

# **Project Finance and Photovoltaic power plants**

*A theoretical and practical perspective*

**Anne Kristine Aasgaard**

**Advisor: Karin Thorburn**

Master Thesis – Department of Finance and Management Science

NORGES HANDELSHØYSKOLE

This thesis was written as a part of the Master of Science in Economics and Business Administration program - Major in International Business. Neither the institution, nor the advisor is responsible for the theories and methods used, or the results and conclusions drawn, through the approval of this thesis.

## **Abstract**

Project finance is a defined structure for developing new activity which involves establishing the project as a separate unit. The review of literature exhibits the distinctive characteristics of project finance and provides a rationale of this form of financing. Project finance entails financial modelling, risk management, legal aspects and the creation of a financial structure. The thesis explores practical use of project finance in a case study of a photovoltaic power plant and presents a financial model looking into central drivers of financial viability in a project. The thesis finds that there is consensus between theory and practice regarding the advantages of risk management facilitated by project finance.

## Acknowledgements

I would like to thank Øystein Hop and Olivier Maison-Blanche at Hydro for helping me develop the idea for my master thesis and assisting with data search. Further, I would like to thank Torstein Berntsen and Valeri Andreev at Scatec for useful insight in practical aspects of project finance and valuable pointers along the way. Last I want to thank my advisor, Karin Thorburn for guidance and helpful comments during the process of working with the thesis.

## Preface

Project finance is a technique for financing new activity that not only involves raising funds, but also includes financial modelling, engineering, economics, environment and law. Project finance is a way of structuring all aspects of the project and is also referred to as “*a seamless web that affects all aspects of a project’s development and contractual agreements, and thus the finance cannot be dealt with in isolation*”<sup>1</sup>.

The thesis is aimed at explaining what project finance involves, how it differs from other forms of financing structures, and the rationale for the use of project finance. Project finance will be considered from a theoretical perspective and a practical perspective. The practical aspects of project finance will be analysed in light of a case from the photovoltaic industry. The thesis attempts to compare theory and practice of project finance with regards to the photovoltaic industry. Photovoltaic power plants make use of the photovoltaic effect in order to generate electricity from sunlight.

I chose project finance as the topic for my master thesis for various reasons. Project finance has become a significant area within the financial sector and is a topic with high practical relevance. The total capital raised in project finance has increased over the years and reached a record of 320.9 billion USD in 2008, most of which was invested in the energy sector and infrastructure sector. Project finance also contributes to the promotion of renewable energy technologies, which is an especially interesting topic of current interest.

The thesis attempts to discuss the central aspects of project finance, but naturally there are interesting areas which could be given more attention. For instance, the importance of project finance in public-private infrastructure projects, and the distinction between limited recourse and non-recourse project debt. The latter is likely to have an effect on the terms for project debt.

Section 1 of the thesis defines project finance and presents relevant theory on the subject. Section 2 deals with project finance and risk. Section 3 provides background information on

---

<sup>1</sup> YESCOMBE, E. R. 2002. *Principles of project finance*, Amsterdam; London and New York:

renewables and photovoltaic technology, while section 4 examines how photovoltaic projects are financed. This section contains information about recently project financed deals and presents a review of term sheets of project finance loans. Section 5 investigates how project finance is conducted in reality by reviewing a real life case from the photovoltaic industry. A financial model for photovoltaic projects is presented and analysed in section 6. Section 7 provides a comparison of project finance in theory and practice, while a summary of key findings is given in section 8.

---

# Contents

<b>ABSTRACT.....</b>	<b>2</b>
<b>ACKNOWLEDGEMENTS.....</b>	<b>3</b>
<b>PREFACE.....</b>	<b>4</b>
<b>LIST OF FIGURES .....</b>	<b>9</b>
<b>LIST OF TABLES .....</b>	<b>10</b>
<b>1. PROJECT FINANCE .....</b>	<b>11</b>
1.1 INTRODUCTION.....	11
1.2 PROJECT FINANCE HISTORY .....	11
1.3 KEY FEATURES OF PROJECT FINANCE .....	12
1.4 SOURCES OF PROJECT FINANCE.....	17
1.5 PROJECT FINANCE AND OTHER FINANCING STRUCTURES .....	20
1.6 RATIONALE FOR USE OF PROJECT FINANCE.....	22
1.6.1 <i>Brealey et al – Agency costs</i> .....	22
1.6.2 <i>Shah and Thakor – optimal capital structure</i> .....	24
1.6.3 <i>Esty – investment distortions</i> .....	26
1.6.4 <i>Other advantages of project finance</i> .....	29
1.6.5 <i>Disadvantages of project finance</i> .....	29
1.7 SUMMARY .....	31
<b>2. PROJECT FINANCE AND RISK .....</b>	<b>34</b>
2.1 INTRODUCTION.....	34
2.2 PROJECT PHASES AND RISK.....	35
2.3 CONSTRUCTION AND OPERATION RISKS.....	35
2.4 RISK MITIGATION .....	38

---

2.5	RISK MATRIX .....	40
<b>3.</b>	<b>RENEWABLES AND PHOTOVOLTAIC TECHNOLOGY .....</b>	<b>42</b>
3.1	RENEWABLES .....	42
3.2	SOLAR ENERGY AND PHOTOVOLTAIC TECHNOLOGY .....	43
3.3	GRID PARITY .....	47
<b>4.</b>	<b>FINANCING PHOTOVOLTAIC PROJECTS.....</b>	<b>49</b>
4.1	PROJECT FINANCE AND PHOTOVOLTAIC PROJECTS.....	49
4.1.1	<i>Project financed photovoltaic parks.....</i>	<i>49</i>
4.1.2	<i>Montalto di Castro PV project.....</i>	<i>51</i>
4.1.3	<i>Review of term sheets .....</i>	<i>53</i>
4.2	GOVERNMENT SUBSIDIES AND FEED-IN-TARIFFS .....	59
4.3	FINANCIAL CRISIS.....	65
4.4	SUMMARY .....	66
<b>5.</b>	<b>CASE STUDY: PV PROJECT .....</b>	<b>68</b>
5.1	INTRODUCTION.....	68
5.2	KEY FEATURES OF PV PROJECT.....	68
5.3	TERMS OF THE LOAN AGREEMENT .....	70
5.4	CONTRACTS.....	71
5.5	RISK MANAGEMENT .....	75
5.6	CASE ANALYSIS .....	80
<b>6.</b>	<b>FINANCIAL MODEL.....</b>	<b>87</b>
6.1	METHODOLOGY.....	87
6.2	DISCUSSION OF FINANCIAL MODEL AND RESULTS.....	90
6.3	SUMMARY .....	103
<b>7.</b>	<b>PROJECT FINANCE IN THEORY AND PRACTICE.....</b>	<b>105</b>

---

<b>8. CONCLUSION .....</b>	<b>107</b>
<b>REFERENCES.....</b>	<b>111</b>
<b>APPENDIX 1 – LIST OF CASE DOCUMENTS .....</b>	<b>115</b>
<b>APPENDIX 2 – PROJECT FINANCED PHOTOVOLTAIC PROJECTS .....</b>	<b>116</b>
<b>APPENDIX 3 – BETA VALUES SOLAR COMPANIES .....</b>	<b>118</b>



---

## List of figures

Figure 1 Illustration of project participants and contracts.....	15
Figure 2 Mandated arrangers of project finance loans 2009-2010.....	19
Figure 3 Annual photovoltaic production .....	43
Figure 4 PV technology.....	44
Figure 5 PV electricity potential in Europe.....	45
Figure 6 GHG emissions .....	46
Figure 7 Organisational structure PV Project .....	69
Figure 8 Repayment structure .....	97
Figure 9 Extended life time .....	98
Figure 10 Increased leverage.....	99
Figure 11 Reduced tariffs .....	101

## List of tables

Table 1 Comparison of corporate finance and project finance .....	21
Table 2 Risk matrix .....	41
Table 3 Montalto di Castro PV .....	52
Table 4 Summary term sheet.....	54
Table 5 Government support arrangements .....	60
Table 6 Solar PV Feed-in-tariffs .....	63
Table 7 Risk matrix PV Project.....	79
Table 8 Initial assumptions financial model .....	92
Table 9 Valuation parameters .....	93
Table 10 Sensitivity analysis.....	96

# 1. Project finance

## 1.1 Introduction

Project finance is a defined procedure for financing new activity which entails financial modelling, a web of contracts, the involvement of many parties and high lender participation. Esty and Christov (2002) define project finance as the following:

*“Project finance involves a corporate sponsor investing in and owning a single purpose, industrial asset (usually with a limited life) through a legally-independent entity financed with non-recourse debt”.*

This definition highlights three important features of project finance. First, the project is created to accomplish one particular task. Second, the project is established as an independent unit separate from the sponsoring company. And third, the debt raised for the project is usually non-recourse, sometimes limited recourse, with regards to the sponsoring company. This means the project itself is responsible for the debt. The sponsoring company, also referred to as sponsor or parent company, is the company who initiates the project.

## 1.2 Project finance history

According to Gatti (2008) project finance was used to finance imports and exports already during the Roman Empire. Project loans were also used to finance trading expeditions from Europe to Asia in the seventeenth and eighteenth centuries. The first large scale application of project finance was the development of oil fields in the North Sea in the 1970s. In recent years, project finance is applied in cooperation between public and private sector known as public-private partnerships (PPP). These projects are typically large infrastructure projects where the private sector builds a facility that is later transferred to the public sector. According to Grimsey and Lewis (2002) these projects are an application of project finance because they involve the establishment of a special purpose project company with high leverage which directly relies on the revenues from the project to cover its financing costs.

Project finance as a way of structuring and financing projects has had a growing importance over the last three decades. In the 1970s project finance was mainly used for natural resource

development. In the 1980s the use of this form of financing increased when new legislation on power purchase in the US made project financing the preferred structure for independent power producers. Project financing is often used for large-scale projects in infrastructure, natural resource and electric power which typically are capital-intensive, large-scale operations. Over the last 20 years, privatisation, deregulation and globalisation have led to increased use of project finance. Former state-owned companies have been privatised, deregulation has taken place in industries such as the power sector, and expansion of markets caused by globalisation has increased the attractiveness of project finance. In developing countries the use of project finance has become wide-spread due to lack of other ways to raise funds for infrastructure. Because of high political risk in these countries, the projects face several challenges.

Today, project finance is utilised in infrastructure, energy and power, and manufacturing facilities among other sectors. According to Project Finance Magazine (2010b) global project finance amounted to 292.5 billion USD in 2009, which is a reduction of 9 % compared to 2008. In 2009, 81 % of the funding raised for project finance deals was debt financing. Energy was the leading sector in 2009, as in the previous years, representing 36 % of the global project finance volume. Within this sector, renewable energy was the only sub-sector to experience increased project finance volume in 2009 compared to 2008. Energy as a whole had a reduction of 5 % from 2008 to 2009, whereas renewable energy increased with 7 % in the same period.

## 1.3 Key features of project finance

### **Organisational structure**

An important feature of project finance is the organisational structure. The project company is a separate legal unit, independent from the sponsor company who initiated the project. The project company is sometimes known as a “*special purpose vehicle*”, established to perform one particular task. Esty (2003) finds that a project typically has one to three sponsors providing equity as well as management and directors on the board of the project company.

### **Recourse**

Project finance debt is either non-recourse or limited recourse to the sponsor company. In the case of non-recourse, the sponsor has no responsibility for the debt in the project company. This is known as pure off-balance sheet-financing. With limited recourse, the sponsor has

some liability. This limited guarantee may apply within a specified time span, for a specified fraction of the debt or until a certain target has been reached<sup>2</sup>. Limited or non-recourse means that lenders must look solely to the cash flows from the project for repayment. This feature of project finance provides protection of the sponsor's other cash flows and assets. Increased recourse leads to higher risk for the sponsor and affects the debt to asset ratio and possibly credit rating of the parent company<sup>3</sup>.

### **High leverage**

Project companies typically have very high leverage. In a sample of project companies Esty (2003) found an average debt level of 70 %, whereas public corporations of the same size had an average debt level around 30 %. Project finance takes advantage of the fact that debt is less costly than equity because lenders require a lower rate of return due to the characteristics of debt. An increased debt level however, increases the risk of the equity and hence, the cost of equity.

Kleimeier and Megginson (2000) compare project finance loans to other syndicated credits. They find that project finance loans have longer average maturity, are more likely to have a fixed interest rate, and more often involve third-party guarantees. Project finance loans also involve more banks, have fewer covenants, and are more often priced at a fixed rate than floating rate. According to Kleimeier and Megginson the reason why project finance loans have fewer covenants, lies in the nature of the projects. Covenants are put in place to protect the creditors from asset substitution and other forms of wealth transfer, which is more probable in complex corporations with numerous divisions than in special purpose vehicles with one specified project. The borrowers of these loans are often found in tangible-asset-rich industries, for example oil and gas, real estate and electric utilities. The study also finds that project finance loans are more likely to be subject to currency risk and are located in riskier countries than other loans. Kleimeier and Megginson illustrate typical differences in level of country risk with an example; if a typical syndicated loan is issued to a borrower in Sweden, a fixed asset based loan would be arranged for a borrower in Singapore, whereas the project finance loan would go to a project based in Bahrain.

---

<sup>2</sup> Esty and Christov (2002), p. 2

<sup>3</sup> Farrell (2003)

When they looked at loans with a floating rate, Kleimeier and Megginson found that these loans have lower credit spreads compared to other syndicated loans, despite their non-recourse nature. This contradicts the general belief that project finance loans are more expensive than other loans. They explain this result with one of the motivations behind the use of project finance; that project finance reduces agency costs. (This and other benefits of project finance will be elaborated on in further sections.) Project finance loans also entail more participants and have higher fee levels, indicating that project finance is perceived to be more risky. The banks require higher fees in order to participate, and less willing to hold large shares of the total debt compared to other loan arrangements. The higher fees may influence the perception of project finance being expensive, despite the fact that the credit spreads are lower.

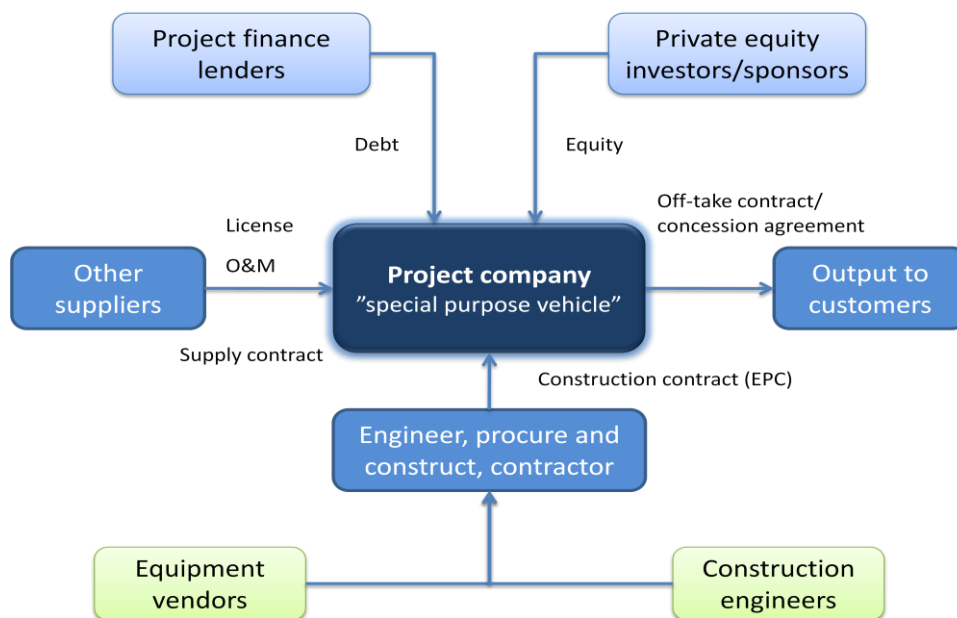
The study by Kleimeier and Megginson also contain a regression analysis, examining what factors affect the spread of project finance loans and other types of syndicated credits. The analysis reveals that project finance spreads are affected by third-party guarantees to a larger extent than other loans. This demonstrates the importance of guarantees in project finance arrangements, and why sponsors are willing to spend time and money on obtaining these from counterparties; compared to other loans, the third-party guarantees lead to higher reduction in the spread.

Based on a study of project finance loans conducted by Standard & Poor suggesting project finance loans have better performance in default situations than comparable corporate loans, Beale et al (2002) derive several characteristics of project finance loans. The underlying study shows that project finance loans have a lower loss given default and lower expected loss than comparable corporate loans. Beale et al attribute much of the explanation of this to the covenants of project finance loans. These include “step-in-rights” allowing the lenders to take over the contract, restrictions on drawdowns and use of proceeds, mandatory prepayments in the lenders’ favour, and restrictions on additional debt. Corporate loans also include such covenants, but in the case of project finance, the covenants are tighter, providing early signals to the lenders if creditworthiness is deteriorating. Beale et al emphasise the banks’ favourable negotiation position. Being the primary source of loan capital for projects enables the banks to implement covenants that protect their interests. The study investigates the probability of project loans defaulting, and finds that they can be compared to BBB+ rated corporate loans in the long term, and loans of BB+ rating in the short term. The inconsistency between short

and long term is explained by the fact that project finance loans become less risky as they reach maturity.

### Importance of contracts

Jensen and Meckling (1976) introduced the idea of considering the firm as “*the nexus of a set of contracting relationships*”<sup>4</sup>. This view is especially suitable for project finance because of the extensive use of contracts. Contracts are used to govern the relations to other parties such as contractors, suppliers, sponsors, the government, customers and lenders. With numerous parties involved it is important to have contracts delegating responsibilities, distributing risk and defining the purpose of the project’s cash flows. Because of this, project finance is sometimes referred to as “*contract finance*”. Figure 1 illustrates key participants and contracts in a typical project finance structure.



Adapted from Goldman et al (2005) p. 2

Figure 1 Illustration of project participants and contracts.

The importance of contracts in project finance is considerable because they provide credit support. Because project finance debt typically has non- or limited recourse, agreements, licenses and guarantees become part of what lenders take into account when deciding the debt capacity of the project. Khan and Parra (2003) list the following as central contracts:

<sup>4</sup> Jensen and Meckling (1976), p. 311

Concession agreement, off-take agreement, site purchase or lease agreement, construction contract, operations and maintenance (O&M) agreement and input supply contracts.

Concession agreements are used in situations where the project company “*provides a service to a public authority or directly to the general public*”<sup>5</sup>. Examples are construction and operation of bridges, toll roads or airports. An off-take contract applies in situations where the project’s production is sold to an off-taker, for example a power producer selling electricity.

Khan and Parra divide the construction contract into three general parts; *engineering, procurement* and *construction*. In the case of all three areas covered in one contract, this is called an EPC contract. The EPC contract describes the scope of the project, including design, technical specifications, criteria for performance, a fixed schedule for progress and a fixed price. In some cases, the contract also includes installation, in which the contract is called EPCI contract.

The O&M contract contains requirements regarding budget limits, health and safety standards, operating standards, routine inspections, and emergency repairs. Input supply contracts share many of the features of an off-take contract; it specifies technical requirements and in some cases volume and price of e.g. raw materials.

### **Risk management**

The capital structure combined with the contracts contributes to distributing the risks involved in the project between all parties involved, not only the sponsors. The web of contracts allocates different risks to the party with the best understanding of that particular risk.

The EPC contract contributes to risk management in several aspects; Khan and Parra describe how this is accomplished. The risks of cost overruns, delays and hidden defects are mitigated through a series of measures. The contract often contains a fixed price and a fixed schedule the contractor has agreed to, as well as a “takeover” test in order to discover any problems. Withholding a fraction of the payment to the contractor until the warranty period expires reduces the risk of loss due to contractor defaulting during the warranty period. The EPC contract often includes a liability cap limiting the potential claims on the contractor to a certain amount.

---

<sup>5</sup> Yescombe (2002), p. 69



The other types of contracts contribute to risk management in the same manner as the EPC contract. The off-take contract primarily reduces market risk because it guarantees a minimum level of revenue. Correspondingly, the input supply contract reduces price risk of required raw materials.

## 1.4 Sources of project finance

Providers of project financing include, according to Farrell (2003), commercial banks, leasing companies, insurance companies, pension funds, governmental bond authorities, finance companies, export credits, international financing agencies, private lenders, and customers. The main sources of funds are equity and debt, in addition comes the possibility of lease finance and government support.

### **Equity**

The equity in the project company is provided by the sponsoring companies. As mentioned earlier, equity is held by one or a few sponsors and constitutes a smaller fraction of the capital structure, typically around 30 %. Since equity has residual claim on any distributions, the risk of equity is higher than debt, which has first priority. Therefore, the required return from equity investors is higher. Equity also has control rights in the form of voting rights. Gatti describes four types of sponsors; *industrial sponsors*, *public sponsors*, *contractors*, and *purely financial sponsors*. The first group consists of companies looking to extend their business either way in the value chain. The next group are governments and municipalities interested in increasing social welfare. The third type of investors is contractors or suppliers who wish to invest in the project in addition to participating later. This can be an effective way to incentivise an EPC contractor as he will benefit from finishing construction on time not only as a contractor, but also as a shareholder in the SPV, which then can start generating cash flows. For the fourth group of investors the project is like any other investment, their reason for investing in the project is solely to gain a return on their equity contribution.

Even though the debt has limited or non-recourse to the sponsor company, the sponsors still have an impact on the project, and are of great importance to the lenders. Lenders wish to have long-term sponsors who involve themselves in the project. From the banks' perspective, this contributes to ensuring project success. It is also even required in the loan agreement that

the ownership of the project remains unchanged, at least for a certain period. For the banks, it is important that the sponsors have enough incentives to support the project. Yescombe argues that a reasonable amount of equity invested in the project and a reasonable return on the investment provide such incentives. The first ensures that the sponsors protect the project from failure, and the latter gives the sponsors reason to continue their involvement.

### **Debt**

Project finance debt can be raised from banks or the bond market. In 2001 133 billion USD was raised as project finance debt, out of which 80 % was bank debt and the remaining 20 % was raised from the bond market. From the borrower's perspective there is little difference between issuing bank debt and bonds, both entail promised payments of principal and interest or coupons. The major difference, according to Yescombe, is that bonds are more liquid than bank loans because they are tradable instruments. Bonds also have lower priority than bank debt. In reality, however, this difference is not as important as many project bonds are sold as private placements and loans are in fact traded between banks. Bonds attract institutional investors such as pension funds, insurance companies and mutual funds in addition to banks.

Figure 2 displays the mandated arrangers in project finance loans in from May 2009 to May 2010<sup>6</sup>. State Bank of India is ranked number 1, the loan volume of 21,632m USD from 47 deals represent 10.7 % of the total amount during the period.

---

<sup>6</sup> From [projectfinancemagazine.com](http://projectfinancemagazine.com)

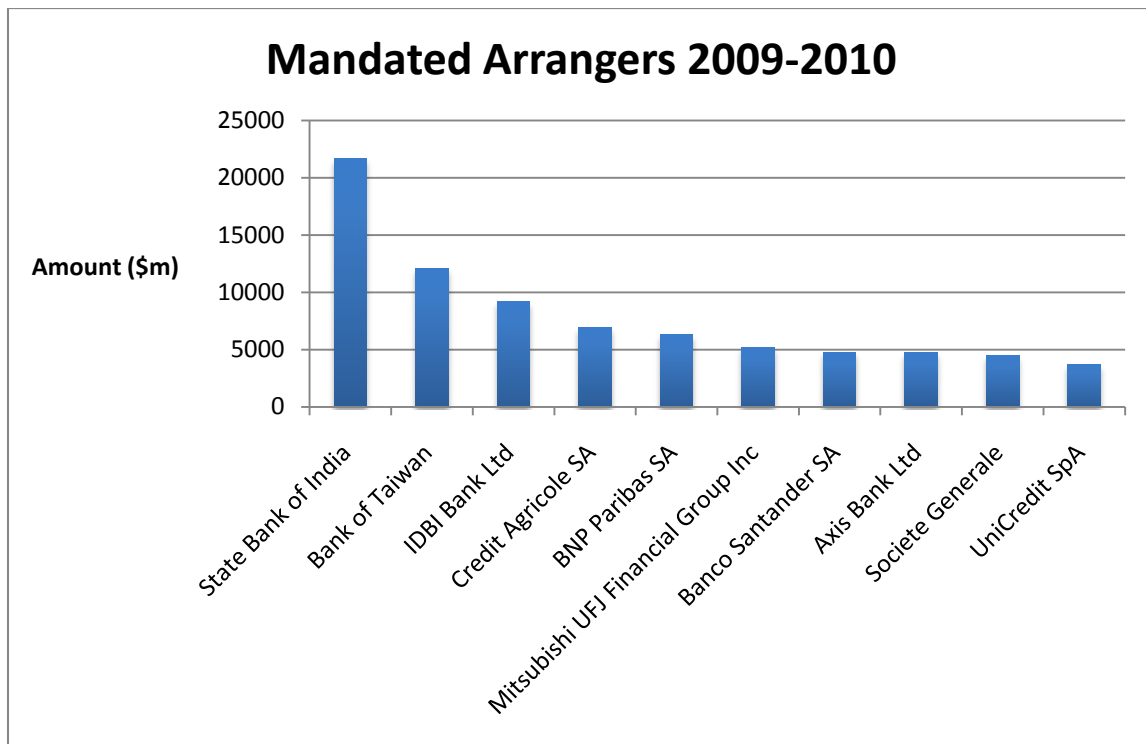


Figure 2 Mandated arrangers of project finance loans 2009-2010

### Lease finance

Leasing is an alternative to purchasing assets and can be considered an addition to issuing debt or equity. In leasing the initial outlay is less than the purchase price, but it resembles debt financing because it entails a series of fixed payments over a certain period of time. Depending on the nature of the lease contract, a distinction is made between *operating* and *financial* leases. Copeland et al (2005) explain this difference; operating leases include financing and maintenance services, is not fully amortised and have a cancellation clause. A financial lease on the other hand, does not include maintenance services, is fully amortised and cannot be cancelled before expiration. Fully amortised means that the rental payments the lessor is entitled to equals the total price of the asset. From an accounting perspective, operating leases are off-balance sheet financing (future lease obligations must be disclosed) whereas financial leases must be shown on the balance sheet.

