low Cost solar cells and Premium Brand inverter ○ Premium Brand solar cells and Low Cost inverter ○ Premium Brand solar cells and Premium Brand inverter
Initiator's Business Model	○ Vertical Integrated Manufacturer ○ Regional Utility ○ Multinational Utility ○ Financial Investor ○ Service Provider
Maintenance Concept	○ System Inspection ○ System Monitoring ○ System Inspection and System Monitoring
Equity	○ 10 % ○ 20 % ○ 30 %

Screenshot 2: Screening section

Here are a few PV projects you might like. For each one, indicate whether it is a possibility or not.

(1 of 6)

Debt Service Cover Ratio (average)	1.2	1.2	1.5	1.5
Capacity	1 MWp-5 MWp	200 kWp-1 MWp	> 10 MWp	1 MWp-5 MWp
Brand	Low Cost solar cells and Low Cost inverter	Low Cost solar cells and Premium Brand inverter	Low Cost solar cells and Low Cost inverter	Premium Brand solar cells and Premium Brand inverter
Initiator's Business Model	Vertical Integrated Manufacturer	Regional Utility	Service Provider	Vertical Integrated Manufacturer
Maintenance Concept	System Inspection and System Monitoring	System Inspection	System Monitoring	System Inspection
Equity	20 %	10 %	10 %	10 %
	○ A possibility ○ Won't work for me	○ A possibility ○ Won't work for me	○ A possibility ○ Won't work for me	○ A possibility ○ Won't work for me

Next

Screenshot 3: Choice task section

Among these three, which is the best option? (We've grayed out any features that are the same, so you can just focus on the differences.)

(1 of 10)

Debt Service Cover Ratio (average)	1.2	1.2	1.2
Capacity	5 MWp-10 MWp	200 kWp-1 MWp	1 MWp-5 MWp
Brand	Low Cost solar cells and Low Cost inverter	Low Cost solar cells and Premium Brand inverter	Low Cost solar cells and Low Cost inverter
Initiator's Business Model	Service Provider	Multinational Utility	Vertical Integrated Manufacturer
Maintenance Concept	System Inspection	System Inspection and System Monitoring	System Inspection
Equity	10 %	30 %	30 %
	○	○	○

Next