According to Yescombe the advantages of lease finance in project finance is related to tax benefits. Project-financed ventures often do not generate sufficient taxable profit in the first years to fully exploit the benefit of tax-related depreciation. Lease finance enables the lessor (i.e. the company who owns the lease object) to obtain the tax benefit which in turn is

beneficial for the lessee (i.e. the party who leases the object) through reduced leasing costs. Another benefit for the project company is the transfer of equipment risk to the leasing company.

### **Government support**

Government support available for project exists in various forms. According to Khan and Parra, governments provide financial support through government guarantees, equity participation, government debt, grants and preferential tax treatment. Government guarantees and financial support play an important role especially for the development of new technologies. In addition to governmental initiatives, bilateral institutions also play a part in project finance; either in the form of Export Credit Agencies (ECA) or investment promotion agencies. ECAs provide direct loans as well as guarantees and insurance to encourage exports from the respective home country.

## **1.5 Project finance and other financing structures**

The main difference between corporate finance and project finance is that while the entire corporate balance sheet is considered when determining debt capacity and defining collateral in the case of corporate financing, only the project itself is responsible for project finance debt. A summary of the differences between corporate finance and project finance is shown in table 1.

In addition to differences in collateral, the accounting treatment differs between the two structures. Whereas corporate finance debt is presented on-balance sheet, project finance, under certain conditions, are off-balance sheet for the sponsor. The main variable considered when deciding the project's debt capacity, is future cash flows to the project. In comparison, corporate debt capacity is affected by the soundness of the whole company, its relations to customers, profitability of all activities, and its assets. Finnerty argues that control and monitoring differs in corporate finance and project finance. In a conventional organisation the management is in control, and monitoring is done by the board of directors, rarely by the investors directly. In project financed ventures, management control is limited and monitoring increased. The transparent nature of project companies and the covenants imposed by project debt enables the creditors to perform closer monitoring, and reduces managerial discretion. Financial flexibility is another area where the two structures deviate. Finnerty argues that financing can be arranged quicker in corporate finance compared to project financed where

the process is more time-consuming due to a thorough due diligence process and contractual negotiations.

	<b>Corporate finance</b>	<b>Project finance</b>
<b>Collateral for financing</b>	Assets of the borrower	Project assets
<b>Accounting treatment of equity at sponsor level</b>	On-balance sheet.	Off-balance sheet (the only effect is the cash outlay to subscribe the equity in the SPV).
<b>Main variables considered when granting credit</b>	Customer relations, financial soundness, profitability, company assets.	Future cash flows.
<b>Sustainable leverage</b>	Depends on the effects on the borrower's balance sheet.	Depends on the cash flow generated by the project (leverage is usually greater).
<b>Control and monitoring</b>	Control is vested primarily in management. Board of directors monitors performance on behalf of the shareholders. Limited direct monitoring by investors.	Management remains control, but is subject to closer monitoring. Contractual agreements governing the debt and equity investments contain covenants and other provisions that facilitate monitoring.
<b>Financial flexibility</b>	Financing can typically be arranged quickly.	Higher information, contracting, and transaction costs are involved.
<i>Sources: Caselli and Gatti(2005), Finnerty (2007)</i>		

**Table 1 Comparison of corporate finance and project finance**

Esty and Christov (2002) compares project finance with other financing structures. Project finance can be similar to joint ventures, but unless the funding is non-recourse, it is identical. Secured debt has recourse to corporate assets, and leveraged-buy-outs (LBOs) lack a corporate sponsor in order to be defined as project finance. Project holding companies may qualify as project finance, but Esty points out that as the number of projects in such

companies increase, cross-collateralisation increases and they are more similar to corporations.

## 1.6 Rationale for use of project finance

Traditional theory on capital structure argues that firm value is unaffected by financing. This was stated by Modigliani and Miller (1958) in their irrelevance proposition:

*“The market value of any firm is independent of its capital structure and is given by capitalising its expected return at the rate  $\rho_k$  appropriate to its class.”*

This proposition however, relies on a number of assumptions. The theory on project finance contradicts this proposition and suggests that firm value can be increased as a result of how the project is structured. Both Esty (1999) and Shah and Thakor (1987) explain this inconsistency as a breach of Modigliani and Miller’s assumptions. Esty argues that in the real world there are taxes, transaction costs, costs of financial distress and costs related to asymmetric information and incentive conflicts. He argues that project finance creates value because it reduces the costs of these market imperfections.

Brealey et al (1998) describe how project finance address agency problems and contributes to risk management, while Shah and Thakor look at how project financing allows higher leverage and reduces the creditors’ screening costs. Esty argues that project finance eliminates four sources of investment distortions. I will in turn look at these theories.

### 1.6.1 Brealey et al – Agency costs

Agency relationships take place when an agent is set to perform certain tasks on behalf of a principal. Agency costs arise when the incentives of the agent are not aligned with those of the principal. Typically the agent will act in his best interest, not according to what is the principal’s best interest. The principal cannot observe the agent’s actions and information directly and it is difficult for the principal to prevent such behaviour since writing complete contracts is expensive, if not impossible. Jensen and Meckling (1976) argue that it is reasonable to assume that this will happen, given that both are utility maximisers. They define agency costs as the sum of the monitoring expenses the principal initiates, the bonding expenditures caused by the agent’s actions, and a loss in wealth caused by the agent not pursuing the principal’s wishes. Bonding expenses are caused by the agent’s attempt to prove

his commitment to the principal's goal. Examples of such expenses are costs of reporting and auditing. The reporting is carried out to document the agent's effort and auditing is conducted to obtain outside approval of this documentation. Brealey et al argue that project finance can reduce the agency problems through contracts distributing risks between the project participants and by giving important incentives.

Jensen (1986) describes situations where agency costs arise because of free cash flow. Jensen defines free cash flow as "*cash flow in excess of that required to fund all projects that have positive net present values when discounted at the relevant cost of capital*". Managers can sometimes have incentives to make the company grow beyond what is the optimal size in the owners' perspective. Examples of reasons for this can be empire building or compensations plans where remuneration depends on growth. Jensen argues that in such situations debt can have a disciplining effect. Having debt as a part of the capital structure commits the manager to making repayments and reduces the cash flow available for spending on negative NPV-investments, pet projects or other purposes not in the best interest of the principal.

Brealey et al argue that while Jensen's theory reduces the agency problem, it does not explain why debt should be located in a project company rather than with the sponsor itself. They put forward two possible reasons for why the location of debt is relevant. The first explanation is that placing the debt in a project company eases monitoring compared with including the debt in the existing parent company. The other explanation applies in situations with more than one sponsor and where the sponsors have differing opinions on how cash in the project should be spent. Having debt then mitigates conflicts since free cash flow is determined for debt service.

Project finance contributes with new ways of solving these agency problems compared to corporate finance. Whereas some measures can be useful in corporate finance, others are more appropriate for project finance.

In corporate finance takeover-threats help discipline managers. Projects however, are privately owned and the market for project takeovers is less liquid compared to corporate takeovers. Measures that are better suited in project finance are corporate governance, concentrated ownership, separate incorporation and contracts. Setting up a new project organisation enables the sponsoring company to design a new corporate governance system which can better address the specific challenges of the project organisation. A tailored governance system can be more efficient in handling project-specific problems.

The concentrated ownership of project organisations with only one or a few sponsors gives stronger incentives for monitoring the project. In more disperse ownership structures; free-riding on other owners when it comes to monitoring costs is likely. With only one or a few sponsors, this is avoided in project finance. The debt in project companies also encourages monitoring. The debt is usually bank debt, not public bonds, giving stronger incentives for monitoring. The fact that the project is a separate unit and therefore more transparent, eases the supervision and reduces monitoring costs. Another mechanism that helps reduce agency costs is the extensive use of contracts in project finance. Contracts regulate several relations and decide the purpose of the project's cash flows. In all, this monitoring helps improve performance, reducing the need for discipline from the market for corporate control.

Jensen's theory predicts that there are agency costs connected to having large free cash flows. Project companies often have high leverage and therefore reduced free cash flows available for non-optimal purposes. In addition, project companies have few growth opportunities; they are established to perform one task and investing in other projects is irrelevant.

The agency cost motivation explains how project finance reduces agency costs based on the features of project finance and less free cash flow. This cost reduction leads to increased project value compared to organising the project as a part of the sponsor company.

### **1.6.2 Shah and Thakor – optimal capital structure**

Shah and Thakor develop a theory on optimal capital structure showing that high risk firms will issue more debt and pay higher interest rates than what is the case for low risk firms. Further, they present a rationale for project finance.

The first part of Shah and Thakor's paper shows how riskier firms choose higher debt levels and pay higher interest rates. Their model assumes two types of firms; high risk firms and low risk firms. The true level of risk is only known by the firm itself, i.e. there is asymmetric information, and releasing information to the capital market about the risk level is prohibitively costly. The reasoning behind their result is that high risk firms have incentives to understate the level of risk they face because this will give them lower interest rates on debt. To avoid untruthful reporting, the banks offer higher debt levels to induce these companies to report higher levels of risk. The banks will offer low risk firms low interest rates to prevent them from mimicking the high risk firms. The high risk firms have a greater probability of achieving very high returns, and therefore high tax-deductible interests are more valuable for



the high risk firms than the low risk firms. The differing motivations lead to a perfectly separating equilibrium where high risk firms have high leverage and high interest rates. Low risk firms are granted lower leverage and lower interest rates.

This contradicts existing theory claiming there is an inverse relationship between leverage and risk, since expected bankruptcy costs increase with the riskiness of the firm and the marginal tax rate does not vary with risk.

In the second part of their paper, Shah and Thakor link this result to project finance. Now, their model allows information production at a certain cost. Therefore, the firms can either release information to the market about firm risk, or reveal the risk level through their choice of capital structure, as described above. The two alternatives are in the following referred to as “*information production*” and “*revelation game*”. The actual information production is carried out by the creditors, but in equilibrium the cost will be borne by the firm. In a situation where a firm chooses to finance a new project within the company (i.e. corporate finance), information must be produced about the whole company. Creditors might have difficulties separating the project’s cash flows from the cash flows from other operations in the firm. This gives the company an opportunity to mislead creditors.

This is a classic case of asymmetric information, as described by Myers and Majluf (1984). When managers have information that outsiders do not have, managers can in some situations decide to not undertake an investment, even though it has a positive NPV (net present value). This is because the financial market is unable to separate between companies in a good and bad state, and because management maximises the value of the old shareholders’ shares. Debt and equity will be priced correctly on average, but firms in a good state will experience underpriced equity and overpriced debt. If the NPV of the project is not high enough to compensate for the mispricing, the firm will reject the project. In their model Myers and Majluf derive a pecking order theory of financing, stating that firms first prefer using internal funds, secondarily debt and last equity.

Another consequence of asymmetric information, which can arise in this situation, is asset substitution. Asset substitution happens when a company can invest in two possible projects; one being low-risk, the other high-risk. The bank lending the company the necessary funds, however, is only aware of the first project and believes the loan will be spent on the low-risk project. After obtaining financing, the managers of the firm, whose goal is to maximise

shareholder value, will choose to invest in the high-risk project. The reason for this is that risk is favourable for equity because equity is a residual claim. Higher risk increases the upside potential, whereas the downside is capped because of limited liability. Asset substitution causes risk shifting from equity holders to debt holders, and consequently a wealth transfer from debt holders to equity holders. In a market with rational participants, lenders will predict this asset substitution *ex ante*, and either refuse to finance the project or introduce debt covenants restricting the company to choose the safer project. Project finance prevents asset substitution because of the use of detailed covenants and lender control initiated by the banks and thorough due diligence performed before signing the loan contract.

If the company chooses project finance instead of corporate finance, the problems of asymmetric information is reduced, since the creditors then only have to produce information about the new project. Asset substitution is also more easily avoided, since separate incorporation increases transparency and eases creditors' monitoring of the project. Project finance is valuable because it reduces the screening costs.

The alternative to information production according to Shah and Thakor's theory is to engage in the revelation game and report the true risk level in order to achieve beneficial terms on the debt. In this case, project finance is beneficial if it can lead to higher leverage. As described above, Shah and Thakor claim riskier firms can obtain higher leverage when they disclose their true level of risk. Project finance is therefore valuable whenever the riskiness of the project is higher than the riskiness of the company as a whole after initiating the project, because the sponsor can gain higher leverage when the project is established as a separate unit.

Shah and Thakor conclude that creditors in project financed ventures will be highly involved, and that the riskiest investments will use project finance. According to their work, the motivation behind the use of project finance is to minimise unwanted consequences of asymmetric information.

### **1.6.3 Esty – investment distortions**

Esty (1999) describes how project finance mitigates four types of investment distortions; *overinvestment* in negative NPV projects, *overinvestment* in high-risk negative NPV projects,

---

*underinvestment* in positive NPV projects, and *underinvestment* in risky, positive NPV projects. The first category is the same free cash flow problem as Brealey et al address in their article. The second investment distortion concerns risk shifting, which corresponds to the asset substitution problem described by Shah and Thakor. The third category concerns a problem known as *debt overhang*. The fourth investment distortion is underinvestment in risky, positive NPV project due to managerial risk aversion. Project finance solves this by isolating the project in a separate company and hence avoids risk contamination. Debt overhang and risk management in project finance is described in detail in the following paragraphs.

### **Debt overhang**

Myers (1977) argues that in certain situations, having debt in place can cause a company to forego new investments, even when they are profitable, because the market value of the equity will be reduced. If the sponsoring company already has debt, taking on a new and profitable project will subsidise older debt claims and lead to a transfer of wealth. Managers will predict this wealth transfer from equity holders to the creditors, and since they act on behalf of equity holders, they will choose not to invest. Financing the project separately solves this underinvestment problem. Project financing brings in new capital and avoids subsidising debt with higher seniority.

### **Risk management**

Project finance contributes to risk management mainly in two ways; it reduces potential collateral damage on the company's other activities, and it provides useful tools for better risk handling. Esty (2002) explains how a risky investment can affect a company's other business: *"Investment in a risky asset exposes a firm to the possibility of risk contamination, the phenomenon whereby a failed investment drags an otherwise healthy firm into default. Even short of default, a failing investment can impose serious collateral damage."*

Keeping the project separate from the parent company protects the company if the project should default. In the case of non-recourse debt there is no financial risk for the sponsoring company, beyond the contributed share of equity. When the debt has limited recourse the sponsoring company has limited liability for the debt and will be affected to some extent in case of default. Separate incorporation enables the parent company to start up a project without exposing their other activities to the risks inherent in the new project. The risk management motivation is important not only in the extreme case of default, but also if the

project underperforms compared to expectations. Investing in a risky project increases the volatility of the company's cash flows and leads to increased costs of external financing. Increased volatility also reduces the expected value of the tax shield. In addition, there are reputation effects influencing the opinions of suppliers, customers and employees. Suppliers and customers may become more reluctant to conducting business with the company if they believe the risk of default is increased as a result of taking on a more risky project. Employees may for the same reason be unwilling to invest their human capital in the company. Esty (2003) defines the consequences above as deadweight costs. If the sum of the deadweight costs is higher than the NPV of the project, the company will choose to forgo the investment. Financing the investment as a separate project avoids these deadweight costs.

According to Esty there is a trade-off between keeping the project separate in order to protect the parent company, and gaining co-insurance in the case of incorporating the project with the company's other businesses. Co-insurance is obtained in large corporations when cash flows from various projects are pooled together and provide cross-collateralisation in case one project performs poorly. Esty (1999) criticises those who claim that isolation of project risk is an advantage of project finance, without paying any attention to lost co-insurance. Believing the sponsors can take part in upside potential without any loss compared to corporate finance, is according to Esty, a "*free lunch fallacy*". The recourse feature does not only protect the sponsoring company from the project's performance, but also vice versa, the project is protected if the sponsoring company should start performing poorly.

The other aspect of risk management is risk handling. Esty argues that project finance is a tool providing risk sharing. With many parts involved in the project, risk can be allocated to the party best suited to handle the risk in question. Brealey et al (1998) give examples of how major risks are allocated through contracts. Since the project sponsors have best control of the overall progress, they are obligated through a facility management contract to make sure the project is completed on time and built and operated according to predefined standards. The main contractor has the responsibility of completing the project on schedule and within budget limits. This is regulated in the EPC contract which often specifies a fixed price and what penalties the contractor faces in the case of delays. In projects with one major supplier a long-term supply contract can mitigate the risk of the supplier taking advantage of his monopoly power. In situations with only one or a few customers revenue risk is a key concern. This risk can be handled in a long-term sales contract, for example with a take-or-pay clause. In other projects, supporting infrastructure may be a concern. In those cases, an

agreement with the government can specify responsibility to build access roads or other forms of communication. This reduces the risk of the project failing due to lack of infrastructure. Brealey et al argue that such an allocation of risks is the most efficient because the use of contracts transfers risk to the party who is controlling the source of the risk.

In contrast to traditional risk management, project finance utilises the organisational form when dealing with risk. Traditional strategies often include the use of derivatives or other financial instruments which may not be applicable for projects because the derivatives do not exist or are too costly.

#### **1.6.4 Other advantages of project finance**

In addition to the above mentioned motivations for using project finance Brealey et al present a few other advantages. They emphasise the ability of project finance to specialise and decentralise management and the possibility of tailoring incentives for project managers.

Yescombe argues that higher leverage increases investors' returns on equity. Although this argument is correct, it disregards the offsetting impact on equity risk. Project finance can in some circumstances also have tax benefits. Esty argues that project's sometimes can obtain tax benefits, e.g. tax credits or tax holidays, which it would not qualify for if it was part of a large corporation. Khan and Parra point at how projects can avoid double taxation. Another advantage they mention is how project finance can be utilised to avoid covenants on existing corporate debt. A company is typically restricted with regards to further indebtedness by covenants on the existing loan. Project finance allows the company to undertake a new project without leading to a breach of the existing loan agreement.

#### **1.6.5 Disadvantages of project finance**

So far, this thesis has focused on the advantages to and motivations behind the use of project finance. However, there are also costs to consider, and situations where project finance may be less suitable. Compared to conventional corporate finance, project finance is more time-consuming and involves higher transaction cost. Establishing a separate project organisation takes, according to Esty (2003), from 6 to 18 months more than setting up the project within an existing organisation. In his article, Esty refers to studies showing that transaction costs

typically are 3-5 % of the amount invested, but can amount to 10 % for small and innovative projects. An illustrative project is the Petrozuata project, an oil field development project in Venezuela. According to Esty (1999) this deal took the sponsors over five years to negotiate. Later this project was awarded Deal of the Year and even Deal of the Decade by Project Finance Magazine. The legal and advisory costs in this 2.45 billion USD deal amounted to 15 million, approximately 0.6 % of the investment. Financing and issuance costs were 17 million, of this 12.5 million for the bond issues and 4.5 million for underwriting, commitment and participation fees for the bank debt. In total the fees represented 1.3 % of the investment cost. The use of internal resources such as time of the employees, are not included in these numbers, further increasing the actual costs.

One of the reasons for the lengthy process and high transaction costs is the extensive use of contracts and documentation and consequently higher legal fees. Esty (2003) also argues that due to the loss of co-insurance, project debt is often more expensive than corporate debt, with spreads up to 400 basis points more. Although it may be true that project finance debt have higher margins, this reflects the higher risk associated with these loans. Therefore this is only a consequence of project finance and its higher leverage, not a disadvantage. Kleimeier and Megginson's study in fact showed that when risk is accounted for, project finance loans have lower spreads than other loans.

These disadvantages make project finance less suitable for smaller projects as smaller scale makes the structure less cost-efficient. However, Esty (1999) claims that simple projects that entail established technologies require less negotiation, and therefore make up for lack of scale.

According to Khan and Parra project finance is time-consuming and will often lead to delays in financial closing because of the lengthy negotiation process. Hoffman (2008) discusses the disadvantages of increased lender supervision. Because the creditors take on greater risk in project finance, they will also demand greater oversight of the project. Increased creditor involvement involves monitoring covenants closely, strict reporting and documentation requirements. Both Hoffman and Khan and Parra argue that this leads to reduced managerial discretion.

## 1.7 Summary

Project finance is more than a source of finance; it is a defined structure that involves special features separating project finance from other types of finance. An essential part of project finance is the separate incorporation of the project as an independent legal unit. This opens for issuing debt with limited or no recourse to the project sponsors, which is central in risk management. The capital structure in a project financed venture typically involves a high debt level, often as much as 70 – 80 % of the total capital. The debt is in most cases provided by commercial banks, but the bond market is also available for projects. The remainder of the capital structure is often equity provided by the sponsors, but capital can also be provided through lease finance and government support.

Another important aspect of project finance is the wide-spread use of contracts. Project finance involves many participants, and contracts contribute to regulate relationships and define responsibilities. The contracts are part of what decides the financial strength of a project, and is considered by the banks when determining debt capacity. The future cash flows to a project are solely responsible for servicing debt because of limited recourse, and therefore off-take contracts are essential to the financial strength of a project.

The use of contracts in project finance is central in risk management. The contracts distribute risks to the parties with the best understanding of each risk. The party who controls a risk source is often best able to handle that particular risk and is able to do so at the lowest cost. In all, this reduces total risk and the cost of risk mitigation. A central contract in this aspect is the EPC contract; since the EPC contractor controls the construction process, he is made responsible for the risk of delay and cost overruns.

Project finance differs from corporate finance in several respects. When it comes to collateral for debt, all company assets are available for banks in traditional corporations, while only the project's assets are available to debt holders in project finance. The debt capacity is determined by the profitability of the entire company in corporate finance, as opposed to project finance where future cash flows to the project are solely responsible for debt service, since there often is no recourse to the sponsors. These differences lead to advantages and disadvantages of both structures. Limited recourse reduces the possibility of risk contamination, but project financed ventures lose co-insurance gained in large corporations.

Different theories seek to explain the rationale for employing project finance. According to Miller and Modigliani's classic finance theory, there should be no difference between establishing a project separately and within the existing organisation.

One explanation is found in agency theory. Agency costs arise in companies with high free cash flows and cause overinvestment and increased spending on non-optimal purposes. Project finance solves the problem of free cash flow by utilising the disciplining effect of debt in the capital structure. Project financing involves high debt levels and therefore reduce the available cash flows. In addition, since the project company is established to perform one particular task, investing in other projects is often not an alternative. Corporate governance is another area where project finance contributes to reducing agency problems. Governance structures in project companies can be more efficient than in large corporations, because projects are smaller and more transparent and because the measures can be designed to handle project-specific problems.

Another theory is that project finance reduces asymmetric information and hence eases problems with underinvestment and asset substitution. Asymmetric information can lead to undervaluation of profitable firms, and cause them to forego investments in positive NPV projects. Asymmetric information may also result in asset substitution which causes a wealth transfer from creditors to equity holders. Shah and Thakor explain how project finance enables firms with high-risk projects to obtain higher leverage than low risk firms. Creditors wish to induce firms to truthful reporting, and award high-risk firms higher leverage to state the true risk level, whereas low-risk firms is given lower interest rates. Shah and Thakor's theory conclude that high risk projects will always use project finance.

A third explanation looks at four scenarios distorting investment decisions. Two of these lead to overinvestment, the other two cause underinvestment. In all four cases the suboptimal investment reduces the firm value. Project finance is advantageous because it removes the source of the investment distortion. Hence, investment choices will be made on the right decision criteria, and firm value is maximised. The scenarios causing overinvestment are free cash flow problems and asset substitution, which are discussed in the agency theory explanation. Reasons for underinvestment are debt overhang and managerial risk aversion. Project finance contributes to easing these problems with separate incorporation and no pre-existing debt and isolation of project risk.



Although these theories suggest project finance can lead to additional value, there is a trade-off between the increase in value and the costs associated with project finance. The process of establishing a separate project company, discussing risk distribution with project participants and debt negotiations with the bank is time-consuming, and legal fees and advisory fees can amount to high costs.

## 2. Project finance and risk

### 2.1 Introduction

Damodaran (2003) defines risk as the likelihood of the return on an investment deviating from the expected outcome. This definition recognises that risks are not necessarily negative, but can also have a positive effect on the result. According to Wisner et al (2004) it is important to distinguish between *risk allocation* and *risk mitigation*. The first concept refers to how the consequences of risks are being treated and who has to deal with them. Risk mitigation concerns reduction of risk and minimising of consequences. There are several ways of categorising risk. Esty (2002) provides a framework that divides risk into three groups; *symmetric risks*, *asymmetric downside risks* and *binary risks*. The categories refer to how the different sources of risk affect returns. Symmetric risks can affect results both positively and negatively, examples of such risks are market risk with regards to quantity and price, supply risk and competition risk. For example, sales can turn out to be higher or lower than projected, leading to higher or lower revenue respectively. Asymmetric downside risks are risks that can only cause a reduction in returns. This can be environmental risk or expropriation risk. The third category, binary risk, is risks with only two possible outcomes – success or failure. Examples include technology failure, counterparty failure, regulatory risk or force majeure.

As mentioned in the section 1, Esty (1999) argues that risk management is one of the advantages of project finance; the financing structure allows distribution of risk to the party best equipped to handle that source of risk. Risk management is important in project finance for several reasons. Because of the limited or non-recourse feature of the debt, lenders will not accept an incautious handling of risks since a poor outcome will affect the project's ability to service the debt. Furthermore, risks may have a greater impact in project finance settings compared to corporate finance. A delay in construction will affect only part of the business in the case of corporate finance and the company may have other sites that temporarily can take over. In project finance, however, the whole business is affected and the result may be default.

## 2.2 Project phases and risk

The project life cycle can be divided into three phases; *development*, *construction*, and *operation*. In the development phase, contracts are being negotiated and financing secured. In the construction stage the funds are drawn and being used for the physical construction of the project. The third phase, operation, is when the commercial activity starts and the project generates revenue, which in turn is used for repayment of the debt. According to Yescombe (2002), the end of the development phase is known as “*financial close*”, whereas “*commercial operation date*” marks the end of the construction phase. The project company is not necessarily established at the beginning of the development stage since it has no purpose until the financing is finalised.

As the project goes through the different phases, the risk profile changes. Hoffman (2008) argues that risks during construction and operation receive more focus than the risks in the development phase. The risk of not being able to service the debt is not applicable in the development phase, but there are still great consequences of the relevant risks at this stage. Many of risks in the development stage are binary, meaning that their outcome determines whether the project will be realised or not. Binary risks combined with the fact that project development often is very expensive, underline the significance of these risks. The development phase is funded by government grants, development loans, equity or a combination of the three.

Among the risks listed by Hoffman are the risk of losing the rights to develop the project, competition risk from other projects, changes in framework conditions, and unavailability of central project components. Examples of essential components are agreements with authorities, permits, off-take contracts, and supply of raw materials. Other factors which can endanger the project are political opposition, citizen opposition, impact on the environment or the native population.

## 2.3 Construction and operation risks

Identification of relevant project risks is important in order to be able to determine appropriate risk mitigation and risk allocation. The following presents the most relevant construction and operation risks adapted from Finnerty (2007), Gatti (2008), Hoffman (2008), and Nevitt and Fabozzi (2000).

**Completion risk**

Completion risk concern delay in construction or the project not being completed at all. Reasons can be force majeure events, cost overruns or technical deficiencies.

**Technological risk**

Technological risk includes both the risk of technological deficiency and technological obsolescence. The latter is especially relevant for industries with high technological development. Projects with a high risk of being technologically outdated after completion are unlikely to qualify for project finance. The same is the case with unproven technologies. According to Hoffman, unproven technologies lack predictability, and are therefore not suited for project finance. However, such projects may receive project finance if a creditworthy project participant, e.g. the contractor or technology supplier, is willing to give a technical performance guarantee supporting the project debt.

**Financial risk**

Financial risks include interest rate risk, currency risk, inflation risk and credit risk. Interest rate risk applies in projects with floating-rate debt. Such projects involve the risk of not being able to service debt if the risk increases above a certain level. Currency risk is present when the project has obligations or receivables in different currencies. If one currency depreciates relative to the other currency there is an imbalance, which can affect the project's results both positively and negatively. Inflation represents a source of risk when cost inflation and revenue inflation develop differently.

Credit risk is also known as counterparty risk. Hoffman underlines the fact that allocating risks to other parties is a useful risk management tool only if that party is creditworthy; "*in the project finance equation, the project company's lack of creditworthiness, therefore, is exchanged with the creditworthiness of the other project participants*"<sup>7</sup>. This is why the lenders in project finance also investigate the financial record of contractors and suppliers, not only the sponsors. In projects with an off-take contract selling all or most of the production, the creditworthiness of this purchaser is especially important. According to Hoffman, factors such as industry ranking, line of business, sensitivity to price fluctuations and reputation are taken into consideration when evaluating the purchaser's creditworthiness.

---

<sup>7</sup> Hoffman (2008), p. 60

**Political risk**

Political risk, also known as legal or regulatory risk, is the risk of the authorities in varying degrees interfering with the project. Examples are legal restrictions, law changes and increased taxes. In more extreme cases, there is a risk of expropriation or expatriation. Hoffman explains expropriation risk as the risk of the host country taking control over the project's assets or rights, whereas expatriation is "*the risk that the profits earned in connection with project operation cannot be removed from the host country*"<sup>8</sup>. Political risk varies between countries, and is often more explicitly present in developing countries, but exists also in developed nations where increased taxes and retroactive law changes can affect project performance negatively. Hoffman emphasises how taxation can be used as a tool for governments to influence a project or an industry. Taxation entail possibilities to introduce new taxes, cancel or modify existing regulation, and remove favourable tax treatment. In projects with foreign sponsors, increased taxes can be a way of retaining the profits in the country (i.e. expatriation).

**Environmental risk**

Environmental risks are concerned with any negative impact the construction of the project can have on the surrounding environment. The government in the host country can impose liability on the project through environmental laws or regulations. Examples are fines and penalties, cleanup costs and treatment costs.

**Force majeure risk**

Force majeure is a collective term for events beyond the control of all project participants. These events are also called "acts of God" and include natural disasters, fire, war and strikes. Force majeure events may delay construction or temporarily stop operations.

**Market risk**

Market risk has a direct effect on the project's cash flows and consists of revenue risk, demand risk and raw material price risk. In case of an increase in raw material cost or reduced revenues, the project is in danger of not generating sufficient cash flow to cover its obligations.

---

<sup>8</sup> Hoffman (2008), p. 49

**Operational risk**

Once construction is completed and operations begin, there is a risk of the project not performing according to predefined specifications. As with market risk, this affects the project's debt service ability and cash flows available for equity holders.

## 2.4 Risk mitigation

After identifying the project risks, the next step in risk management is to implement measures to mitigate the risks. According to Gatti, the Special Purpose Vehicle (SPV) has three basic choices when it comes to risk mitigation; the SPV can retain the risk, the SPV can transfer risk to another project participant, or the SPV can transfer the risk to insurance agents, whose main tasks are risk management. The first option applies for the risks that cannot be allocated to counterparties, either because it is too costly to do so, or because it is not feasible. The second option is managed in contracts with stakeholders in the project.

There are also additional risk mitigation measures the sponsors can initiate. Choosing an EPC contractor which also can supply O&M services avoids misunderstandings and possible conflicts where the EPC contractor blames the O&M provider and vice versa and neither accepts responsibilities for deficiencies. Having a local partner, either as sponsor or another central stakeholder, can reduce the expropriation risk because local interests in the project make it less tempting for the host government to confiscate resources from the project.

The importance of maintaining good relations with project participants, the banks and the authorities should not be disregarded. Although financial soundness such as creditworthiness is the primary concern for the lending bank, reputation and relations with the sponsor company also play a part in negotiations. Trust between the bank and the borrower is essential to receive funding. The bank must be assured that the borrower is dedicated to the project and intends to pay back the debt according to the loan agreement.

**Contracts**

Contracts are part of risk mitigation because they describe the responsibilities of all project participants and allocate the project risks to the SPV and its counterparties. The contracts give incentives to comply with agreements because they state the penalties for parties not meeting their obligations. This risk allocation ensures that the costs resulting from any incidents are covered by the responsible party, not the SPV or the lenders.

Important contracts and what risks they cover will be described in detail in the case study in section 5. Central contracts are the Transfer of rights agreement, EPC contract, O&M contract, off-take agreement, loan agreement, permits from the authorities, and land lease or purchase agreement. These contracts entirely or partially cover revenue risk, technical risk, completion risk and operational risks.

A special type of contract is the financial hedging contract mitigating financial risks. Financial risks can be hedged with derivatives contracts such as options, swaps, futures and forwards. The perhaps most common hedge in project finance is the interest-rate swap. The interest rate risk of a floating-rate loan can be hedged with a swap, which receives a floating-rate interest and pays a fixed-rate interest. The net obligation for the SPV is fixed interest rate, and the risk of increases in the floating-rate is avoided. The lending bank often requires an interest rate swap.

### **Insurance**

According to Khan and Parra, insurance policies is a credit enhancement tool in project financing, since it covers risks not handled by any of the project participants. The answer to which party is best able to handle a risk in the least costly manner is often an insurance company. Insurance can in some case be required by the host country, in other cases by the lending bank. For several of the risk sources described, there exist insurance products which can mitigate the particular risk. Gatti emphasises that there is a trade-off between insurance and risk premium paid to the lending bank. The necessity of an insurance policy should be evaluated against the premium charged by the bank in absence of that insurance.

Common insurance policies according to Gatti are transport policy, third-party liability and accidental pollution, employers' third party liability, all assembly risks policy, all site equipment risks policy, force majeure, and business interruption. A special type of insurance is political risk insurance. Political risk insurance is provided by bilateral or multilateral agencies and commercial insurance companies. Export credit agencies (ECAs) provide political risk coverage for SPVs based in developing countries. The coverage often includes currency availability, expropriation and political violence. The coverage of creeping expropriation, change in law risk and contract risk varies between the different ECAs.

## 2.5 Risk matrix

After identifying the sources of risk and attempting to mitigate these through different measures, the agreed risk allocation between the project participants can be summarised in a risk matrix. A general risk matrix is presented in table 2. The matrix also contains what effect each risk has on project result; whether the effect can be positive, negative or both. Though it may seem as almost all risks are distributed away from the SPV, there are often remaining risks that must be borne by the project company. Even though most risk sources are distributed to various project participants, there is a possibility that the counterparty is unable to meet his obligations. The degree of recourse decides how much of the residual risk is allocated to the sponsors.



<b>Effect on project results:</b>	<b>Risk:</b>	<b>Mitigation mechanism:</b>	<b>Allocation to:</b>
-	Completion risk	EPC contract	EPC contractor
-	Technical risk	Warranties, guarantees	EPC contractor, technology supplier, equipment manufacturer
+/-	Financial risk: Interest rate risk	Derivatives, e.g. interest rate swap	Bank
+/-	Financial risk: Currency risk	Derivatives	Bank
+/-	Financial risk: Inflation risk	Derivatives	Bank
-	Financial risk: Credit risk	Due diligence examining creditworthiness of counterparties	SPV/sponsors
-	Political risk	Political risk insurance	Insurance provider (e.g. export credit agency)
-	Environmental risk	Insurance	Insurance provider
-	Force Majeure risk	Insurance	Insurance provider
-	Market risk: Revenue risk	Off-take contract	Purchaser
-	Market risk: Raw materials price risk	Long-term supply contract	Raw materials supplier
-	Operational risk	O&M contract, guarantees	O&M contractor, equipment manufacturer

*Table 2 Risk matrix*

## 3. Renewables and photovoltaic technology

### 3.1 Renewables

Utilising renewable energy sources is not a new phenomenon; before fossil fuels were discovered renewables such as sunlight, wind and water were the only available sources of energy. I will in the following use the term “*renewables*” as a collective term for renewable energy technologies. Although it is grammatically incorrect, this terminology is commonly used in the industry.

Renewables are preferred over conventional energy sources such as coal, oil and gas, because of their lower environmental impact. There are several factors driving a transition from fossil energy to renewable energy. Climate change, increased energy demand and energy security are central driving forces for the deployment of renewable technologies. In addition, Asplund (2008) points at technology improvements, demand for distributed power solutions and rising electricity prices as catalysts for the clean energy industry. The U.S. Energy Information Administration (EIA, 2009) has projected an increase in the world’s energy consumption of 44 % from 2006 to 2030. Substituting part of this increase with renewable energy would reduce the greenhouse gas emissions, which are part of the cause of climate change. Uncertainty about the remaining reserves of fossil fuels also contributes to making renewables the preferred future energy source, as well as both economic and physical energy security.

Although a transition from conventional energy sources to renewables is needed, the strategy for how to achieve this is not apparent. The Economist (2009a) characterises climate change as the hardest political challenge the world has ever faced: “*It is a prisoner’s dilemma, a free-rider problem and the tragedy of the commons all rolled into one.*” The topic is receiving more attention from both media and politicians than before, but it seems difficult to translate words into action. Scheer (2007) compares the consumption of fossil energy in a period where several global conferences took place. From 1990 to 2002 the consumption of renewable energy increased with 33 %, whereas the consumption of fossil energy resources increased with 44 %. Between 1995 and 2002 there were ten conferences discussing climate protection, which according to Scheer “*have not been able to change a single thing about this*

*development; the world's fossil energy consumption grew more rapidly than ever before*"<sup>9</sup>. More recently, the UN climate conference in Copenhagen in 2009 failed to meet the expectations of reaching a global agreement concerning climate change, and was described by The Economist (2010) as a failure.

## 3.2 Solar energy and photovoltaic technology

Today solar power provides only a marginal part of the world's energy generation, but the industry has experienced high growth during the last years and has great potential. Solar energy can be converted into electricity utilising the photovoltaic effect (this will be explained further in the following paragraph). Figure 3 shows the impressive growth in photovoltaic production from 1975 to 2007<sup>10</sup>.

According to Siegel et al (2008) the solar resources are enormous compared to fossil resources:

*"The amount of solar energy the Earth receives every minute is greater than the amount of energy from fossil fuels the world uses in a year"*<sup>11</sup>.

To illustrate the potential of renewable energy, Scheer (2007) calculates the size of the area required if the global electricity consumption were to be generated using only photovoltaic technology. This area is 210,000 km<sup>2</sup>, equal to approximately 2 % of the USA or Europe, or 5 % of Norway or Germany.

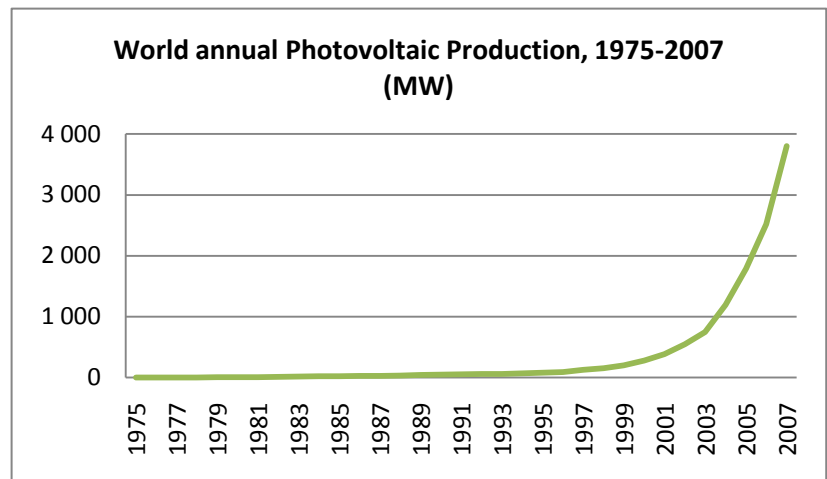


Figure 3 Annual photovoltaic production

<sup>9</sup> Scheer (2007), p. 2

<sup>10</sup> Earth Policy Institute (200)

<sup>11</sup> Siegel et al (2008), p. 27

## Solar energy

Energy from the sun can be utilised mainly in two ways; through thermal or photovoltaic technology. Thermal systems make use of solar energy in heat-driven mechanisms, for example converting water into steam, which then is used to generate electricity in a steam turbine. Photovoltaic (PV) systems transform sunlight directly to electricity utilising the photoelectric effect which was first described by Albert Einstein in 1905<sup>12</sup> and later awarded him the Nobel Prize in physics. I will in this thesis concentrate on projects using PV technology.

## PV technology

Figure 4 shows how PV technology makes use of sunlight. The solar panel is made up of several solar cells. Electric current is created when photons of sunlight strike the solar cell. Solar panels are in turn connected together in an overall system placed on a roof-top or mounted on the ground. Electricity from the modules is converted by a power inverter to the current used in the grid. Solar energy produces direct current (DC), which must be converted to alternating current (AC) by the inverter. Because PV technology utilise both direct and indirect irradiation, PV is not as dependent on direct sunlight as thermal solar systems are, and therefore applicable in greater parts of the world. Figure 5 shows the potential for PV electricity in Europe<sup>13</sup>.

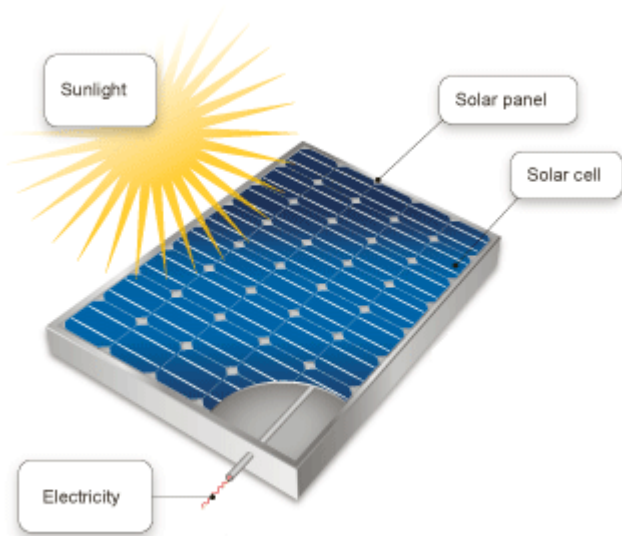


Figure 4 PV technology

---

<sup>12</sup> Store Norske Leksikon (2009)

<sup>13</sup> European Commission (2006)

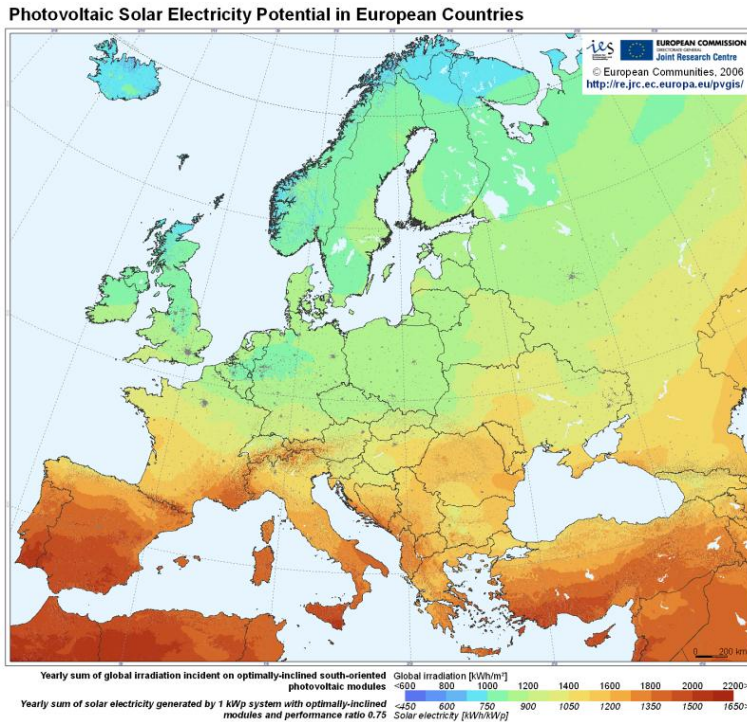
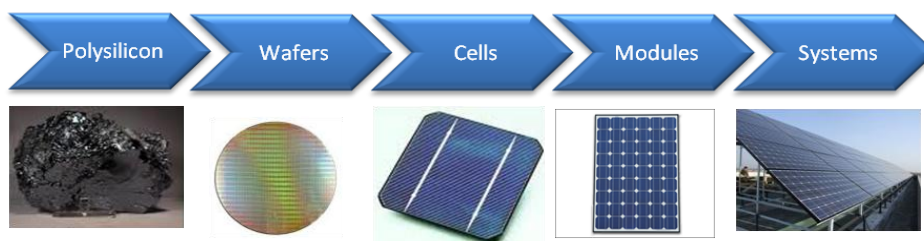


Figure 5 PV electricity potential in Europe

Watt-peak (Wp) or kilowatt-peak (kWp) is the unit of measurement for power generated by a solar module under standard test conditions. The actual generated power depends on weather conditions and module efficiency. The performance ratio (PR) is a measure of efficiency and reliability of a PV plant. The ratio is the relationship between actual and theoretically possible energy output.

The process of producing solar power starts with extracting silicon from quartz and ends with producing electricity in solar systems. The PV value chain is illustrated below. The first step is the process of transforming silicon of about 98-99% purity into high purity silicon, so-called polysilicon, with a purity of more than 99.9999%. In the next step polysilicon is cast into ingots, which are sliced into thin wafers. The third step of the process creates solar cells from the wafers in a chemical process. The fourth step assembles the cells together in modules, and in the final step modules are connected in solar systems to produce electricity.



An alternative to using silicon is thin-film PV. This technology uses other elements in the production process. According to Siegel et al thin-film technology has the greatest potential of reducing the cost of PV since it is better suited for mass-production and avoids the expensive

process of purifying silicon. However, thin film modules are currently less efficient and less suitable for system installations with area limitations, e.g. roof tops.

### Advantages and disadvantages of PV power

An apparent advantage to electricity generated using PV technology is its use of a renewable energy source and consequently low greenhouse gas emissions. The European Photovoltaic Industry Association (EPIA, 2010b) has identified 10 reasons for using PV electricity. Among these are no fuel costs, low maintenance required, no emissions and safe and reliable systems.

According to Asplund *“the energy from the sun that hits the earth every day is sufficient to meet the energy needs of the earth’s 6.6 billion inhabitants for 27 years<sup>14</sup>”*.

Availability of resources is therefore not an

issue. This gives PV a competitive advantage over other technologies when it comes to both securing energy supply and meeting increasing energy demand. These are both concerns to many governments. The availability of silicon is neither a problem, as this is the world’s second most abundant element after oxygen in the earth’s crust. Since this element is non-toxic, PV is one of the least polluting technologies when it comes to greenhouse gas emissions. A comparison with other electricity generation technologies is presented in figure 6<sup>15</sup>. Both polysilicon technology and thin-film have low green house gas emissions, only wind pollutes less.

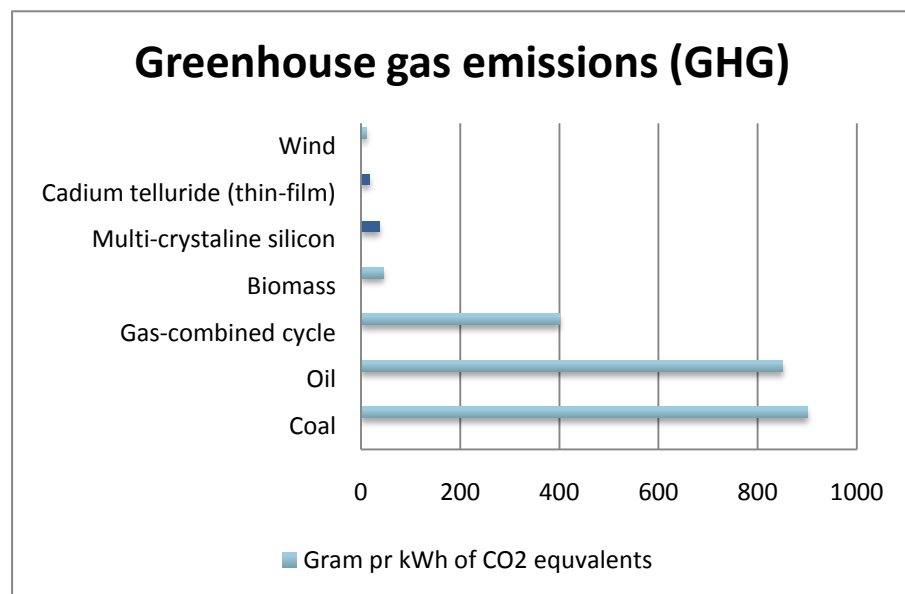


Figure 6 GHG emissions

<sup>14</sup> Asplund (2008), p. 75

<sup>15</sup> EPIA (2010b)

An advantage regarding R&D activity is that the silicon wafers used in PV are the same as the ones used in the semiconductor industry. A common knowledge base can be advantageous for both industries. An obvious drawback of PV is that it only generates electricity during the day. Another disadvantage of PV is that it still is expensive compared to conventional energy sources and depends on subsidies from governments.

### 3.3 Grid parity

A challenge for any power generating technology is to be competitive with other technologies and reach *grid parity*. Grid parity is the break-even cost defined as “*the point where the cost of PV-generated electricity equals the cost of electricity purchased from the grid*”<sup>16</sup>. For solar this goal has not yet been reached, except for in some markets where conditions are especially favourable. Additional efficiency gains, technological progress and cost reductions are needed for further development. The historical improvement in this area is impressive. From having a conversion efficiency of 5 % in the 1950s, modern cells have improved to 12 to 18 % efficiency. Whereas the cost of PV capacity was approximately 300 USD per watt in 1956, the cost in 2009 was 5 USD per watt<sup>17</sup>. This reduction is partially due to economies of scale, and partially to experience curve effects. Calculations done by Bradford (2006) suggest a learning rate of 18 percent from 1980 to 2003 for grid-connected PV modules. This means the unit cost has dropped 18 percent for every doubling of installed capacity. The cost reduction causes the price gap between PV power and power generated by fossil fuels to decrease, and in turn brings the price of PV electricity closer to grid parity.

A study on grid parity conducted by NREL (Denholm, 2009) found that the key drivers are not technical factors such as solar resource, but cost of electricity, rate structure and financing availability. Since incentive systems and electricity prices vary over time and geographical areas, break-even is reached in different markets at different times. The study shows that break-even was reached or almost reached in 2008 in some US states. In California grid parity

---

<sup>16</sup> Denholm et al (2009)

<sup>17</sup> EIA (2009)

was reached due to good solar resources, while drivers of grid parity in New York State and Massachusetts were high electricity prices combined with incentives.



## 4. Financing photovoltaic projects

### 4.1 Project finance and photovoltaic projects

I will in this part of the thesis present data on project finance loans in the PV industry. Section 4.1.1 summarises selected project financed PV deals announced since 2009. Section 4.1.2 looks into the details of the project financed Montalto di Castro PV project, which was awarded Deal of the Year by Euromoney in 2009, while section 4.1.3 analyses a sample of actual term sheets.

#### 4.1.1 Project financed photovoltaic parks

In order to take a closer look at current project financing, I have examined news from the PV industry mainly published in Project Finance International and Project Finance Magazine from January 2009 until April 2010, limited to projects in Germany, Italy, France and the Czech Republic. These countries are chosen for various reasons; Germany is the largest PV market in the world, the other countries are emerging markets at different stages. According to New Energy Finance (2010) the capacity installed in Germany in December 2009 alone, is greater than installed capacity in any other country for the whole year. Solarbuzz (2010) reports Germany, Italy and the Czech Republic as the top three countries in PV in 2009. The results of this analysis are presented in appendix 2.

The review shows that the Puglia region in Italy is centre for a great deal of the PV plants in Europe. The size of the projects ranges from 1 to 100 MW; the total size of all deals in the period is approximately 600 MW. (A cautionary note should be made here; the numbers are intended only as an illustration, not statistics.) One of the large PV plants project financed in Germany is the *Lieberose project*. With a size of 53 MW this is predicted to be Germany's largest and the world's second largest PV plant of its kind, according to Project Finance Magazine (2009b). Some of the largest projects are portfolios of parks. The value of the projects varies from below 10 up to 200m EUR. The sponsors of the PV projects are mostly solar developers working with building, financing, owning and operating solar parks. Examples of companies acting as sponsors for several of the deals in the selection are SAG Solarstrom AG, Fotowatio, and EDF Energies Nouvelles. Central banks are Centrobanca, Santander, UniCredit, Commerzbank, and Deutsche Bank. In addition, some of the projects have governmental support such as the *Cellino San Marco PV project* where SACE, the

Italian export credit agency, covers part of the debt. Another example of government support is the 500 million EUR loan the European Investment Bank (EIB) has granted EDF Energies Nouvelles for PV projects in France and Italy. The loan from EIB will constitute half of the debt needed for the projects, whereas commercial banks will contribute with the other half.

The tenor of the loans is typically around 17-19 years, reflecting the fact that feed-in-tariff agreements often last 20 years, and the banks wish to ensure that the loan is repaid before the FIT period ends. Besides maturity and an estimated loan amount, not many details about the loans are being disclosed. A common feature of the lending, however, is high leverage. Of the loans disclosing information about loan amount and total investment, the highest debt level is 86.3 % whereas the lowest is 62.6 %.

### **Cellino San Marco PV project**

One of the most costly investments in the sample, is the *Cellino San Marco PV project* in Italy, initiated by the sponsors AES and Riverstone. According to Project Finance Magazine (2010a) the 43 MW project is estimated to cost 200m EUR, where 172.25m is project debt, the rest equity. The debt is provided by five banks; SC, UniCredit, BNP Paribas, Credit Agricole, and Dexia Crediop. The banks have different areas of responsibility; SG handles documentation, modelling and hedging, whereas BNP Paribas deals with insurance. The 172.25m loan consists of a 92.5m construction facility, 60.8m term loan, 3.18m standby facility and 15.7m VAT facility. The tenor of all facilities is 18 years, except for the 5 year VAT loan. This deal illustrates the time-consuming process of structuring project finance, as it took the participants around one year to finalise the deal. Two main concerns in the lengthy process were risk concerned with feed-in-tariffs and risk regarding the thin film solar panels. The material risk was reduced with a 10 year availability guarantee provided by the PV supplier, First Solar.

The tariff risk involved uncertainty about what tariff the project would be granted. In case the plant is completed in 2010 as scheduled, there is no risk concerning the tariff amount. If, however, there is a delay, the tariff in 2011 is unknown. Since the risk of delay is highly present, this represented a major concern for the project participants. The risk was mitigated through a covenant forcing the sponsors to inject sufficient equity to compensate for the lost FIT revenues, in the event the actual tariff was lower than the 2010 level. Project Finance

Magazine predicts that this structure will be copied in other projects, since there is uncertainty about the Italian tariffs. This structure emphasises the importance of the sponsors'

creditworthiness. Part of the reason why the risk of delay was present in this project is that the process of receiving the necessary permits from the Italian authorities tends to be quite time-consuming. Head of project finance in Italy at Calyon (Crédit Agricole's corporate and investment banking entity) has stated: "*The development costs are quite high in Italy because the lead time to get authorisations is quite long ... the lower costs of the plant (materials) may be partially offset by the development costs*"<sup>18</sup>. Project Finance Magazine (2009d) discusses how time spent on dealing with authorities can affect an otherwise attractive market. The Greek PV market may look promising as a potential growth area, but the fact that some developers wait 18 months or more to get the required permits makes Greece less interesting to PV developers. In contrast, the authorisation period in Germany may take only two or three months.

#### **4.1.2 Montalto di Castro PV project**

The project financing of a 24 MW solar park in Lazio, Italy, was awarded the *Euromoney Deal of the Year* in 2009. The sponsor, SunRay, managed to receive financing for the so far biggest PV project in Italy even though SunRay is rather new in the solar development business, and banks were hesitant to lend as they were still recovering from the financial crisis. A third complicating factor was the already mentioned lengthy Italian permitting process. SunRay managed to overcome these obstacles and the process of financing the *Montalto di Castro PV project* has been a great success. Key information on the deal is presented in table 3. The plant generates electricity which is sold to an Italian grid operator. According to the Italian feed-in-tariff regulation the SPV receives a tariff plus the electricity price for the delivered output. The project also has the rights to negotiate power purchase agreements with end users. The lifetime of the plant is initially 20 years, equal to the Italian tariff period. SunPower, an American company operating in different areas across the PV value chain, is the EPC contractor, and also provides O&M services to the project. The EPC contract and permits from regional authorities are central contracts in the project.

---

<sup>18</sup> PROJECTFINANCEMAGAZINE 2009b. Solar flares. *Project Finance Magazine*, Iss. 305, 42-43.

Project Finance Magazine (2009c, 2010c) points at several factors contributing to making this deal a success. Head of project finance at SunRay has stated that the company had a strong focus on conducting a thorough project finance process:

*“Banks were impressed by the extent of our own due diligence across all aspects, particularly on the project contracts and legal issues. [...] We returned to old-fashioned project finance values – for instance, we issued a detailed information memorandum to banks, something that hasn’t been done in the market for about five years!”<sup>19</sup>*

Part of what convinced the banks, were an extensive legal due diligence and the guarantees provided by the EPC contractor. The legal due diligence reduced risk by clarifying regulatory issues with the regional authorities. This careful treatment of legal aspects combined with the fact that the sponsor owns the land for the plant contributes to ensuring that potential future conflicts are avoided. The EPC contractor, SunPower provides several guarantees, and has a strong credit rating compared to its competitors, many of which having problems with excess capacity. This ensures the bank that the project will not fail due to problems with the contractor.

### Montalto di Castro PV

<b>Project company</b>	Cassiopea PV S.r.l
<b>Sponsor</b>	SunRay
<b>Mandated arrangers</b>	lead Banca Infrastrutture e Sviluppo, Société Générale, WestLB AG
<b>EPC contractor and O&amp;M contractor</b>	SunPower
<b>Capacity</b>	24 MW
<b>Total investment</b>	145m Eur
<b>Loan facility</b>	120m Eur
<b>Debt level</b>	80-85 %
<b>Margin</b>	Approx. 275-300 bps
<b>Tenor loan agreement</b>	19 yrs, cash sweep at year 8

Source: Project Finance Magazine (2009c,2010c)

Table 3 Montalto di Castro PV

<sup>19</sup> Project Finance Magazine (2009c)

Another feature of the deal is the participation of SACE, the Italian export credit agency. SACE guarantees 80 % of the debt provided by Société Générale.

Project Finance Magazine emphasises the importance of SunRay convincing the lenders of their long-term commitment to the project, especially since SunRay is a new developer. SunRay did this by actively taking part in construction and operations, and demonstrated a long horizon through plans of extending the plant up to 100 MW. These plans are still on an early stage, but such an enlargement would make it the world's largest PV plant, surpassing the 60 MW Spanish plant in Olmedilla which currently is the largest. Project Finance Magazine also points at the community-based development model SunRay employs as a success factor for this deal. One of the tasks of the 35 people team in Italy is to maintain the relationship with local stakeholders.

The project demonstrate typical features of project finance as the it makes use of proven technology and uses equity in the construction period before drawing on the debt. Investing own funds before borrowed is another sign of commitment.

Whereas the Cellino San Marco project struggled with tariff uncertainty, this was not an issue in the Montalto project. The tariff drop of 2 % in 2010 was already known in 2009 when the financing of the Montalto project was being negotiated. The EPC contract with SunPower also contained a special compensation package if the plant would not be completed and grid-connected in 2009.

The Montalto di Castro project demonstrates successful project finance with its thorough planning process and high focus on providing detailed information to the bank. From the banks' perspective, the long-term commitment of the sponsor and the choice of a solid EPC contractor are positive signals of the viability of the project. The project is predicted to be a template for future ventures because of its structure.

### **4.1.3 Review of term sheets**

A review of 8 confidential term sheets reveal typical characteristics of loans available for PV projects and their inherent covenants and restrictions. Table 4 presents a summary of common terms and range.

The leverage found in this sample is consistent with the theory predicting high debt levels, in these examples 70-86 % of the capital structure is debt. The sizes of the loans are from 2.8m-34m Eur.

<b>Term</b>	<b>Range</b>
<b>Leverage</b>	70/30 – 86/14
<b>Loan size</b>	2.8m – 34m Eur
<b>Maturity</b>	12-20 yrs
<b>Interest rate</b>	EURIBOR plus margin
<b>Margin</b>	170-325 bps
<b>Up-front fee</b>	175-250 bps
<b>Commitment fee</b>	40-50 % of margin p.a.
<b>Minimum Debt Service Coverage Ratio</b>	1.05-1.30x
<b>Debt Service Reserve Account</b>	Next 6 months debt service
<b>Governing law</b>	Local or English

*Table 4 Summary term sheet*

Maturity varies between 12 and 20 years. Most of the loans have a tenor of 17 or 18 years. This is because FIT agreements usually last 20 years, and the bank wishes to ensure that the loan is repaid before the end of the guaranteed stream of revenues.

The interest rate is made up from EURIBOR (Euro interbank offered rate) plus the applicable margin. The margin on the loan varies in this sample from 170 to 325 bps. The margin is typically higher at the end of the tenor. One of the sample loans illustrate this: The margin is 275 bps during construction, during the first seven years of operation the margin is 275 bps, it then increases to 300 bps from year 8 and increases again to 325 bps after year 14.

The fee structure of the loans include a one-time up-front fee and an annual commitment fee, possibly also a fixed administrative fee. The up-front fee is typically 2.50 % of the loan

facility whereas the commitment fee is priced at around 50 % of the margin on the interest rate, payable on any undrawn amount. The law governing the transaction is either English law or local law in the country where the project is located.

The banks demand a minimum level of the Debt Service Cover Ratio (DSCR) of 1.05 to 1.30. This requirement means that the projects at all times must have sufficient cash available to meet the debt service requirement plus an additional 5 to 30 %. A diminishing DSCR is considered an early warning sign. The DSCR minimum requirement illustrates the banks' proactive approach. A diminishing DSCR triggers reactions from the bank. Rather than acting when payments are missing, the bank will initiate measures when the debt service ability is deteriorating. Because of the limited recourse or non-recourse feature it is essential to the banks to recover their receivables while there still are funds in the project.

Reserve accounts described in the term sheets are Debt Service Reserve Account (DSRA) and Maintenance Reserve account (MRA). The standard requirement is that the DSRA contains sufficient funds to cover the next 6 months debt service.

In addition to the term loan, the loan agreement often also includes a VAT facility intended for VAT expenses accruing during construction. The VAT loan comes with a separate set of terms, similar to those for the loan. These terms typically involve a shorter maturity and somewhat smaller fees.

The term sheet lays out a so-called "*cash flow waterfall*" stating how the cash flows from the project are to be prioritised among the project participants. Operating expenses and taxes are the first priority, followed by interests, hedging costs, and principal payment. Then reserve accounts, possible cash sweep, voluntary prepayment of senior debt, and lastly, distribution to shareholders.

The term sheet contains a plan for repayment. The repayment schedule is either linearly, annuity-based, or sculpted. 4 of the 8 term sheets involve sculpting based on a certain DSCR, for example 1.3 or 1.45. Sculpting involve adjusting the annual repayments according to the size of the cash flows available for debt service based on the DSCR determined by the bank.

Some of the term sheets include a cash sweep mechanism that gives the bank access to available funds for early debt repayment given certain conditions. Three of the term sheets included a cash sweep at year 6 or year 8. Nevitt and Fabozzi (2000) explain how a cash

sweep works; in their example, a project is financed with a 30-year loan. In case the deal is not refinanced before the end of year 6, a cash sweep mechanism will force all surplus cash flows to be used for loan prepayment. Consequently, the maturity is then expected to be reduced from 30 years to 12 years. The motivation behind the use of this cash sweep is to encourage refinancing since the project once completed, involves different risks compared to when the project financing was agreed. The new risks are expected to be attractive to other kinds of investors such as the capital market and bond investors especially, making the project eligible for refinancing.

One side of the loan financing is the hedging contract. The bank providing the loan will also in many cases require a hedging contract, often in the form of an interest swap contract. Two of the term sheets demand that at least 75 % of the loan amount must be hedged in an interest rate swap. The arranging bank will often provide the hedge contract; one of the term sheets even reserves the right to do so.

Another central part of the term sheet, seen from the bank's perspective, is security. Most term sheets describe what the bank is entitled to as security for their funds. These lists include pledge on equipment, receivables from sales of electricity, reserve accounts (DSRA and MRA), all shares in the borrower as well as a cross guarantee between sponsors ensuring that the bank will be repaid, even if one of the sponsors cannot meet his obligations. The term sheets also state provisions for voluntary and mandatory prepayment. Voluntary prepayment is typically dependent upon certain conditions and trigger unwinding costs to end the interest rate swap contract. Mandatory prepayment is required in case of insurance payments, event of refinancing, or liquidation of the project company.

In order to evaluate the project, the banks hire own experts on technical aspects, yield, legal issues, and taxes and accounting to evaluate the project. In some cases the bank will accept using the same advisors as the project to avoid duplication of effort. This additional due diligence is beneficial for the project, but must of course be paid for. All costs and expenses, including legal fees and advisors' remuneration, are borne by the borrower.

The term sheets all specify certain restrictions on the purpose of the loan and shareholders' actions. Covenants concern both the sponsors' undertakings and the borrower's undertakings. The sponsors will often have to maintain their ownership share and are not allowed to abandon the project. A possible change in ownership must be approved by the lenders. The



borrower (i.e. the SPV) on the other hand, must provide the bank regular progress reports during construction and later financial information, including calculations of cover ratios. The borrower must continue the insurances required by the lenders, perform maintenance as agreed and comply with permits and authorisations. The borrower is obligated to notify the bank in the event of default, delays or insurance claims. Moreover, the borrower has restrictions or is even prohibited against further indebtedness. There are also limitations on transactions with affiliates, such as the sponsors, investments and dividend disbursement. A typical covenant is the “*no change in business*”-requirement, preventing asset substitution from taking place. In case of a change in plan that requires additional investments, this must be financed by the sponsors through equity or a subordinated loan.

The term sheet typically contains a list of “*Conditions Precedents*”, or CPs, which are prerequisites the project company must fulfil before drawdown of the loan can begin. Common CPs are presenting final reports from legal, technical and insurance advisors, the financial model, evidence that the sponsors have provided promised equity to the project company, evidence of payment of fees and other costs and expenses. Further, CPs require presentation of relevant documentation such as building permits, certificates, insurance policy, hedging strategy, yield assessment, the contract with the grid operator and the land lease contract. Before drawdown, the Debt Service Reserve Account must be fully funded, and the required insurances must in effect.

The term sheets illustrate the power of the banks in project finance. The banks control and monitor all aspects of the project through numerous restrictions and covenants. Securing the banks’ interests is always the first priority, which is natural since the bank operates in a downside business. The banks are exposed to downside risk, but have no upside potential. The banks secure their interests in four provisions. First, sculpting is often used to determine annual debt service. Second, the bank demands a debt service reserve account, typically with funds to cover the next six months debt service. The third mechanism is the list of securities in the term sheet, where the bank gets access to the SPVs equipment, reserve accounts, receivables from electricity sale, possible recourse to the sponsor and cross guarantee with the sponsors’ other projects. Last, there is a fourth mechanism protecting the banks interests. The relationship between the bank and the sponsors is central, even though “hard facts” such as asset value and future cash flows is most important. The bank must be sure that the sponsors can be trusted and that the sponsor will not sell their share to a less credible company after the loan agreement is signed. The maturity of the loans also underlines the banks’ wish to secure

repayment, as the tenor of the loan is shorter than that of the fixed revenues (i.e. feed-in-tariffs). In some term sheets, there is even a cash sweep clause further shortening the maturity.

The term sheets also demonstrate how the bank charges for all services. In addition to the margin on the loan, the bank charges an upfront fee, a commitment fee, possibly other fees, a margin on the hedge contract and all expenses the bank has with due diligence.

Further, the term sheets illustrate how the banks are key participants in the projects. Their role is not to passively lend out money, but actively taking part in the process. The different covenants and provisions put in place by the banks apply in different situations, at different stages of the project and are intended to cover several types of risks. Most of the terms are aimed at protecting the banks' interests before the project performance deteriorates, whereas a few apply in events of default. In situations where profits for various reasons start falling, the diminishing debt service coverage ratio will alert the banks of the decline. If unexpected expenses arise, the reserve accounts may be utilised to cover the costs, and hence not affect the debt service ability in that year. In some projects equity holders may suspect that the project will run into difficulties later and wish to distribute dividends as soon as possible. The cash flow waterfall and other requirements for dividend disbursement will in such situations prevent distributions to the equity holders before all other claims are paid. Other projects may experience great variation in profits from one year to the other. Here, the sculpting technique for repayment can secure that the banks receive interest and instalments also in the years with lower profits. In addition, sculpting reduces the free cash flows in the years with higher profits. Another scenario involves projects receiving an insurance indemnity. The cause of the insurance claim might have led to losses and might indicate uncertainty regarding future performance of the equipment. The bank is protected from any impact of these uncertainties through the mandatory prepayment covenant giving the bank the right to the indemnity.

The term sheets are an illustration of why the expression "*the devil is the detail*" is sometimes used about project finance. The term sheets contain detailed cash flow waterfalls, requirements for shareholder distributions, restrictions on the sponsors' actions, and purpose of the loan. The latter is aimed at preventing asset substitution from taking place in the projects, since the term sheet clearly describes the project and how the loan amount is to be spent.

## 4.2 Government subsidies and feed-in-tariffs

Subsidies from governments have been crucial in the development of the PV industry. For new industries, government support is often necessary to promote growth. The PV sector has experienced growth during the last years, but is not yet competitive with fossil energy and investments in PV still depend on subsidies from governments in order to be profitable.

These subsidies arrangements come in different forms, examples are feed-in-tariffs (FIT), tax credits, investment funds, reduced VAT and renewable portfolio standards. Feed-in-tariffs provide an explicit monetary amount per MWh the plant feeds into the grid, capital subsidies eases the high up-front investment, while tax credits allow for a reduction in taxable profits. Another supporting arrangement is renewable portfolio standards requiring that a certain proportion of electricity sold by a utility company must be from renewable technologies. Such standard can also have specifications of what proportion must come from PV in particular. Even though there are several instruments governments can make use of in order to increase clean energy production and PV, feed-in-tariffs has proven to be the most efficient.

Table 5 present the support arrangements for PV in various European countries. Feed-in-tariffs, tax credits and investment subsidies are the most common support mechanisms. Five countries offer beneficial credit terms, often in the form of so-called “green loans” with reduced interest rates and grace periods. Net metering is employed in Belgium, Italy and Portugal. This entitles the system owner to a certain credit according to how much green electricity is fed into the grid.

	FIT	Net metering	Tax credits	Green certificates	Investment subsidies	Tax exemption	Beneficial credit terms	Reduced VAT
Belgium		✓	✓	✓				
Czech Republic	✓		✓		✓	✓		✓
France	✓		✓				✓	✓
Germany	✓		✓		✓		✓	
Greece	✓		✓		✓		✓	✓
Italy	✓	✓	✓					✓
Luxembourg	✓		✓		✓			
Netherlands	✓		✓				✓	
Portugal	✓	✓			✓		✓	✓
Spain	✓		✓					
Switzerland	✓				✓			
UK	✓							
Source: EPIA(2010a)								

Table 5 Government support arrangements

### Feed-in-tariffs (FIT)

Mendonça and Jacobs (2009) explain the principles of feed-in-tariffs:

*“Such schemes pay renewable energy producers a set rate (tariff) for each unit of electricity fed into the grid, and generally oblige power companies to purchase all electricity from eligible producers in their service area over a long period of time -- usually 15 to 20 years”.*

Mendonça and Jacobs seek to explain why feed-in-tariffs have become a popular support scheme in many countries. They find that *“feed-in tariffs are empirically proven to promote the fastest expansion of renewable electric power, at the lowest cost”*. The grounds for this, according to their article, is that FITs are more simple, transparent, democratic, performance-based, cost-efficient and quickly deployed than other alternatives for subsidising renewable technologies. FITs can be self-financed through dividing the cost between the consumers of electricity, leaving the government with no cost. The cost of the FIT arrangement is often paid by electric utility customers as part of their electrical bill. An advantage over other support schemes is the possibility of making the FITs technology specific. With specific support, grid parity for each technology is easier to reach.

### **Feed-in-tariffs in Germany**

Mendonça and Jacobs illustrate their opinion on the effective nature of FIT using Germany as a case; FITs introduced by the German authorities contributed to the increase in production of power generated by renewables of more than 200 % from 2000 to 2008. Germany is often referred to because of its success with PV. Germany is the world leader on PV, however, this is not obvious given the German solar resources. According to Leder (2010) Germany has less solar radiation than 49 of the U.S.' states. The introduction of government arrangements supporting the PV industry financially combined with increased support for the Green Party, high oil prices and Germany's high dependence on energy import, made Germany a market leader on PV. In 1998, only 2 % of the country's electricity need was covered with renewable energy, in 2007 this number had increased to 14.2 %. The growth in the PV industry also affected the job market. In 2004 there were 160,500 jobs in Germany related to renewable energy, in 2007 there were 249,300 such jobs and the government predicts this number to grow to 400,000 by 2020. The exact effect of the FITs is difficult to quantify, but Milford (2007) estimates that annual installations in Germany would be 10 MW without feed-in-tariff, compared to the current level of 750 MW.

The German Renewable Energy Sources Act, Erneuerbare-Energien-Gesetz (EEG, 2009) gives electricity generated from renewable technologies priority connection to the grid and instructs grid operators to pay a defined tariff to the producers for generated electricity. The tariffs for solar are fixed for 20 years. The act from 2008 determines the tariffs for plants being installed until January 2010. Tariffs after this are subject to reduction, given by an annual degression rate. The degression rates also depend on a so-called "growth corridor". If the growth in installations is higher than a certain amount determined by the Federal Network Agency, the degression rate is increased by 1 percentage point. Accordingly, the rate is decreased by 1 percentage point if the growth is lower. The "growth corridor" is a way of regulating degression in correlation with market growth. The reduction in the tariffs only affects new installations. According to Mendonça and Jacobs tariff degression gives an incentive for technology development and cost reduction. They argue that the degression rates should reflect the learning potential of the technology and suggest that wind power, which is a more mature technology, has no or only a very low rate, while a 10 % degression rate is suitable for solar. This corresponds with the degression rates in Germany; wind power (excl. offshore wind) is subject to a 1 % degression and PV 10 % in 2010.

The EEG contains rules for equalisation among grid operators. The operators are required to record and report how much electricity they purchase from PV parks. An average share of electricity generated from PV is calculated. The grid operators who have purchased a higher share of PV power than the average is entitled to sell electricity to the operators who have purchased a lower share. Eventually, all grid operators will have purchased the average share.

### **Feed-in-tariffs in Europe**

Table 6 compare FITs available for PV projects in 5 European countries. The FIT arrangements differ when it comes to the tariff amounts, and also regarding terms. Lower duration and no inflation indexation, which is the case in Italy and Germany; impact a project's financial situation negatively. Project Finance Magazine (2009e) argues that inflation indexation increases the debt capacity of a project, and point at the significance of inflation swaps for hedging purposes. In Spain such swaps turned out to be crucial as the inflation in most of 2009 was negative. The same article discusses an increasing importance of government risk. Flaws in the design of the FIT structures may lead to uncertainty regarding whether the countries can afford the subsidies. An example of this is Spain and Italy where the expiration date for qualifying for feed-in-tariffs is not fixed, but depends on the total capacity installed within a period. After a certain capacity is built, new projects can no longer qualify for FITs. As a result of this, solar developers race against their competitors to finalise their project. According to Project Finance Magazine, there are severe consequences for the projects that do not qualify for FIT, as they are not profitable given the current market prices on electricity. In all, the FIT arrangements represent a great risk to solar developing companies and are crucial to get project financing.

Table 6 include Standard & Poor's (S&P) country rating in 2009 illustrating differences between the countries. The article in Project Finance Magazine finds it less likely that the countries in question will fail to meet their obligations, but in attempts to save money, they may search for reasons to disqualify projects from receiving tariffs. This was seen in Spain where The National Energy Commission initiated an audit investigating projects that had been granted feed-in-tariffs before October 2008. The recent downgrading of Greece, from A in 2009, down to BB (often referred to as "junk") in April 2010, reflects poor conditions for investors.

---

**2009 Solar Photovoltaic Feed-in-Tariffs**

Country	S&P Country Rating (long term)	Tariff 2009 (Grid connected > 1MWp)
Spain – 25 yrs, inflation-indexed	April 2010: AA <sup>20</sup>	Eu302
Italy – 20 yrs, no inflation	A+	Eu353 + electricity price (~Eu80)
France – 20 yrs, inflation linked	AAA	Eu300
Greece – 20 yrs, 25 % CPI indexed	April 2010: BB+ <sup>21</sup>	Eu304-Eu453
Germany – 20 yrs, no inflation	AAA	Eu319

Adapted from: Project Finance Magazine (2009e), Dagens Næringsliv (2010a)

*Table 6 Solar PV Feed-in-tariffs*

### **Criticism of feed-in-tariffs**

Despite the apparent success of the FIT arrangements, FITs have been criticised for being unsuccessful when it comes to making renewable energy cost-efficient. An article in The Economist (2009b) discussing policies quote the director of carbon markets at New Energy Finance on wind and solar promoting policies: “*These policies are not particularly efficient, but they have been quite effective*”. The article points at the consequences after Spain reduced their feed-in-tariffs in 2008. The Spanish tariffs were established in 2007 at Eu459 per MWh. When it was decided to reduce this to Eu320 from the end of 2008, almost 30 % reduction, solar developers raced to build their projects before 29 September 2008<sup>22</sup>. The result was a market collapse, The Economist reports price falls of 30-40 % and 50-75 % drop in the share price of many solar companies. The Economist criticise the subsidy system for creating

---

<sup>20</sup> Dagens Næringsliv (2010b)

<sup>21</sup> Dagens Næringsliv (2010a)

<sup>22</sup> Project Finance Magazine (2009e)

subsidy cycles where recessions and booms follow each other in the market according to changes in tariffs.

A report on economic impacts of subsidies in Germany prepared by Frondel et al (2010) is sceptical to whether the German Renewable Energy Sources Act (EEG) really is cost-efficient, since the cost is borne by private and industrial consumers through increased electricity prices. They criticise the fact that PV counting for a smaller part of the electricity production receive the highest support per kWh. According to their article, PV received 24.6 % of the total feed-in-tariffs in Germany and contributed with 6.2 % of the renewable energy production. They compare the beneficial situation of PV with hydro power. Hydro power accounted for 7 % of renewable energy production while receiving 4.2 % of the FITs. Further, they emphasise that the increased electricity prices for the consumers it not a short-term consequence, but will have a long-lasting effect since the FIT period in Germany is 20 years. This means that even if the arrangement is ended in 2011, the tariffs will be paid until 2031 to the projects that have been granted FITs. They refer to a study done by Traber and Kemfert (2009) finding that the consumer price of electricity is increased by 3 % due to the EEG. According to Frondel et al, the impact of the EEG on European emissions is negligible compared to this price increase. Their assertion, however, is based on the fact that reduced CO<sub>2</sub> emissions in Germany affects the need for reducing emissions in other countries in the ETS (European Union Greenhouse Gas Emission Trading System) regime where Germany is a member. Frondel et al state in their article that the CO<sub>2</sub> emissions in Germany is in fact substantially reduced, but *“the emissions are hardly altered at the European scale by Germany’s EEG. This is due to the fact that Germany’s electricity production from renewable technologies mitigates the need for emission reductions in other countries that participate in the ETS regime, thereby significantly lowering CO<sub>2</sub> certificate prices by 15 % relative to the situation without EEG”*.

Though there may be some truth to what the critics claim, their arguments are aimed at how the subsidy systems are designed, not the systems themselves. The negative consequences of the Spanish reduction in tariffs have been a lesson to many other countries now considering reducing their FITs. The arguments from Frondel et al suggest there are challenges within the ETS regulation, not the German EEG. Their opinion is that the German EEG is unsuccessful because the effect on European emissions is negligible, even though there has been a reduction in German emissions. They may be right in their scepticism towards the effect on



emissions at the European level, but the influence on certificate prices in ETS is a different issue, not a negative aspect of the EEG, which needs to be solved separately.

### **Feed-in-tariff phase-out**

The PV industry in several countries is now growing and becoming more competitive. This has led many governments to reduce the FITs. As already mentioned, Spain reduced the tariffs from 2008 to 2009. The negative impacts of this reduction have made other countries implement a more gradual phase-out of the subsidies. In Germany FIT cuts have been anticipated for some time, but the present suggested cuts are lower than first expected. According to New Energy Matters (2010) a draft from the German Bundesrat suggests 16 % reduction in the support to rooftop projects (i.e. installations placed on roof tops), 11 % reduction for brownfield sites (i.e. previously industrial sites) and no supports for PV projects located on farmland. To compensate the PV industry of the reduction in FIT, the German government proposes a EUR 100m R&D subsidy.

The suggested changes to the French FITs signal a more specialised support scheme. According to Project Finance Magazine (2009a) the suggestions include higher tariffs for categories with low growth, while rooftop systems that now experience high demand will receive no support. The changes also entail measures intended to streamline the process of qualifying for FITs in order to encourage growth. Another interesting suggestion is tariffs differentiated by solar resource intensity. This means PV plants in cloudy regions will receive higher tariffs than plants in sunnier regions. This differentiation has been employed in wind energy tariffs in France and Germany since 2000, but never in solar energy.

## **4.3 Financial crisis**

Investments in clean energy have experienced tremendous growth the last years; annual growth rates from 2004 to 2007 have been as high as 76 %, but in 2008 investments in this sector faced a 4 % decline compared to the previous year<sup>23</sup>. The financial crisis and following credit crunch affected investments in renewable energy severely. Credit tightening reduced the availability of debt, and hence reduced project financed investments especially since they have high leverage. According to The Economist (2009c) investments in renewables were

---

<sup>23</sup> Liebreich et al (2010)

particularly negatively affected by the financial crisis because of the characteristics of renewable investments. They typically have low operating costs, but high investment costs, as the case of PV. The Economist point out the fact that some of the banks that were affected badly by the financial crisis such as Royal Bank of Scotland, Lehman Brothers, Washington Mutual and Fortis, were also among the biggest contributors in clean-energy finance. Reduced debt availability means higher competition for funding and stricter conditions from the banks. Less risky projects will be prioritised, and debt levels are expected to decrease. Project Finance Magazine (2009e) has predicted that the capital market will make an effort to distinguish between good and bad projects, forcing developers to care more about details.

Recent financial turmoil in the Euro area, feed-in-tariff reductions and rumours of subsidy cuts in Spain with retroactive effect have lead to decline in share prices in the solar industry. While these conditions affect the owners of the solar parks negatively, they also influence the banks' willingness to finance future PV projects.

## 4.4 Summary

The empirical data presented here on how PV projects are being financed, is in accordance with much of the theory on project finance. Recent project financed PV plants demonstrate high leverage, ranging from 62 % to 86 % debt level. An example of how a project finance process can be time consuming is the Cellino San Marco project where it took the participants around one year to finalise the loan deal. This project also illustrates how risk management is an important feature of project finance. Mitigation FIT risk was crucial in the process, and led to a financing structure that included a special clause forcing the sponsors to contribute with more equity in event the FIT revenues would be reduced.

The Montalto di castro PV project was awarded *Deal of the Year 2009* by Euromoney and is predicted to be a template for the structuring of future PV projects. This project is an example of how the project involves many participants. Sponsors, contractors, suppliers, authorities and banks all affect the financing of the project. The Montalto project illustrates the importance of conducting a thorough process in order to receive project financing.

The central role of the banks in project finance is apparent from the review of term sheets. The term sheets all focus on protecting the banks' interests. The banks introduce several

measures intended to reduce the banks' share of project risk both before the project is initiated and during the loan period. Before a loan is granted, the bank conducts its own due diligence investigating legal, financial and technical aspects of the project. The indicative term sheet and the final loan agreement specify the purpose of the loan and the cash flow waterfall. Both measures limit managerial discretion and reduce the possibility of asset substitution. After the loan is drawn, the bank monitors the project closely. A diminishing Debt Service Coverage Ratio rather than non-payment of debt service is a warning sign to the banks that causes measures to be effectuated. There are also mechanisms aimed at reducing the maturity of the loan; cash sweeps may force early repayment, and higher margin on the loan at the end of the tenor gives incentives for shortening the tenor. In case the project should default, the bank has rights to the projects assets and receivables.

A significant part of financing PV project is the governmental support arrangements. Feed-in-tariffs are employed in many countries, and have proven to be a successful mechanism to drive technical development and increase competitiveness. In Germany, FITs have contributed to increasing the share of renewable energy in the total energy generation. The FIT schemes are now being modified and reduced in several countries as a response to the industry becoming more competitive. Critics accuse FIT arrangements for creating subsidy cycles in the PV industry, and even of market collapse in the Spanish PV market. Much of this critic concerns the design of the FIT arrangements, not the idea of subsidies. However, grid parity is not yet reached, and PV projects still depend on subsidies. The strong dependence on FITs make PV projects exposed to government risk.

The financial crisis led to a reduction in clean-energy investments due to credit tightening. The competition between projects is now higher with regards to receiving funds; therefore the project developers must spend more effort on convincing the bank about the capability of their project. While the first part of the financial crisis seems to be over, the future is uncertain especially for European PV developers with the current currency turmoil. Recession may lead governments to reduce public spending, which can affect subsidies to the PV industry.

## 5. Case study: PV Project

### 5.1 Introduction

The following section will illustrate the presented theory on project finance with an actual case from the PV industry. The project in question will in the following be referred to as “*PV Project*” or “*SPV*”. Name of the project and participants is kept anonymous. Information about the project is acquired through interviews with a central participant and confidential documents. A list of the documents is presented in appendix 1.

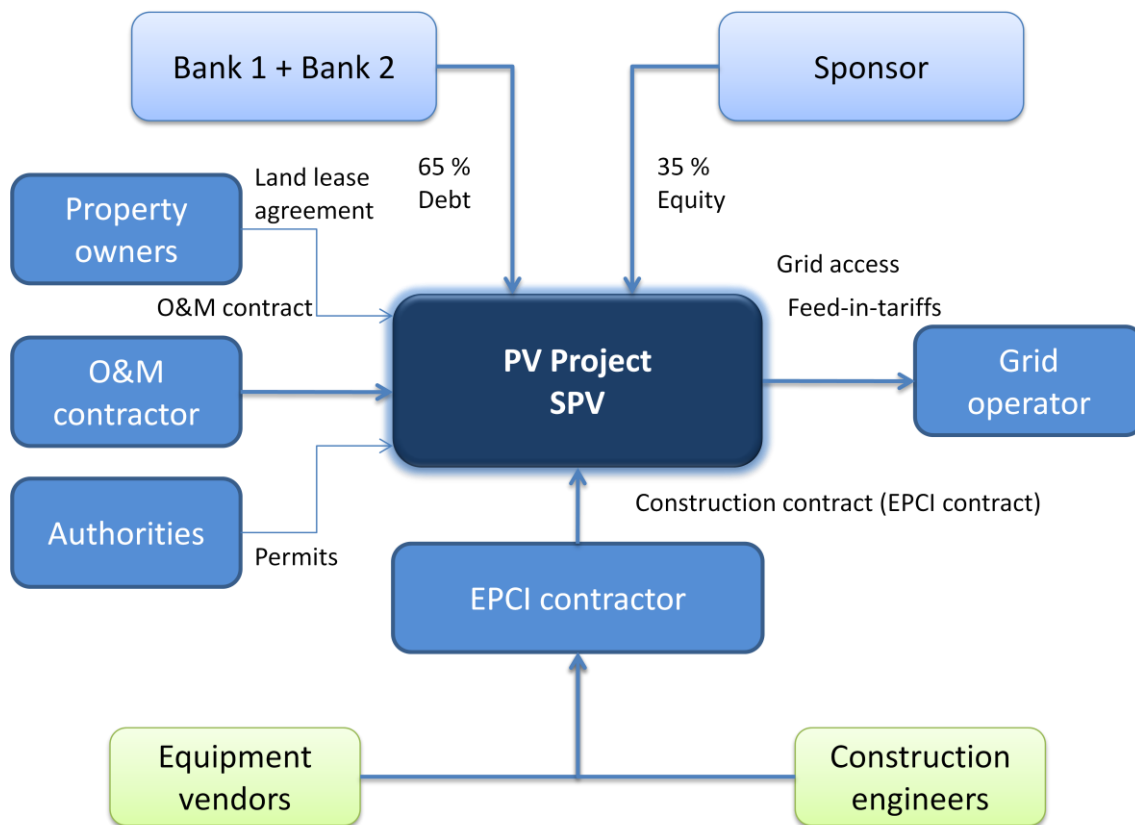
The thesis will look at how a real-life PV power plant is project financed with regards to key features of project finance, capital structure, contracts and risk management. Central project documents will be reviewed to describe parties involved, terms and process of project financing the power plant. Finally I will analyse advantages and disadvantages of project finance in light of this particular project, and compare PV Project to other project financed ventures. The analysis also attempts to suggest improvements to the structure of PV Project.

The analysis does not include the financial model of PV Project as this is confidential. However section 6 contains a financial model of a hypothetical PV plant.

### 5.2 Key features of PV Project

#### **Organisational structure**

PV Project is an expansion of an already existing PV power plant located in Germany. With this expansion the capacity of the solar plant will be around 5 MW annually. PV Project is a special purpose vehicle fully owned by one sponsor. Debt is provided by two banks; one government-owned development bank and one international, commercial finance institution. Other central participants in the project are the EPCI contractor, the O&M provider, local authorities, the insurer, and the grid operator. Figure 7 illustrates the organisational structure of PV Project.



Adapted from Goldman et al (2005) p. 2

Figure 7 Organisational structure PV Project

### Capital structure

The capital structure of PV Project consists of approximately 35 % equity and 65 % debt. The loan from the finance institution is regulated by a loan agreement between the bank and the SPV. The loan agreement is a result of the negotiations with the bank. The indicative term sheet and the loan agreement contain many of the conditions and restrictions term sheets normally include. The terms are discussed in section 5.3.

### Technology

PV Project makes use of polysilicon PV technology. Three different reports from independent engineers estimate the annual yield and the performance ratio of the power plant. They all consider the modules, inverters, cell technology and design of the park as well as meteorological data when calculating expected yield. Their results are all in the same range, the yield estimate varies with only a few kWh per kWp.

### Feed-in-tariffs

PV Project qualifies for receiving feed-in-tariffs under the German Renewable Energy Sources Act, EEG. The tariffs for solar are fixed for 20 years. The output of the project is sold

to a grid operator and in return PV Project receives feed-in-tariffs per MWh delivered. Because of the degression rate in the FIT arrangement, a delay in the project may cause lower tariffs.

## 5.3 Terms of the loan agreement

The tenor of the term loan is 16 years. This ensures that the loan is repaid 4 years before the revenue stream from feed-in-tariffs end. The loan agreement specifies the fee structure; a one-time structuring fee (i.e. up-front fee), and a commitment fee to be paid monthly. The loan agreement require entering an interest derivative contract in the form of an interest swap, and emphasises that this is a separate contract which will continue even though the loan agreement is terminated.

### **Security**

The bank secures its interests in a list of 11 collaterals. This list includes transfer of several project rights to the bank in case of project default. These rights include the rights the purchase agreement, insurance policies, warranty agreement and usage rights. When it comes to reserve accounts the loan agreements require a debt service reserve account (DSRA), a maintenance and reserve account (MRA) and the accrual of an additional reserve account for dismantling the PV plant. The magnitude of the reserve account in total is around 200,000 Eur. The reserve accounts are established during the first years of the loan period and maintained for the entire tenor. The purpose of these accounts is to cover unexpected expenses which arise during the life time of the project, without affecting the project's debt service coverage ratios.

### **Cash flow waterfall and disbursement of dividends**

The next item in the loan agreement is the cash flow waterfall, which determines the priority of the claims on the project's cash flows. Operating costs including insurance premium have first priority, followed by debt service, payments to the DSRA, payments to the other reserve accounts, and last, disbursement of dividends. In order to pay out dividends, 22 specified criteria must be fulfilled. This list includes presentation of signed versions of all relevant contracts and agreements, having opened accounts, provided promised equity, all rights to the project being transferred to the SPV, verification of technical requirements and proof that the

project fulfils the requirements according to the building permit. The bank also requests copies of official land register maps, where the site of the photovoltaic plant, the cable route and the transfer point to the utility company are identified. Further, the bank requires proof of the operating costs. If the costs exceed the previous calculated operating costs, the amount of equity must be increased in order to maintain the debt service coverage ratio (DSCR) at minimum 1.2.

The terms of the loan agreement are all aimed at securing the bank's interests. Maturity, collateral, security and cash flow waterfall are among the many measures put in place to ensure that the loan is repaid, and to give the bank access to assets and funds in case of default. Together with requirements during construction and operations this illustrates the strong creditor involvement in project finance. The banks' participation in the project is advantageous because it is aimed at protecting the project from risk, but can also be unfavorable as it is time-consuming and not always in line with the equity holders' wishes. Equity is a residual claim with limited liability (may depend on the degree of recourse) and therefore more in favor of risk. Since the banks only have downside potential, conflicts may arise in situations where equity investors want to take more risk.

## 5.4 Contracts

The establishment of PV Project and the construction of the power plant are regulated in a series of contracts. I will here present the most important contracts and central content. In the following section I will analyse how these contracts affect risk management.

### **Transfer of rights agreement**

A highly central contract in the establishment of the solar park is the Transfer of rights agreement. The process of constructing a solar park often begins with a solar project developing company obtaining all the necessary rights and permits to build and operate the PV plant. The rights to the project are then sold to the sponsor. The Transfer of rights agreement contains all these rights and the System purchase agreement, stating the price of the transaction.

In this case, the developer transfers its ownership share in PV Project (i.e. 100 %) to the sponsor including all rights to the solar park in return the sponsor pays the solar developer a certain price. The rights to PV Project include land lease and land use agreements with

property owners, building permit from the authorities, an urban development agreement with the municipality, and contract with the grid operator.

The Transfer of rights agreement defines the purpose of the agreement, which is the construction of a PV plant, and the purchase price of the share in SPV (i.e. 100 %).

PV Project does not own the land where the plant is located, but leases the area. Therefore, the land lease agreements with the property owners are essential. These contracts regulate the purpose of the lease, duration, termination, remuneration, and liability. The lease period is 20 years from start of construction. The annual rent is a certain share of the FIT revenues multiplied with a size factor. The contracts entitle the SPV to build the necessary transmission lines, transformer, roads and fences on the site. In addition to the land lease agreements, the SPV has also signed a land use agreement with the property owners regarding right of way for grid connection cables.

The contract with the grid operator ensures access to the grid, and allows the SPV to feed a specified maximum quantity of electricity into the grid annually.

The contracts with the authorities include the building permit which approves the plans for the construction. This permit also contains specific and detailed requirements to ecological compensation areas, also known as “green space compensation”. This is a special requirement for German PV plants, which entail planting and maintain certain areas. Other contracts with governmental agencies regulate the deconstruction of the plant after discontinuation.

### **EPCI contract**

The EPCI contract states the obligations of the contractor, which include planning, construction, transport, completion, installation, testing and commissioning of the planned solar park. The contractor must install the solar park in accordance with specifications and within the agreed timeframe. The specifications include following best industry practice, requirements from the insurer, and German law. The contract states that the solar park shall be handed over “turnkey ready”, meaning that the park must be connected to the power grid and ready to feed electricity into the grid. According to the contract, the EPCI contractor ensures that the park is constructed in compliance with all permits, agreements, authorisations, approvals, certifications and expert opinions.



The contract determines the latest possible date for start of operation. This is important since the start of operations determine the level of the feed-in-tariff. If the plant starts operating before this date, but the taking over process is not finalised, all revenues from FIT and operating expenses accrue to the SPV. The contract further specifies the base purchase price based on certain assumptions about yield and performance. In case these variables are changed, there will be adjustments made to the price. The contract also defines payment terms, including a security deposit which allows the SPV to withhold a certain percentage of the purchase price for 5 years after start of operations. This ensures that the EPCI contractor can cover potential warranty claims.

Further, the agreement regulates the taking over procedure, testing period, warranties, limitation of liability and general contractual terms. The taking over procedure consists of three parts; *technical*, *legal* and *final taking over*. For the technical taking over the SPV appoints a technical expert to do an audit of the capacity, functionality, and whether the plant is built according to specifications. The legal taking over is performed either by the SPV itself or by a legal firm appointed by the SPV. The purpose of this is to ensure that all assets are transferred from the EPCI contractor to the SPV, that all the rights described in the Transfer of rights agreement are valid and transferred to the SPV, and that all other conditions for the taking over are fulfilled. In the final taking over, the contractor and a representative from the SPV inspects the completion of minor outstanding works. The results of all three parts are documented in written protocols.

Prior to the taking over procedure is a testing period of 100 hours in order to test electrical and mechanical components and to make sure that the productivity is as promised. The EPCI contract specifies warranties, which are central in mitigation of technical risks. For the solar park the warranty lasts 5 years, for the modules 5 years and the inverters 2 years.

### **O&M contract**

The O&M contract is similar to the EPCI contract. It describes how the O&M contractor shall perform monitoring, operation, routine maintenance and repairs of the solar park on behalf of the SPV. The contractor is to perform these tasks in compliance with applicable law, specified regulation and standards, permits, requirements from the grid operator, warranty conditions, and insurance conditions. The contract specifies how monitoring and maintenance is to be carried out, and what documentation of operational data and yield data the O&M contractor must record. The O&M contractor is also responsible for warranty and insurance

management. The installed inverter comes with an extended warranty that includes full coverage of material and labour costs related to repairs. In addition to the regular O&M tasks, the contractor is responsible for property management. This includes ensuring that vegetation around the modules is kept low in order to prevent shadows, and maintenance of the ecological compensation areas.

Remuneration of the O&M contractor consists of an annual fixed amount which is adjusted with a fixed percentage every year, and a possible over performance bonus from year 3. The bonus applies whenever the electricity production exceeds the expected production estimated in the base case calculation. In years when this occurs the O&M contractor receives 50 % of the FITs from the first 6 % of the excess electricity production, independent of the reason for the over performance. This incentivises the contractor to contribute more than the required minimum effort.

### **Insurance contracts**

The insurance coverage of PV project consists of three parts; photovoltaic facility insurance, third-party liability insurance, and a profit shortfall insurance. The first two insurance policies cover physical damage and injuries to personnel and include standard terms. The third form of insurance, the profit shortfall insurance, is a more specialised insurance. This policy is applicable when the actual obtained yield is more than 10 % lower than the predicted annual yield. The calculation of the profit shortfall is as follows:

$$\textit{Profit shortfall} = (a - b) \times c - d$$

Where

a = 90 % of the predicted annual yield (kWh)

b = actual energy yield (kWh)

c = reimbursement rate (cents/kWh), i.e. the feed-in-tariff

d = indemnity from other policies

The annual predicted yield is confirmed by experts on behalf of the insurance company. The maximum indemnity is 30 % of the predicted annual yield, implying that the policy covers a loss when the actual yield is 10 to 30 % lower than expected. Under the policy, PV Project is obligated to disclose information about the plant and technical details about the modules,

inverters, radiation, utilisation degree of the plant and the individual systems to the insurer. This information must be approved by an independent expert.

The policy insures profit shortfalls caused by reduced global irradiation, material defects, wear and tear of the plant, pollution of the plant or parts of the plant, and internal operational failures of modules or invertors. Causes not covered are maloperation of equipment, interruptions or disconnection from the power network, breakdown of the supply meter, maintenance work, or trees or buildings clouding the modules.

The profit shortfall insurance may at first seem valuable, but further assessment reveals that this policy is rather worthless. The insurance is only available for short durations implying that if the SPV experiences a profit shortfall that is covered and is granted indemnity, the insurance company will know this when the SPV wishes to renew the policy. The SPV have then “revealed” the true level of irradiation and the insurance company reduces the base case estimates.

Expected variation in irradiation is around 10 %, making the policy relevant only for more extreme changes in irradiation level. After a few years, the insurer learns what the normal irradiation level is, and adjusts the base case estimate accordingly. The remaining uncertainty is the normal variation, which is not insured. The policy is not very costly, this is however not surprising given the low benefit of the policy.

## 5.5 Risk management

PV Project faces several of the risk sources described in section 2. I will in this section present the most relevant risks to the project, what mechanisms are employed to mitigate the risks, and to what party the risks are allocated. An overview is presented in a risk matrix in table 7.

### **Technical risk**

The technical risks in the project are concerned with the materials and components used. Choosing experienced technology suppliers with good track records is important to avoid deficiencies.

Technical risks are allocated mainly to the EPCI contractor and other suppliers through warranties. As an example, the industry has experienced problems with frequent break downs

of inverters. This risk is handled by a warranty extension with duration of 20 years. The warranty obliges the inverter manufacturer to perform scheduled maintenance and service as well as being available for emergency repairs. This is important because a stop in production leads to reduced profits. If an inverter breaks down during the high irradiation months, a greater part of that year's revenue can be lost. The Transfer of rights agreement makes sure all warranties are transferred to the SPV.

Mitigation of the technical risks is obtained through technical due diligence and the technical taking over. In the technical due diligence, an independent engineer reviews the components and design of the park. Further mitigation is gained from monitoring performance and carrying out necessary maintenance as stated in the O&M contract.

### **Political risk: Legal risk**

PV Project operates in Germany, a country with a well functioning, stable justice system. This reduces the possibility of legal disputes and provides sound conditions for the project. A reliable legal environment is especially important in project finance because of the many contracts involved. For PV Project the Transfer of rights agreement, land lease agreements, and building permit are all essential to the success of the project. Problems with interpreting or implementing the contracts, can cause costly delays or even prevent the project from being realised.

A regulatory risk present in all PV projects is the risk of changes or elimination of the feed-in-tariff system. There are currently discussions regarding continuation of the FITs. A reduction of tariffs and phase-out of the German Renewable Sources Act is likely in the long-term, but changes being made to the existing tariffs seem unlikely. Other sources of uncertainty are the general risk of increased taxes and general political risks. In politically stable countries such as Germany, war and civil strife and expropriation are less likely.

Legal due diligence, the legal taking over and continuous follow up done by the SPV are measures contributing to mitigate the legal risks. The legal due diligence reviews all agreements and warranties in order to reveal potential problems, and makes recommendations on how to handle these.

### **Operating risk**

The main operating risks PV Project faces are the performance risks due to estimation errors in the yield report, planned or unplanned downtime, grid cut-offs, force majeure events,

failure of counterparties, and unexpected operating costs. Overestimation in the yield report regarding solar resources and performance ratio leads to reduced production and hence lower revenues, than expected. Downtime and grid-cut offs are especially unfavourable during summer and day-time which is high irradiation periods. Counterparty failure concerns both performance and payment failure of central project participants. Important payments to the project are feed-in-tariffs, insurance claims and warranty claims. Unexpected operating costs may arise from major repairs not covered in the O&M agreements, lawsuits and tax disputes.

The performance risks connected with errors in yield estimation is mitigated through the technical due diligence performed by an independent engineer who evaluates the input in the yield calculations. Scheduling of planned repair work and downtime can prevent production stops in periods with high irradiation. Unplanned repair and grid cut-offs cannot be avoided, but the consequences can to some extent be limited through building a maintenance reserve, which covers unexpected costs without deteriorating the debt service ability and avoids breach of the loan agreement terms. Force majeure events are mitigated through the insurance contracts. A special feature of PV Project's insurance contracts is the profit shortfall insurance. This policy covers losses due to lower irradiation than expected. However, this policy only applies for large deviations and is of little value after the first times it has paid out an indemnity.

The risks of counterparty failure and unexpected operating costs are reduced through active contract management and scoping of the O&M contract. Contract management include selecting suppliers, negotiation, and following up after signing. The over performance bonus in the O&M contract reduces the risk of the contractor only contributing minimum effort. The operating risks are distributed among the insurer, the O&M contractor and PV Project.

### **Financial risk**

Financial risks relevant for PV Project are interest rate risk, credit risk and inflation risk. Currency risk is less relevant for PV Project since both costs and revenues are denoted in Euro. The risk of interest rates changes is hedged through an interest swap, required in the loan agreement. Inflation is a source of risk especially since German feed-in-tariffs are not inflation regulated. If cost inflation is high in the coming years, there will be an imbalance between costs and revenues. Another financial risk PV Project faces is the risk of counterparties not being able to fulfil their obligations. An example is the credit risk of the

EPCI contractor during the warranty period. This risk is mitigated through a security deposit containing funds for a potential warranty claim.

### **Construction and completion risk**

The construction and completion risk is concerned with events causing a delay in the project. This can be Force Majeure risks, cost overruns, material defects and legal defects. The risk of force majeure events is allocated to the insurer. Most of the remaining construction and completion risk is borne by the EPCI contractor because of the turn-key EPCI contract, stating a fixed price and time frame for the project.

### **Risk matrix**

The risk matrix summarises the most important risks PV Project must deal with, what mechanisms are utilised to mitigate the risks and to what party they are allocated to. The contracts are central in both risk mitigation and risk allocation, but it is important to note that contracts are incomplete and there is always remaining risks, which the project company or the sponsors must cover.

<b>Risk:</b>	<b>Mitigation mechanism:</b>	<b>Allocation to:</b>
<b>Completion risk</b>	Turn-key EPCI contract	EPCI contractor
<b>Completion risk:</b> the project company lack the rights to the project	Transfer of rights agreement	SPV/Sponsor
<b>Completion risk:</b> cost overruns	Fixed price EPCI contract	EPCI contractor
<b>Technical risk</b>	Warranties, guarantees	EPCI contractor, technology supplier, equipment manufacturer
<b>Technical risk/operating risk</b>	Testing period	EPCI contractor
<b>Technical risk</b>	Technical taking over	EPCI contractor
<b>Technical risk</b>	Final taking over	EPCI contractor
<b>Financial risk:</b> Interest rate risk	Interest rate swap	Bank
<b>Financial risk:</b> Credit risk of EPCI contractor	Security deposit regulated in EPCI contract	EPCI contractor
<b>Political risk:</b> legal risk	Legal taking over	SPV/Sponsor
<b>Force Majeure risk</b>	Insurance	Insurance provider
<b>Third part liability</b>	Third part liability insurance	Insurance provider
<b>Force Majeure risk/ technical risk:</b> level of yield	Profit shortfall insurance	Insurance provider
<b>Market risk:</b> Revenue risk	Feed-in-tariffs	Government
<b>Operational risk</b>	O&M contract, guarantees	O&M contractor, equipment manufacturer
<b>Operational risk</b>	Extended inverter warranty	Inverter manufacturer
<b>Operational risk:</b> O&M contractor underperform	Over performance bonus	SPV/Sponsor
<b>Operational risk:</b> O&M cost increase	Fixed O&M price	O&M contractor

*Table 7 Risk matrix PV Project*

## 5.6 Case analysis

PV Project is an example of project finance in practice. The project entails the typical features predicted by the theory on project finance; separate incorporation, one sponsor and high leverage. The web of contracts delegates responsibilities to the project participants and is a central part of risk management. The loan agreement with its numerous covenants underlines the bank's strong position in project finance.

Project finance is suitable for PV Project for various reasons. Since the revenues are fixed, and the operating costs are fairly low, the project is relatively predictable. PV Project makes use of a relatively new, but proven technology, which leaves little room for alterations after construction. The fact that there are few built in options in the project, also underlines the predictability of the project. Naturally, there is uncertainty regarding whether the project will be realised according to the predictions, but these risks are being handled in the thorough risk management process.

This analysis will compare PV Project to other photovoltaic projects and other project financed ventures in order to see how the project is affected by financing and what improvements could be made done to the structure of the project. The analysis also compares PV Project with the rationale of project finance presented in the theory section 1.

### **PV Project and other photovoltaic projects**

PV Project differs from other photovoltaic projects with respects to several features such as to size of the plant, leverage and shorter maturity of the term loan. 5 MW is quite small compared to the projects described in section 4.1.1; PV project corresponds to only 9 % of the Lieberose project, which is predicted to be the largest in Germany. This does not however imply that small projects are unusual, but information about smaller parks is not given the same attention by the media. PV Project has a debt level of 65 %, which is within the leverage range found in the analysis of recent project financed PV parks, but in the lower percentile. The maturity of the loan is 16 years, whereas 18 years seems from the term sheet review and analysis of PV parks to be most common. A possible reason for the somewhat shorter tenor may be the fact that the loan agreement does not entail a cash sweep mechanism as opposed to other loans. The cash sweep forces prepayment and shortens the effective maturity.

The differences described above represent areas where potential changes can be made to the structure of PV Project. The fact that the size of the project is relatively small can be a



drawback since project finance is predicted to be better suited for larger projects due to high transaction costs. If the size were greater, the project would be able to capture economies of scale in the form of lower legal and advisory fees per Euro invested. For instance must a small project obtain the same contracts and permits with the same number of counterparties as a larger project. The negotiations in large projects are naturally more comprehensive, but there may be room for some savings due to economies of scale. Constructing a larger plant could reduce the transaction costs in proportion to capex. In order to achieve this, the project might need support from another sponsor, as it otherwise would be too big for one company. A joint venture structure may also permit higher leverage, since cross-collateral between the sponsors can be obtained. In addition to higher leverage, this structure may provide better credit terms., for example lower interest rates and longer maturity, possibly longer than the current 16 years tenor. However, there may be physical or regulatory limitations restraining a size increase.

Another alternative for profiting from economies of scale is to organise the project as part of a portfolio of projects. A portfolio structure allows for organising smaller projects in the same manner, using the same technology, the same O&M contractor and the same suppliers hence saving costs. Pooling projects into portfolios require the projects to have similar characteristics. Esty (2002) mentions project holding companies when he compares project finance and other financing structures. He claims that as the number of projects in portfolios increase, the structure will have more in common with corporate finance, since cross-collateralisation between the projects increase.

Source of funds is another possible improvement area for PV Project. A bond issue is probably not achievable as the project is too small for the bond market. Lease financing to obtain tax benefits and avoiding equipment risk may be a possibility. Refinancing can attract other investors with another risk preference after a few years of operations when the composition of risk is changed. At that point, the risk of delay and construction risks are resolved, and the participants have more knowledge of the commercial ability of the project. However, the loan agreement has covenants regarding changes to ownership of the project which can put a stop to such a transaction. There are also unwinding costs of terminating the loan agreement before maturity, especially with respects to the hedging contract since this contract is customised for the project. It is important to note that while these proposed changes could have a positive impact on the project, they may not be feasible. The financial structure of the project is a result of the accessible financial alternatives at the time the project

was initiated. The structure may be a consequence of limited opportunities, rather than a choice from a broad range of alternatives.

### **PV Project and other project financed ventures**

Compared to examples of project finance in other industries, PV Project is relatively uncomplicated. The project involves a relatively restricted number of uncertainties; limited to technology, yield, and time of start-up and corresponding feed-in-tariffs. An example of a project with more complex risk exposure is the Euro Disneyland Project initiated by the Walt Disney Company in 1988. A case study done by Finnerty (2007) presents the numerous uncertainties this project faced because of the many business areas the project involved. In addition to the theme park with attractions, shops and restaurants, the project entailed resorts and real estate. Euro Disneyland experienced uncertainty regarding cultural differences between American and European values and behavioural patterns, price forecasts on tickets, general price movements, attendance estimates, real estate projections, and what turned out to be a European recession. All these risks combined with a very high leverage almost caused bankruptcy and forced the Disney Corporation to contribute more equity. Although Euro Disneyland for these reasons may be perceived as an unsuccessful project, it is also an example of how an investor comprehends all risks involved, and protects existing business from the outcome of the project through separate incorporation of the new project. PV Project is of course a much smaller project than Euro Disneyland, but the comparison illustrates the straightforward nature of the project and the reasonably comprehensible risk exposure.

PV Project also has the advantage of having a public off-taker in a country with low probability of default, hence reducing credit risk and providing security for project financing. The German Renewable Sources Act (EEG) gives renewable power priority in the grid, thereby reducing demand risk and the risk of competition from other power generating technologies. This, however, makes the project exposed to regulatory risk, but since the project is located in Germany, sudden regulatory changes are less likely.

A possible disadvantage of PV Project compared to other projects, is that the market for the project's assets is less liquid compared to markets for other assets classes. This is mainly a concern to the bank as it reduces the value of the collaterals in case of project default, but in turn also a disadvantage for the project. If the project defaults, the bank has pledge on the assets and project rights, and can either take over operations of the plant, or sell the assets to recover as much as possible of their receivables. Awerbuch (2000) argues that PV systems

easily can be dismantled and sold as modules. However, other projects may have more marketable assets. Shleifer and Vishny's theory (1992) claims that the buyers for a project's assets are often found in the same industry. When a project is in default, the underlying reasons for the difficulties are likely to affect its competitors as well, leaving the project with no potential buyers for its assets. Shleifer and Vishny predict that asset illiquidity is a potentially important cost of leverage. More specialised assets, which are the case in PV Project, have lower reutilisation value, thus less liquid. This leads to increased credit support for such projects, whereas PV projects may be considered less attractive to banks.

### **PV Project and corporate finance**

Financing PV Project in a corporate finance structure may affect several aspects of the project. Project financed ventures have higher leverage than conventionally financed projects. Therefore, in a corporate finance structure, PV Project is likely to be financed with less debt.

The internal due diligence process would probably be the same, but less effort and internal resources would be needed for convincing the bank of the project's viability. Co-insurance and cross-collateralisation gained from the company's other activities and assets reduces the bank's risk and thereby the need for a lengthy due diligence process. The bank will in this situation consider the whole company when deciding debt capacity, taking the company's reputation and position in the market into account. In cases where the company has an existing relation with the bank, the process of applying for new debt can be quicker, as the assessment of the company is already performed and the bank has knowledge of the company's activities.

Kleimeier and Megginson (2000) found that third-party guarantees are more important in project finance loans than other comparable loans. Therefore it is likely that such guarantees would play a less central role if PV Project was corporately financed. Reduced importance of contracts makes the negotiation process shorter and reduces the costs of advisory and legal fees, though contracts still are crucial to the realisation of the project. According to Kleimeier and Megginson's study, the spreads on project finance loans are not higher than those of other loans; therefore are the financing costs not likely to be reduced. However, less internal resources and lower advisory and legal fees may lower the transaction costs.

The comparison of project finance and corporate finance in section 1.5, suggested that managerial discretion is higher in corporate finance structures. For PV Project, higher

managerial discretion could mean increased flexibility and the possibility of making decisions quicker. There would still be covenants to relate to, but of a less specific nature, leaving the managers to make choices about suppliers and other operational decisions without approval from the bank.

### **PV Project and rationale for project finance**

The theory presented in section 1 proposes different explanations to the rationale of project finance.

Brealey et al argue (1998) that project finance reduces the agency costs which could incur if the project was not separately incorporated. If PV Project was a part of the sponsor company, the agency relationship in question would be the conventional relationship between shareholders (principal) and managers (agent). Possible conflicts in this setting can arise from risk averse managers and differing incentives. Managers who are more concerned with their own interests than those of the agent may engage in empire building or favor their own pet projects. PV Project is unlikely to contribute to empire building as the project is relatively small, and the level of prestige and status that comes with it is rather low. If PV Project was one of many investment opportunities in a large corporation where managers value such project characteristics, PV Project could have difficulties competing with other projects with more perquisites and would maybe not be initiated.

Jensen's (1986) theory on how debt can reduce free cash flow and consequently reduce agency costs corresponds well with project financed debt based on a sculpted repayment structure. Sculpting adjusts annual debt service requirement to the cash available for repayment in each year, thereby reducing the free cash flow. This way of limiting free cash flow is less applicable in sizeable companies with large, co-mingled cash flows.

Agency costs of free cash flow seem likely to arise in the situation where PV Project is part of a corporate structure. The transparency of separate incorporation gives rise to improved cost control and eases the process of reducing spending. In addition, it makes PV Project responsible for all expenses, whereas large companies entail the possibility of deficits being covered by other activity areas.

Another benefit of project finance is how the structure enables tailor-made corporate governance measures. Since the continuous O&M work is out-sourced to a contractor the

project has few employees, and because there are few decisions to be made after the project is commissioned, this advantage appears less relevant for PV Project.

Shah and Thakor's theory (1987) explains the rationale of project finance in connection with asymmetric information. Inevitably, there is some degree of asymmetric information inherent in PV Project. Even though the bank has conducted a thorough due diligence process, project managers and the sponsor will have more information about the project, for example updated knowledge of technology, market conditions and project participants resulting from hands-on experience.

Shah and Thakor have a more theoretical approach than Brealey et al and Esty, which is difficult to compare with one particular case. PV Project has a relatively high leverage, though lower than many other projects in the same industry. According to Shah and Thakor this implies that PV Project is a risky project, but less risky than its comparables. It is hard to make a conclusion on whether there is some truth to this prediction without more information about other projects. The implications of their theory should be investigated on a broader selection of projects with different characteristics of risk level, leverage and interest rates in order to evaluate the practical relevance.

Esty (1999) proposes a rationale for project finance with respects to four types of investment distortions. The first is the already mentioned free cash flow problem. The second is asset substitution, which is also difficult to evaluate with regards to one project. If however, the sponsor wishes to obtain financing for projects later, asset substitution should be avoided out of consideration for the company's reputation.

The third investment distortion in Esty's theory is debt overhang. Whether this could prevent PV Project from being realised if it was part of a large corporation depends on the capital structure of the sponsor. If the sponsor has debt in place, debt overhang can be a problem for the realisation of the project. I do not have this information about PV Project's sponsor, but cannot dismiss the possibility of this investment distortion.

The fourth investment distortion; risk aversion among managers leading to underinvestment in risky, positive NPV projects, may be the most relevant in practice. Project finance avoids risk contamination on a company's other activity, thereby limiting possible negative consequences to the project, and making it easier for managers to undertake risky investments. The risk attitude in a sponsor company may depend on what line of business the

company is in compared to the proposed project. If the investment opportunity represents a new focus area, managers may be more risk averse compared to investing in the core activity area of the company. The risk management feature of project finance seems to be the advantage with the highest practical relevance.

## 6. Financial model

### 6.1 Methodology

The success or failure of a project financed investment is determined by the project's ability to generate sufficient cash flows to service debt and provide a satisfactory return to the equity holders. Therefore the financial model which evaluates a project's economic viability becomes essential to the project participants. The financial model is a spreadsheet designed to gather input and make calculations in order to assess overall project performance. The input to the financial model consists of macroeconomic assumptions, capital structure, investment costs, revenues, operating costs and the loan repayment schedule.

The output of the model includes cash flow statement, balance sheet, key ratios and drawdown of equity and debt. The model is useful in all stages of the project. First, the financial model is useful for due diligence when the project is being evaluated by potential lenders. Second, the model is valuable when sponsors and creditors negotiate terms such as loan terms and covenants. Finally, the model is an important tool in the construction period for monitoring the progress and performance of the project.

#### **Valuation**

The cash flow statement is prepared based on estimates of cash flows to the project. This statement provides an input for the income statement and the free cash flow calculation. Since the project company has only one purpose the retention ratio is zero; after satisfying the demands of the loan agreement, all profits are distributed to the investors as dividends.

The free cash form the basis of the valuation of the project. Free cash flow is determined by the following formula (EBIT is earning before interest and taxes):

$$FCF = EBIT (1 - t_c) + Depreciation - Capital expenditure - \Delta Working capital$$

According to Brealey et al (2008) the appropriate valuation technique for project financed investments is the Adjusted Present Value (APV) since the debt ratio is not constant, but typically high in the first years and reduces over the years of operation. The APV calculates a base-case NPV (net present value) as if the investment was all-equity financed and accounts for effects of financing separately. Other valuation techniques, such as the Weighted Average

Cost of Capital (WACC) incorporate financing effects in one calculation, but is less suited when the debt-to-value ratio varies.

*APV = base – case NPV + sum of present values of financing effects*

An important financing effect is the interest tax shield of debt. The APV is then the base-case NPV plus the present value of the tax shield:

$$APV = \sum_{t=0}^n \frac{FCF_t}{\rho} + \sum_{t=0}^n \frac{D_t \times r_d \times t_c}{r_d}$$

$$\rho = r_f + [E(R_m)]\beta_U$$

Where

$FCF_t$  = free cash flow in year t

$\rho$  = unlevered cost of equity

n = lifetime of the project

$D_t$  = face value of debt in year t

$r_d$  = cost of debt

$r_f$  = risk-free rate

$R_m$  = market risk premium

$\beta_U$  = unlevered beta

$t_c$  = corporate tax rate

If the calculated APV is positive, the project increases value and should be undertaken.

### **Debt coverage ratios**

Debt coverage ratios indicate a project's financial sustainability and are of interest to the lenders when evaluating their margin of safety. The lending bank will often require the average debt coverage ratios to stay above a minimum level. There are several varieties of such ratios. Two commonly used ratios are the *Debt service cover ratio* (DSCR) and the *Loan life cover ratio* (LLCR). The DSCR is used to evaluate the project company's capability to service debt on an annual basis, whereas the LLCR evaluates the same ability over the whole loan term. The DSCR is the ratio between the cash available for debt service (CAD) in any given year and the required debt service in that year. Cash available for debt service is equal to the cash flow from operations before interest expenses. The LLCR is the ratio between two discounted flows; the NPV of cash flows available for debt service over the remaining term,



and the NPV of the remaining debt service requirements. If the LLCR is greater than 1, there is a surplus available to the sponsors if they were to liquidate the project immediately. The definitions of the ratios are shown below:

$$DSCR_t = \frac{CAD_t}{DS_t}$$

$$LLCR = \frac{\sum_{t=s}^{s+n} \frac{CAD_t}{(1+i)^t}}{D_t}$$

Where

$CAD_t$  = cash available for debt service in year t

$DS_t$  = debt service in year t (= instalment<sub>t</sub> + interest<sub>t</sub>)

$D_t$  = outstanding debt at the end of year t

$i$  = interest rate of debt

$s$  = time of valuation

$s + n$  = last year of debt repayment

Another profitability measure is the internal rate of return (IRR), given by the formula:

$$NPV = \sum_{t=0}^n \frac{FCFF_t}{(1 + IRR)^t} = 0$$

The IRR rule is to accept projects when the IRR is higher than the opportunity cost of capital. The IRR is subject to several shortcomings compared to the NPV (and APV, since this is an extension of the NPV). For instance, if the project contains both negative and positive cash flows, or there are mutually exclusive projects, the IRR rule can be misleading. The IRR is however widely used in practice and can provide an indication of whether or not the project should be undertaken.

## 6.2 Discussion of financial model and results

In this section, I will present the results of a financial model for a PV plant located in Germany. Since the financial information about PV Project is confidential I have made a general financial model for a PV park with industry standard costs as input. Based on a set of assumptions, the model prepares an income statement, cash flow statement and loan balance, which then is used to calculate the adjusted present value (APV), internal rate of return (IRR), and coverage ratios. After presenting the main assumptions I will present the results of the valuation and a sensitivity analysis. The model makes certain simplifications, but still provides a good basis for the analysis.

### **Main assumptions and input**

The park is assumed to start generating electricity in year 2008, when the German feed-in-tariffs were 354.9 EUR/MWh, fixed for 20 years. The revenue each year is found by multiplying the applicable tariff with the annual energy output, given in MWh per year. The output is a function of average annual yield (kWh/kWp) and effective installed capacity (kWp). The output also takes into account diminishing module efficiency.

Operating costs and the purchase price of the system are based on 2008-level prices in Germany. The opex and capex are 35 and 3700 EUR/kWp respectively, resulting in a total capex of 18.72m EUR. The annual energy generation of the park is 5500 MWh. The calculation of taxes is simplified compared to the German tax system. The effective annual tax rate is assumed to be 28 %. Changes in working capital are negligible.

The useful life of the park is 20 years, equal to the German FIT guaranteed period. The capital structure consists of a senior term loan and equity. The amount of equity and debt is determined by the leverage, which is an input variable in the model. Initially, the leverage is assumed to be 70 %. The 13m EUR loan is subject to the typical terms found in the review of the actual term sheets in section 4.1.3, except for certain simplifications. The repayment follows a sculpted structure where annual instalments are modelled according to cash flows available for debt service each year, taking into account a minimum debt service coverage ratio of 1.3, according to the following formulas:

$$Interest_t = \text{Face value of debt}_t \times r_d$$

$$Instalment_t = \frac{CAD_t}{\text{min DSCR}} - interest_t$$

Where

$r_d$  = cost of debt

$CAD_t$  = cash available for debt service in year t

The requirement of the debt service reserve account is an amount equal to the debt service for the next six months. The up-front fee is 2 % of the loan amount. The model assumes there is no salvage value. This assumption will be discussed in the analysis in the last paragraph of this section.

The input to the model is summarised in table 8.

---

<b>Financial model – input</b>	
<b>Years of operation</b>	20
<b>Feed-in-tariff (EUR/MWh)</b>	354.9
<b>Tariff period (years)</b>	20
<b>Annual yield (kWh/kWp)</b>	1100
<b>Installed capacity (kWp)</b>	5000
<b>Tax rate</b>	28 %
<b>Leverage</b>	70:30
<b>Nominal interest rate</b>	4 %
<b>Up-front fee</b>	2 %
<b>Opex year 1 (EUR/kWp)</b>	35
<b>System purchase price (EUR/kWp)</b>	3700

*Table 8 Initial assumptions financial model*

## Valuation

Table 9 summarises the parameters used in the APV valuation. The risk-free rate,  $r_f$ , of 3.70 % is equal to the interest rate on long-term government bonds in Germany in 2006<sup>24</sup>. The market risk premium,  $E(R_M)$  is 5.30 %, equal to the historical equity premium in Germany from 1900 to 2005 according to Dimson et al (2006).

Valuation parameters	
$r_f$	3.70 %
$E(R_M)$	5.30 %
$\beta_U$	1.60
$r_d$	4.00 %

*Table 9 Valuation parameters*

One approach for approximating the unlevered beta according to Damodaran (2002) is to estimate the beta from the fundamental characteristics of the investment using betas of comparable firms. This is done by finding the betas of firms operating in the same business as the project in question. Since these betas depend on the firms' financial leverage, they must be delevered before an average is calculated. The following formula deleveres the levered beta:

$$\beta_L = \left[ 1 + (1 - t_c) * \frac{D}{E} \right] * \beta_U$$

Operating leverage (i.e. cost structure) may also vary among the companies, and should be controlled for by calculating a business beta taking into account the average ratio between fixed and variable costs.

In this case, finding publicly listed comparables to the relatively small PV park is difficult. I have made a selection of firms in the solar industry in order to provide a rough estimate. Ideally, company size, country where the companies are listed, line of business and operational leverage should be taken into consideration. However, the purpose of this exercise is to illustrate the estimation approach. The selection of companies is enclosed in appendix 3. The calculation could be further refined by not just applying the simple average, but also assigning weights to the companies based on different criteria. For simplicity, the calculation does not control for operational leverage. Based on data from [financialtimes.com](http://financialtimes.com) an average

<sup>24</sup> From <http://data.un.org/>

unlevered beta is 1.62. The asset beta reflects systematic risk, and since the demand for electricity tends to increase in periods of growth hence increasing the prices, the asset beta of PV investments is likely to be positive. Despite the shortcomings of the underlying analysis estimating the solar industry beta, I will use 1.60 as the unlevered beta in the valuation.

These input variables lead to an unlevered cost of equity of 12.18 %. Since the cash flows are expressed in real terms, they are transformed into nominal values using the German inflation in 2006 of 0.60 %<sup>25</sup>.

## **Results**

The model calculates a base case NPV of -7122 kEUR. The present value of the tax shield, given the cost of debt equal to the interest rate of 4 %, is 954 kEUR. This gives an APV of -6168 kEUR. The IRR is 5.61 %. A negative APV suggests that the project is unprofitable and should not be initiated. However, the scope of this analysis is to study the effect of changes in the input variables and financing alternatives, the size of the APV in itself is less interesting. Part of the negative APV could be attributed to the simplifications done in estimating cash flows. A more thorough approach could give another result. Other changes to the analysis which could improve the result will be discussed in the paragraph on financial side effects at the end of this section.

Since the repayment schedule of the term loan is based on a DSCR of 1.3, this is also the average and minimum DSCR. The model calculates an average LLCR of 2.68, the minimum LLCR is 1.64. This means that on average there is 2.68 EUR available for every 1 EUR of outstanding debt. If the project was to liquidate in year 1 when the LLCR is equal to the minimum LLCR, the project could fully reimburse the loan of 13,134 kEUR and distribute 8,931 kEUR to the sponsors (this is equal to 0.64 times the loan amount).

## **Sensitivity analysis**

PV plants are subject to a number of risks, all of which may affect the input in the financial model. In order to investigate the impact these risks have on the outcome on the project, a sensitivity analysis is conducted. The sensitivity analysis examines the effect on the APV and IRR for changes to the input variables. The purpose of the analysis is to provide an overview of the most critical assumptions, which in turn is useful for risk management.

---

<sup>25</sup> From UN Data <http://data.un.org/>

---

The risk of delay in construction may lead to reduced feed-in-tariffs if the commercial operation date is postponed to the next calendar year. The model assumes the project starts operations in 2008, when the tariffs were 354.9 EUR/MWh. If operations start in 2009, the prevailing FITs were 319.4 EUR/MWh. This FIT level results in an APV of -7132 kEUR, a 15 % reduction of the APV. Table 10 shows the changes in the APV for changes in input variables. The result is quite sensitive to changes in the tariff level; the changes in the APV are greater than the changes in the tariff. A 15 % reduction in tariffs leads to a 23 % reduction in APV. The break even tariff level is 527 EUR/MWh, which is significantly higher than the 2008-level. It is highly unlikely that the tariffs will reach this level, as the current debate in Germany concerns reductions in the tariff level, not increases.

Cost overruns are another source of risk in PV projects. Table 10 displays the project's sensitivity to changes in operating costs (opex) and investment cost (capex). Whereas changes to capex have a significant impact on the APV, the APV is less sensitive to opex changes. A 15 % increase in operating costs leads to an insignificant 1.9 % reduction in APV. The same increase in opex results in a 35.8 % decrease in APV. However, the risk of cost overruns affecting the investment cost is resolved shortly after construction start, whereas the level of operating expenses applies for the whole project life time.

The risk of the project not performing as predicted is analysed with regards to changes to the yield (kWh/kWp). The yield estimates is based on reports prepared by independent engineers. These reports also conduct sensitivity analyses with respect to yearly variation in irradiation, and find that the deviation from the long-term mean decreases as the measuring period increases. A typical 15-year average corresponds to +/- 3.5 % deviation from the mean. The annual yield is closely linked to irradiation, hence is a 10 % or 15 % change in yield, as table 10 is based on, highly unlikely. A 4 % reduction in yield leads to a 6.3 % decrease in APV. This indicates that performance risk is present in the project, but not to a large extent.

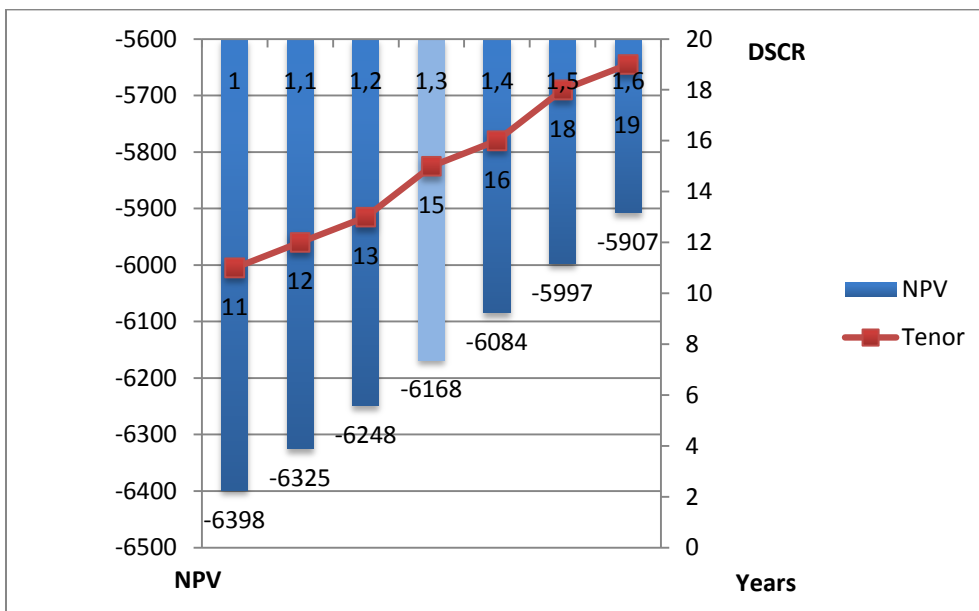
The results of the sensitivity analysis with regards to yield presented in table 10 show that the percent impact of changes to feed-in-tariffs and yield are the same. This is due to the modelling structure; because both variables are input to the calculation of revenues, the impact the APV in the same manner.

		<b>Change in input variable</b>			
<b>Variable:</b>		+ 15 %	+ 10 %	- 10 %	- 15 %
<b>FIT</b>	APV	-4688	-5185	-7132	-7605
	% change	24.0 %	16.0 %	-15.5 %	-23.3 %
<b>Capex</b>	APV	-8399	-7659	-4660	-3902
	% change	-36.2 %	-24.2 %	24.4 %	36.7 %
<b>Opex</b>	APV	-6306	-6260	-6075	-6029
	% change	-2.2 %	-1.5 %	1.5 %	2.3 %
<b>Yield</b>	APV	-4688	-5185	-7132	-7605
	% change	24.0 %	16.0 %	-15.5 %	-23.3 %

*Table 10 Sensitivity analysis*



The repayment structure of the term loan is sculpted based on a debt service cover ratio (DSCR) of 1.3, resulting in a maturity of the loan of 15 years. Figure 8 shows how changes to the repayment schedule of the term loan affect APV and IRR. The varying DSCR is presented on the x-axis with the values of APV on the y-axis to the left. The right y-axis display resulting maturity illustrated by the red graph. As the DSCR increases, so does the APV. The intuition behind this is that as the tenor increases, so does the interest rate tax shield, and consequently the APV. Future cash flows are more uncertain than current cash flows, and since this is also the case for future and current obligations; postponing repayment with a longer maturity is preferred from the sponsors' perspective. The banks have the opposite opinion and wish quicker repayment to ensure that the loan is paid back before, and preferably well in advance, discontinuation of the project.



*Figure 8 Repayment structure*

The life time of the solar park is assumed to be 20 years, but often the equipment has a useful life of 25 to 30 years. Figure 9 shows the effect of extended life time on the APV. The revenue period is extended accordingly, even though the German FIT period is 20 years. This simplification uses the FIT level as a proxy for revenues after year 20. A more accurate approach would be to model revenues from wholesale of electricity after the project no longer receives feed-in-tariffs. The x-axis in figure 9 marks years of operation, from 18 years up to 30. The APV on the left y-axis is higher as the life time is extended, naturally, so is the internal rate of return.

The figure shows as expected that a prolonged lifetime increases the profitability of the project. The calculations do not however take into account possible reinvestments due to replacement of equipment. This result underlines the potential of the solar park after the tariff period, hence should the project company try to find other sources of revenue after the first 20 years of operations.

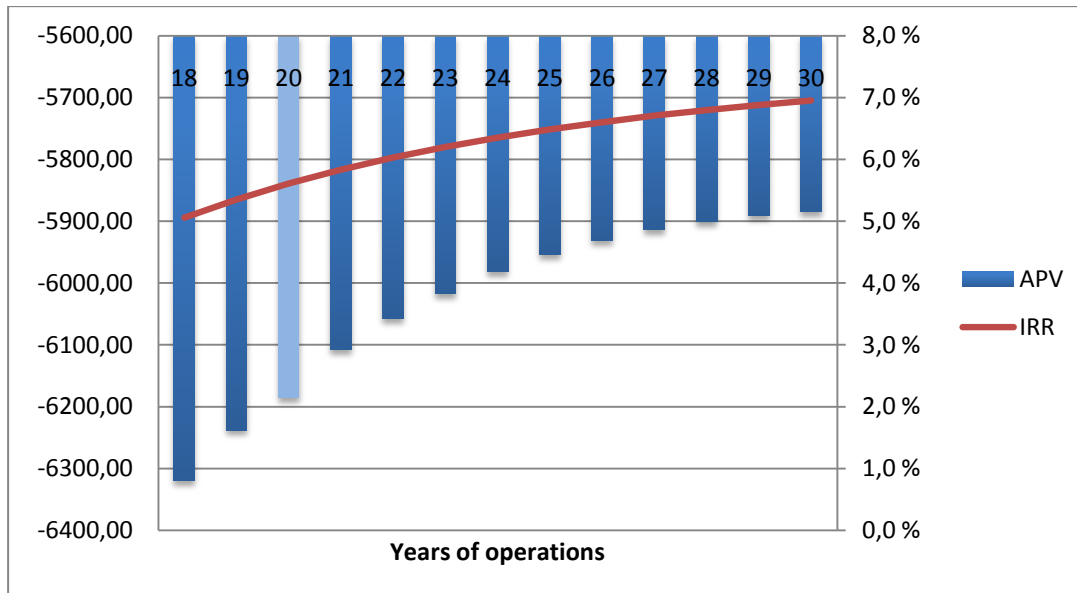


Figure 9 Extended life time

The analysis also investigates the effect of increased leverage, see figure 10. Higher leverage increases the value of the tax shield, and hence the APV. Higher leverage also leads to longer maturity, since the sculpting technique determines repayment. However, a significant increase of leverage may lead to higher bankruptcy costs.

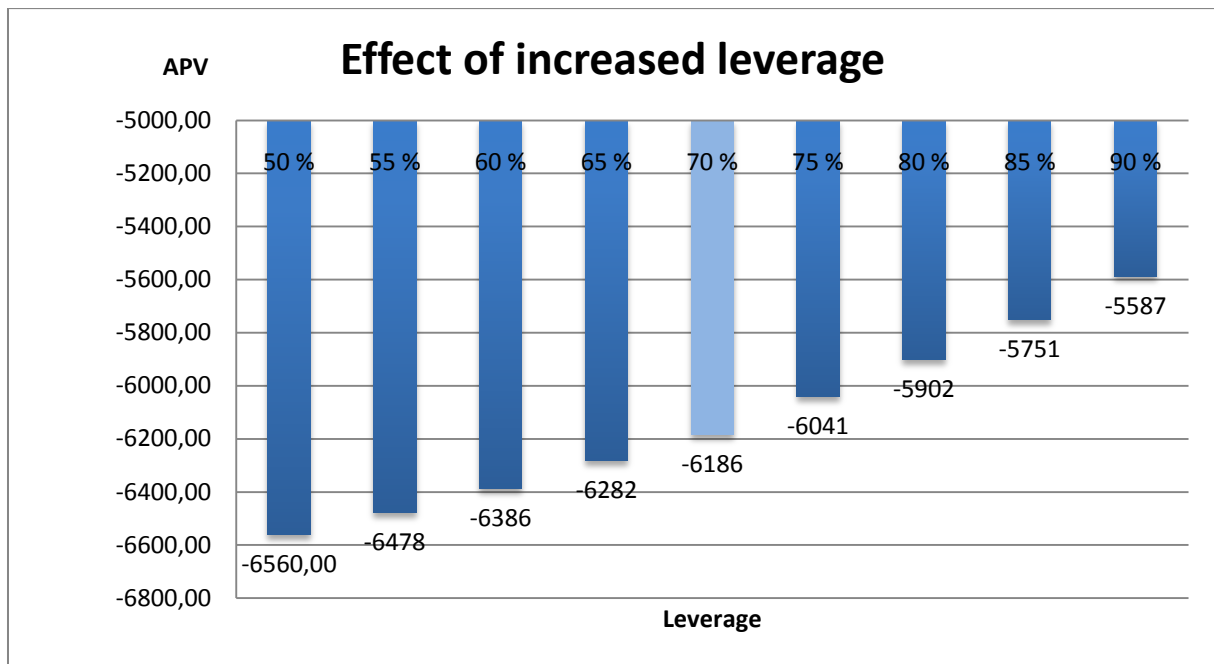


Figure 10 Increased leverage

Part of what causes the APV of the project to be negative, may be the parameters applied in the APV valuation. The IRR of 5.61 % implies that for the project to be valuable, the unlevered cost of equity would have to be below 5.61 %. This IRR does not account for the value of the tax shield; the comparable “break-even” unlevered cost of equity is 6.24 %. There is a great difference between 6.24 % and the current unlevered cost of equity of 12.18 %, hence is a significant increase of the project’s free cash flows or a reconsideration regarding the valuation assumptions required for the project to be profitable.

The valuation assumes a risk premium based on the German historical average. If however, the investors do not limit their investments to the German market, the international risk premium should be applied. According to Dimson et al (2006) this world historical average risk premium from 1900-2005 is 4 %. Replacing the German risk premium with the international risk premium, gives an APV of -4462 kEUR, almost 30 % increase compared to the initial APV. This difference indicates that the underlying assumptions in the valuation are critical to the outcome of the calculations.

The unlevered beta,  $\beta_U$ , and the risk-free,  $r_f$ , rate also affect the outcome of the valuation, but not to the same extent as the risk premium. A reduction of  $\beta_U$  from 1.6 to 1.5 increases the APV with 6.5 %, whereas reducing the  $r_f$  with 70 bps to 3 % leads to a 8.6 % change in the

APV. Applying all these changes at once, improves the APV with 2780 kEUR, underlining the importance of the parameters in the valuation.

Awerbuch (2000) argues, contrary to the assumptions of this valuation, that PV investments have a *negative* beta. According to his argumentation, fossil price movements have historically been counter-cyclical and this will also be the case for the value of electricity generated from PV, hence the value of PV investments. Further, he argues that PV investments with long-term fixed-price contracts for the output are zero-beta investments. Implementing his argument and valuing the project assuming  $\beta_U$  is -0.7 or 0 because of the feed-in-tariffs representing a long-term fixed-priced contract gives an APV of 14081 kEUR and 4345 kEUR respectively. This tremendous improvement of the APV emphasises the importance of carefully determining the valuation parameters. Awerbuch claims the fossil price movements tend to be counter-cyclical; however oil prices have historically increased with increasing demand in growth periods and decreased in recessions. The U.S. Energy Information Administration (EIA, 2010) confirms this connection between oil prices and market expectations. EIA points at how prices collapsed in July 2008 when the consequences of the financial crisis became evident. Therefore, I believe a positive asset beta is a more accurate input, and will base my modelling on the beta estimate of 1.60.

### **Scenario analysis**

The sensitivity analysis examines the effect of changes in the various input variables separately. This approach provides an overview of which variables are the most sensitive, but may be less realistic, as variables in real-life do not change only one at a time. It is also unlikely that changes in the assumptions apply for the entire lifetime of the project; changes are more probable in the last years as the future is uncertain.

#### *Scenario 1: Reduced feed-in-tariffs from year 10*

Revenue risk is a central source of uncertainty for any PV project. It is unlikely that the promised feed-in-tariff is cancelled, but given the current uncertainty regarding the continuation of the FIT arrangements it may be valuable to examine the consequences of future reductions in the tariffs. In this scenario, I assume a reduction of 10 to 30 % is implemented from year 10 to year 20. Figure 11 illustrates the consequences of the tariff reduction. Reductions varying from 10 to 30 % are displayed on the x-axis, while APV is indicated on the left y-axis and IRR on the right y-axis. The red line indicates the level of the initial APV. The figure shows that the consequences of reduced tariffs are not very large.

Again, this underlines that the cost and revenue input in the model may not affect the APV as much as the valuation parameters does. The fact that the reduction in tariffs happens 10 years ahead in time also contributes to the low effect, as the reduced cash flows are discounted 10 years back.

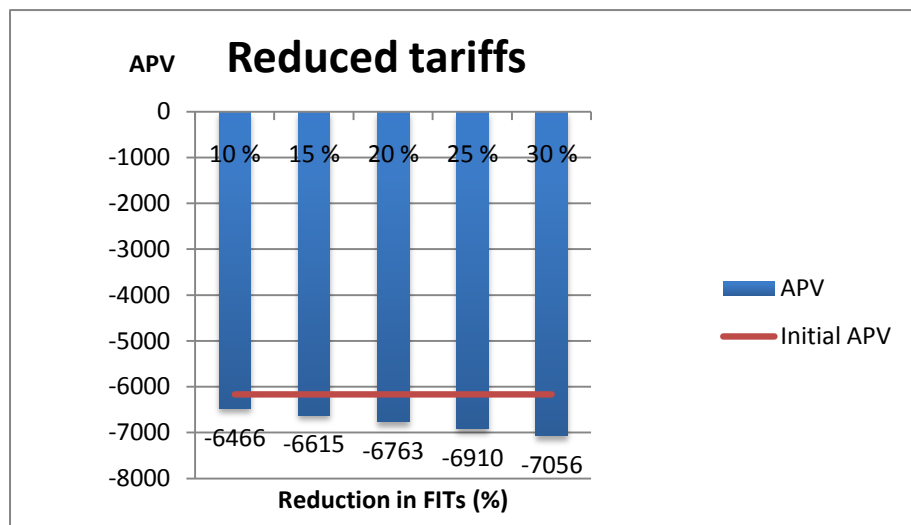


Figure 11 Reduced tariffs

#### *Scenario 2: Increased interest rates towards the end of the tenor*

Several of the term sheets described in section 4.1.3 included increasing interest rates towards the end of the loan maturity. Scenario 2 takes this into account with interest rates increasing from 4 % to 4.5 % in year 5, further to 5.25 % in year 9, and to 6 % from year 13 throughout the remaining tenor. This results in an APV of -6095 kEUR, 1.2 % higher than the initial value. The slight increase is due to the increase in the tax shield resulting from higher interest rates. The result indicates that the interest rate risk in the project is not very high. In addition, this risk is often hedged in an interest rate swap.

#### *Scenario 3: System break down and re-investment*

Technical risk is a central risk source in PV projects, which may cause production stops and increased costs of repair or replacement of equipment. In this scenario a technical deficiency causes a 40 % reduction in revenues in year 5 and re-investment the following year. The result of this is a 16 % reduction in APV. The event may entitle the project to an insurance indemnity or warranty claim mitigating the problem, but can be a bad indication for the project's future performance as this may be the first symptom of a reoccurring problem.

### **Financial side effects**

According to Brealey et al (2008) project finance can entail other financial side effects in addition to the tax shield, which should be included in the calculation of the APV. Examples of these are favorable interest rates or lease terms. Contracts with suppliers or customers can

also provide credit support. The value of these side effects should be added to the APV. In the case of PV projects, the government support schemes are examples of financial side effects.

One particular form of financial side effects is real options. According to Black and Scholes (1973) an option is: “*A security giving the right to buy or sell an asset, subject to certain conditions, within a specified period of time*”. The connection between financial options and real options was put forward by Myers (1977), who firm value as the sum of the present value of earnings generated by the firm’s assets in place, plus present value of growth opportunities. The present value of growth opportunities is according to Myers “*options to make further investments on possibly favourable terms*”. Examples of real options are deferral options, options to abandon, options to contract or expand, switching options, compound options and rainbow options. The value from real options can in some situations mean the difference between undertaking and rejecting a project. The traditional NPV can be negative, but there is so much value from options that this makes up for the negative NPV. This is especially important for projects with a high degree of uncertainty, because this is what drives option value. Higher volatility of the value of the underlying asset, in the case of real options the present value of the project, and longer time to expiration increase the value of the option.

Investments in renewables, so-called “*green investments*” may entail various real options. Green investments which today generate low profits or even are unprofitable can enable a company to take part in technology development and achieve learning curve effects, which in turn provides a leading position in renewables in the future. This rationale of green investments is confirmed in by the chief executive of SunPower who has pronounced that the company is “*extremely well-positioned*” for the shift to renewables which, according to him, is “*an unassailable shift*”<sup>26</sup>.

BP and Shell are examples of large companies that have made investments in renewables. However, they both admit that these investments have problems competing with their other investment opportunities. In 2000 BP, the company formerly known as “*British Petroleum*” announced its new strategy in renewables and changed name to “*Beyond Petroleum*”, signaling the priority area for the company. 9 years later, the investments in renewables fell and renewable-energy assets were being sold off. The Economist (2009c) argues that these

---

<sup>26</sup> The Economist (2010)

investments will not reach their profitability potential before investments in conventional energy sources cover the costs of the pollution they cause.

Another real option in PV projects is the possibility of extending the project's life time. The financial model assumes the life time is 20 years, since the fixed tariff revenue ends after 20 years. The useful life of the technical equipment however, can be 25 to 30 years. This represents an option to switch to wholesale after the FIT period. The reason why this value is not taken into account is mainly the high degree of uncertainty and that the bank is unwilling to consider the values of a real option materialising in 20 years. There is uncertainty regarding the level of electricity prices in 20-25 years from now and technology development. The current technology may be outdated and not able to compete with more effective power generating technologies. Nevertheless, this is a real option and the value of the option should be added to the APV. The inherent uncertainty in the project is valuable in the valuation of the real option as uncertainty leads to higher option value. The sensitivity analysis confirms that the APV increase with longer life time, and hence indicates that the project company should search for other sources of revenue after the FIT period ends.

The value of this real option comes from three sources: revenues from wholesale, refinancing debt, and other support arrangements not present at the time of the investment, e.g. grants, tax incentives, and CO<sub>2</sub> instruments. Debt refinancing can result in better terms as most of the risks have been resolved. Higher performance from replaced technical components is also a potential source of value.

## 6.3 Summary

The purpose of the financial model is to evaluate the project with regards to APV, IRR and debt service coverage ratios. The initial assumptions result in a negative APV, indicating that the project is unprofitable and should be not initiated. The debt service cover ratios demonstrate the project's ability to meet its obligations. The LLCR indicates that the project at all times is able to repay the debt and make distributions to equity holders if the project is to be liquidated. The negative APV of 6168 kEUR implies that the project should not be initiated. However, the APV is less interesting since the purpose of the thesis is to analyse the effects of changes in the financial model

The sensitivity analysis looks into what assumptions and variables are critical to the project's financial viability. The project is vulnerable to changes in the feed-in-tariffs reflecting revenue risk and substantial risk of delay. The risk of cost overruns is low with regards to operating costs, but higher when it comes to the investment cost. When the predictions from the yield reports are considered, the APV is not very sensitive to the level of the obtained yield, indicating low performance risk. Further, the analysis shows that higher leverage increases the APV. The impact of technical risk is examined in the scenario analysis, which shows that the consequences of a system break down can be severe. This is especially relevant if the break down leads to production stop in high irradiation periods and consequently high revenue losses.

Whereas changes in the input variables in the financial model do not mean much for the APV, the impact of changes to the valuation parameters is greater. This underlines the importance of carefully determining these parameters.

The negative APV implies that the project should not be undertaken. Expanding the analysis to other side effects such as real options however, may alter this result. Real options are likely to be part of green investments, for example in terms of making strategic investments today to secure a favorable market position in the future. Another real option is the option to extend the project's lifetime past the tariff period. The large degree of uncertainty makes the banks unwilling to take this value into consideration when they evaluate a project, but the sensitivity analysis confirms that extending the life time increases the value of the investment. Therefore, this real option should be valued and added to the APV.



## 7. Project finance in theory and practice

The presented theory on project finance in section 1 explain the use of project finance with respect to reduced agency costs, asymmetric information, risk management and other investment distortions such as debt overhang.

Risk management seems to be the explanation with the highest relevance to project finance in practice. The separate incorporation feature of project finance enables a parent company to invest in a new project without fear of how a negative outcome may affect existing business. The Cellino San Marco project and the Montalto di Castro project described in section 4 illustrate how risk management plays an important part in project finance.

Evidence from practical project finance, both from the overview of current PV projects in Germany, France, Italy and the Czech Republic, as well as the case project, confirm that project financed ventures employ high leverage compared to corporately financed projects.

According to Brealey et al (2008) two thirds of corporate financing in Germany, Japan, and the United Kingdom are internal funds. They raise the question of whether firms rely too much on internal funds since this way of raising capital is more convenient than raising funds in the capital market and being investigated by potential investors or creditors. Avoiding the disciplining capital market may put managers in a more comfortable situation.

Increasing the amount of debt in the capital structure increases the tax shield resulting from tax-deductible interests. There are however also costs of financial distress, for example bankruptcy costs increasing with debt level. According to the trade-off theory the optimal debt ratio is reached when the present value of the tax shield is offset by the present value of the costs of financial distress. Consequently, riskier firms should have lower leverage than safer firms, because riskier firms have a higher probability of bankruptcy. Since there are costs of adjusting the capital structure, companies will not be optimally financed at all times.

Brealey et al go on to investigating whether debt levels in real-life support this theory. On one hand, industry differences in capital structure confirm the theory. An example is high-tech growth companies with intangible, risky assets having low debt levels, compared to airline companies with tangible, safer assets having higher debt levels. On the other hand Brealey et al observe that the most profitable companies tend to borrow the least.

Empirical evidence also suggests many companies are underlevered. Graham (2000) estimates the net benefit of increasing the debt level in the capital structure in a typical tax-paying company. He finds that increasing the leverage on average leads to a 7.5 % increase in firm value, indicating that most companies could benefit from more debt.

The fact that project finance entails higher leverage than corporate finance, may indicate that project finance results in debt levels closer to optimal capital structure. A possible explanation for this is agency costs. Having debt in the capital structure is often considered unpleasant by managers who consequently choose not to issue debt in order to finance a new project. The loss of NPV of this project is therefore an agency cost. Project finance reduces the discomfort connected to debt by separately incorporating the project outside the parent company.

Jensen and Meckling (1976) argue that the optimal capital structure minimises the total agency costs consisting of agency costs of debt and agency costs of equity. Project finance enables higher leverage, and thereby reducing agency costs. This model does however, not explain how the optimal debt level is found, and disregards taxes.

## 8. Conclusion

This thesis has analysed project finance from a theoretical and a practical perspective. The literature review presented theories on project finance, whereas the case study and summary of recent project finance deals looked into how project finance is applied in photovoltaic projects. The general financial model values a project and illustrates important aspects of financial modeling.

The key features of project finance make this form of financing differ from other methods for funding a new project. The most important differences are separate incorporation and limited or no recourse to the sponsors. The theoretical rationale of project finance includes reduced consequences of agency costs, asymmetric information, and investment distortions. Contracts with project participants provide the core of risk management in project finance. The study on loan spreads by Kleimeier and Megginson finds that project finance loans have lower spreads than other loans. This result supports the hypothesis that project finance has competitive advantages over other forms of financing for certain types of projects.

Practical aspects of project finance are examined in light of photovoltaic (PV) power plants which generate electricity from the sun utilising the photovoltaic effect. Photovoltaic projects are suited for project finance since they apply new, but proven technology, have predictable cash flows and few decisions to be made after commissioning. The review of recent PV deals suggests risk management is the most important advantage of project finance from the practitioners' perspective. The web of contracts in project finance allows distribution of risks to the party who is best able to handle that particular risk. Various risk mitigation mechanisms incentivise the project participants to handle risks efficiently, thereby reducing total risk. However, not all risks are allocated; some risk is retained in the project and must be borne by the project company or the sponsors, depending on the recourse of the project debt. Establishing the project as a separate unit is an advantage for the sponsors, because it avoids risk contamination on the sponsors' existing business. Significant risk sources in photovoltaic projects are technology risk, risk of delay and regulatory risk. Government subsidies in various forms, particularly feed-in-tariffs, have contributed to growth in the PV sector, for instance as experienced in Germany. Electricity generated with PV technology is not yet competitive with energy from conventional sources, but as the competitiveness of the industry is increasing, government support schemes are being phased-out.

The banks' provide the greater part of funding in project finance and are key participants in the projects. Their involvement is concerned with reducing risk, illustrated by the many covenants included in the term sheets. One particular mechanism employed by the banks in order to protect their interests, is structuring debt repayment based on sculpting. This technique adjusts annual debt service to cash flows, consequently reducing free cash flow and ensuring repayment to the bank.

The case study of PV Project looks into the details of the project financing of a PV plant in Germany. The project entails the key features described in theory, and the web of contracts contributes to risk management. Important contracts are the Transfer of rights agreement, the permits from the authorities and the EPCI contract. Examples of risk mitigation mechanisms used in the project are the over performance bonus in the O&M contract, the use of the same contractor for EPCI and O&M services to avoid potential conflicts, and an extended inverter warranty alleviating technical risk. The comparison of PV Project and other projects gives rise to certain improvement areas. Structuring the project differently could make PV Project achieve economies of scale, higher leverage, and better terms for the loan agreement. In contrast to project financed investments in other lines of business, PV Project is exposed to a limited number of uncertainties, faces low revenue and demand risk, but may suffer from low value of the project assets in default situations. Specialised assets have low redeployment values and provide lower credit support than more marketable asset classes.

The comparison of theory and practice with respects to PV Project underlines the importance of risk management as the advantage with most practical relevance. This is confirmed in the general analysis. The advantages of project finance presented in the theory section may all apply in practice, but a broader set of case examples is needed to investigate this further. The general analysis also finds that project finance enables projects to obtain higher debt levels which may be closer to the optimal level.

The general financial model for a photovoltaic project illustrates how a project's financial viability is analysed. The sensitivity analysis revealed that the valuation parameters have a greater impact on the APV than the input variables which determine predicted cash flows.

The financial model resulted in a negative APV, implying that the investment should not be undertaken. Taking financial side effects such as real options into the calculations could alter this result. Strategic considerations can come into play when green investments are initiated.

The intention of undertaking a seemingly less profitable project today may be that it enables a lucrative market position in the future. PV has great potential given increased energy demand, low greenhouse gas emissions, and practically unlimited availability of resources, but is still highly dependent on subsidies from governments. Some argue that renewables will not be profitable until investments in fossil fuels are required to pay for the costs they impose on the environment.

A development seen in project finance the last years is increased use of the bond market. From 2002 to 2005 the bond market grew from 13.8m USD to 26.7m USD, partially due to positive experience from the U.S bond market<sup>27</sup>. Project Finance International (2009) attributes much of the increased attractiveness of the bond market to reduced availability of bank loans after the financial crisis, and tougher terms in form of shorter tenors and higher spreads and fees.

SunRay has issued one of the first publicly-rated project bonds for solar for a 52 MW plant in the Lazio region of Italy. According to Project Finance Magazine (2010e) the 200m EUR bond issue is arranged by SG and BNP Paribas and has a maturity of 18 years. SolarWorld AG issued a 400m EUR bond, mainly intended for the expansion of their production site in Freiburg, Saxony. The bond had a maturity of 7 years and a coupon of 6.13 %. Philipp Koecke, CFO of SolarWorld, said this about the success of the bond issue: *“With the issue of this bond we are continuing our successful ten-year stock exchange history and we are delighted with the trust that the capital market has been placing in us. This was confirmed by the fact that the bond was oversubscribed twice over within a very short period of time. The bond is another building block in our sound financial basis.”*<sup>28</sup>

In addition to the increased attractiveness of the bond market for project finance in general, larger PV plants may be part of why the PV industry now approaches the bond market. Project Finance Magazine (2010d) reports of a tendency of increasing size of PV plants. Currently there are three projects in Italy competing to be the biggest PV plant in Europe. The 110 MW project by AES Solar and 123 MW project by Samsung are yet to receive full

---

<sup>27</sup> Gatti (2008), p. 212

<sup>28</sup> SolarWorld (2010)

authorisation, whereas the 72 MW plant by SunEdison has been granted the necessary permits and will be the biggest PV plant in Europe if it is completed before the two others.

The future of PV investments is threatened by announced phase-out of feed-in-tariffs, the financial problems in the Euro area and the fact that the industry is still policy-driven, not market-driven. Project Finance Magazine (2010d) refers to a project financier arguing that the effect of FIT cuts will be lower leverage; from current levels of 85 % debt, to 65 %. A solar developer on the other hand, predicts that the cuts will be compensated by cost reductions in the PV industry and subsequently lower capex. The aftermath of the financial crisis combined with the current financial turmoil in the Euro area have lead to uncertainty regarding whether governments will afford to continue their subsidy arrangements. The Economist (2010) emphasises that two of the countries facing problems, Spain and Italy, are important participants in the global PV market. There are also optimists believing that the shift to renewable energy sources is unquestionable, and green investments will pay off in future. The many advantages of renewables over fossil energy sources are apparent, but the answer to how and when the transition will happen remains unknown.

---

## References

- Asplund, R. W. (2008). *Profiting from clean energy: a complete guide to trading green in solar, wind, ethanol, fuel cell, power efficiency, carbon credit industries, and more*. Hoboken, N.J.: Wiley.
- Awerbuch, S. (2000). Investing in photovoltaics: risk, accounting and the value of new technology. *Energy Policy*, 28(14), 1023-1035.
- Beale, C., Chatain, M., Fox, N., Bell, S., Berner, J., Preminger, R., et al. (2002). Credit Attributes of Project Finance. *Journal of Structured and Project Finance*, 8(3), 5.
- Black, F., & Scholes, M. S. (1973). The Pricing of Options and Corporate Liabilities. *Journal of Political Economy*, 81(3), 637-654.
- Bradford, T. (2006). *Solar revolution: the economic transformation of the global energy industry*. Cambridge, Mass.: MIT Press.
- Brealey, R. A., Cooper, I. A., & Habib, M. A. (1998). Using Project Finance to Fund Infrastructure Investments. In J. M. Stern & D. H. Chew, Jr. (Eds.), *The revolution in corporate finance* (pp. 223-236): Third edition.
- Brealey, R. A., Myers, S. C., & Allen, F. (2008). *Principles of corporate finance*. Boston, Mass.: McGraw-Hill/Irwin.
- Caselli, S., & Gatti, S. (2005). *Structured Finance: Techniques, Products and Markets*. Berlin: Springer.
- Copeland, T. E., Weston, J. F., & Shastri, K. (2005). *Financial theory and corporate policy*. Boston, Mass.: Pearson Addison-Wesley.
- Dagens Næringsliv. (2010a). Nedgraderer Portugal og Hellas (Downgrades Portugal and Greece) Retrieved 27.04.2010, from <http://www.dn.no/forsiden/utenriks/article1886735.ece>
- Dagens Næringsliv. (2010b). Nedgraderer Spania (Downgrades Spain) Retrieved 29.04.2010, from <http://www.dn.no/forsiden/utenriks/article1887793.ece>
- Damodaran, A. (2002). *Investment valuation: tools and techniques for determining the value of any asset*. New York: Wiley.
- Denholm, P., Margolis, R. M., Ong, S., & Roberts, B. (2009). Break-Even Costs for Residential Photovoltaics in the United States: Key Drivers and Sensitivities Retrieved 09.03.2010, from <http://www.nrel.gov/docs/fy10osti/46909.pdf>
- Dimson, E., Marsh, P., & Staunton, M. (2006). The Worldwide Equity Premium: A Smaller Puzzle Retrieved 08.06.2010, from [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=891620](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=891620)
- Earth Policy Institute. (2007). Solar Cell Production Jumps 50 percent in 2007 Retrieved 15.06.2010, from <http://earthpolicy.org/index.php?/indicators/C47/>
- EEG. (2009). Renewable Energy Sources Act 2009 (EEG) Retrieved 01.05.2010, from <http://www.erneuerbare-energien.de/inhalt/42934/>
- EIA. (2009). International Energy Outlook 2009 Retrieved 09.03.2010, from <http://www.eia.doe.gov/oiaf/ieo/world.html>
- EIA. (2010). International Energy Outlook 2010 - Highlights Retrieved 15.06.2010, from <http://www.eia.doe.gov/oiaf/ieo/highlights.html#3>
- EPIA. (2010a). Overview of European PV Support Schemes Retrieved 04.05.2010, from [http://www.epia.org/uploads/media/Overview\\_support\\_schemes.pdf](http://www.epia.org/uploads/media/Overview_support_schemes.pdf)

- EPIA. (2010b). Photovoltaic energy, Electricity from the sun Retrieved 09.03.2010, from <http://www.epia.org/index.php?id=18>
- Esty, B. C. (1999). Petrozuata: A Case Study of the Effective use of Project Finance. *Journal of Applied Corporate Finance*, 12(3), 26-42.
- Esty, B. C. (2002). Returns on Project-Financed Investments: Evolution and managerial implications. *Journal of Applied Corporate Finance*, 15(1), 71.
- Esty, B. C. (2003). The Economic Motivations for Using Project Finance. *Mimeo*.
- Esty, B. C., & Christov, I. L. (2002). An Overview of Project Finance - 2001 Update. *Harvard Business School Supplement 202-105*.
- European Commission. (2006). Photovoltaic Solar Electricity Potential in European Countries Retrieved 13.06.2010, from [http://re.jrc.ec.europa.eu/pvgis/countries/europe/EU-Glob\\_opta\\_presentation.png](http://re.jrc.ec.europa.eu/pvgis/countries/europe/EU-Glob_opta_presentation.png)
- Farrell, L. M. (2003). Principal-agency risk in project finance. *International Journal of Project Management*, 21(8), 547-561.
- Finnerty, J. D. (2007). *Project Financing: Asset-based Financial Engineering* (2nd ed. ed.). New Jersey: Wiley Finance.
- Frondel, M., Ritter, N., Schmidt, C. M., & Vance, C. (2010). Economic impacts from the promotion of renewable energy technologies: The German experience. *Energy Policy*, 38(8), 4048-4056.
- Gatti, S. (2008). *Project Finance in Theory and Practice: Designing, structuring, and financing private and public projects*. Amsterdam: Academic Press, Elsevier.
- Goldman, D. P., McKenna, J. J., & Murphy, L. M. (2005). Financing Projects That Use Clean-Energy Technologies: An Overview of Barriers and Opportunities Retrieved 10.03.2010, from [www.nrel.gov/docs/fy06osti/38723.pdf](http://www.nrel.gov/docs/fy06osti/38723.pdf)
- Graham, J. R. (2000). How Big Are the Tax Benefits of Debt? *Journal of Finance*, 55(5), 1901-1941.
- Grimsey, D., & Lewis, M. K. (2002). Evaluating the risks of public private partnerships for infrastructure projects. *International Journal of Project Management*, 20(2), 107.
- Hoffman, S. L. (2008). *The Law and Business of International Project Finance* (3rd ed. ed.). New York: Cambridge University Press.
- Jensen, M. C. (1986). Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers. *American Economic Review*, 76(2), 323.
- Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, Agency costs and Ownership structure. *Journal of Financial Economics*, 3(4), 305-360.
- Khan, M. F. K. K., & Parra, R. J. (2003). *Financing Large Projects using Project Finance techniques and practices*. Singapore: Prentice Hall.
- Kleimeier, S., & Megginson, W. L. (2000). Are Project Finance Loans Different From Other Syndicated Credits? *Journal of Applied Corporate Finance*, 13(1), 75-87.
- Leder, S. (2010). Why Germany? Why Solar? A Political Economic Analysis, Series issue 4, Retrieved 15.06.2010 from <http://www.ecoalign.com/node/355>
- Liebreich, M., Greenwood, C., Bismarck, M. v., & Gurung, A. (2010). Green Investing 2010. Policy Mechanisms to Bridge the Financing Gap Retrieved 09.03.2010, from [http://www.newenergymatters.com/UserFiles/File/Presentations/Green\\_inv\\_report\\_2010%20FINAL.pdf](http://www.newenergymatters.com/UserFiles/File/Presentations/Green_inv_report_2010%20FINAL.pdf)
- Mendonça, M., & Jacobs, D. (2009). Feed-in Tariffs Go Global: Policy in Practice Retrieved 20.01.2010, from <http://www.renewableenergyworld.com/rea/news/article/2009/09/feed-in-tariffs-go-global-policy-in-practice>



- 
- Milford, E. (2007). Powering on - The finances of solar energy in Europe Retrieved 20.01.2010, from <http://www.renewableenergyworld.com/rea/news/article/2007/03/powering-on-the-finances-of-solar-energy-in-europe-51545>
- Modigliani, F., & Miller, M. H. (1958). The Cost of capital, Corporation Finance and the Theory of Investment. *American Economic Review*, 48(3), 261.
- Myers, S. C. (1977). Determinants of corporate borrowing. *Journal of Financial Economics*, 5(2), 147-175.
- Myers, S. C., & Majluf, N. S. (1984). Corporate financing and Investment decisions when firms have information that investors do not have. *Journal of Financial Economics*, 13(2), 187-221.
- Nevitt, P. K., & Fabozzi, F. J. (2000). *Project Financing* (7th ed. ed.). London: Euromoney Books.
- New Energy Finance. (2010). Germany's solar capacity soars by a record 3.8GW during 2009 Retrieved 24.04.2010, from [newenergyfinance.com](http://newenergyfinance.com)
- New Energy Matters. (2010). Bundesrat warns feed-in-tariff cuts should "not exceed 10 %" Retrieved 27.04.2010, from [newenergymatters.com](http://newenergymatters.com)
- Project Finance International. (2009). Bank vs bonds. *Project Finance International*, Iss. 410, 12.
- Project Finance Magazine. (2009a). France announces new solar feed-in-tariffs. *Project Finance Magazine*, Iss. 305, 9.
- Project Finance Magazine. (2009b). Lieberose solar project financed Retrieved 12.05.2010, from [projectfinancemagazine.com](http://projectfinancemagazine.com)
- Project Finance Magazine. (2009c). Montalto di Castro PV: Debt in a cold climate. *Project Finance Magazine*, Iss. 304, 26-27.
- Project Finance Magazine. (2009d). Solar flares. *Project Finance Magazine*, Iss. 305, 42-43.
- Project Finance Magazine. (2009e). Solar rearray. *Project Finance Magazine*, Iss. 299, 26-28.
- Project Finance Magazine. (2010a). Cellino San Marco PV closes Retrieved 26.04.2010, from [projectfinancemagazine.com](http://projectfinancemagazine.com)
- Project Finance Magazine. (2010b). Dealogic Global Project Finance Review - Full Year 2009 Retrieved 18.05.2010, from [projectfinancemagazine.com](http://projectfinancemagazine.com)
- Project Finance Magazine. (2010c). European Solar Deal of the Year 2009. Montalto di Castro PV: Big solar. *Project Finance Magazine*, Iss. 307, 51.
- Project Finance Magazine. (2010d). Is Italian solar in trouble? Retrieved 15.06.2010, from [projectfinancemagazine.com](http://projectfinancemagazine.com)
- Project Finance Magazine. (2010e). SG and BNP on SunRay bond Retrieved 12.05.2010, from [projectfinancemagazine.com](http://projectfinancemagazine.com)
- Scheer, H. (2007). *Energy autonomy: the economic, social and technological case for renewable energy*. London: Earthscan.
- Shah, S., & Thakor, A. V. (1987). Optimal Capital Structure and Project Financing. *Journal of Economic Theory*, 42(2), 209.
- Shleifer, A., & Vishny, R. W. (1992). Liquidation Values and Debt Capacity: A Market Equilibrium Approach. *Journal of Finance*, 47(4), 1343-1366.
- Siegel, J., Nelder, C., & Hodge, N. (2008). *Investing in renewable energy: making money on green chip stocks*. Hoboken, N.J.: Wiley.
- Solarbuzz. (2010). Solarbuzz reports World solar Photovoltaic market grew to 6.43 Gigawatt in 2009 Retrieved 25.04.2010, from <http://www.solarbuzz.com/News/NewsNACO1096.htm>

- Solar World. (2010). SolarWorld AG Places 400 Million Euro Bond/ Financial Flexibility for Growth wiht Focus on Germany Retrieved 26.04.2010, from <http://www.solarworld.de/4322.html?L=1>
- Store Norske Leksikon. (2009). Foton (Photon) Retrieved 09.05.2010, from <http://www.sn�.no/foton> (Norwegian encyclopaedia)
- The Economist. (2009a). Getting warmer. In A special report on the carbon economy, *The Economist*.
- The Economist. (2009b). Good policy, and bad. In A special report on the carbon economy, *The Economist*.
- The Economist. (2009c). The green slump. In a special report on the carbon economy, *The Economist*, pp. 10-12.
- The Economist. (2010). Green-energy blues Retrieved 15.06.2010, from [http://www.economist.com/node/16245724?story\\_id=16245724](http://www.economist.com/node/16245724?story_id=16245724)
- Traber, T., & Kemfert, C. (2009). Impacts of the German Support for Renewable Energy on Electricity Prices, Emissions, and Firms. *Energy Journal*, 30(3), 155-178.
- Wiser, R., Bachrach, D., Bolinger, M., & Golove, W. (2004). Comparing the risk profiles of renewable and natural gas-fired electricity contracts. *Renewable and Sustainable Energy Reviews*, 8(4), 335-363.
- Yescombe, E. R. (2002). *Principles of project finance*. London: Elsevier Science, Academic Press.

## Appendix 1 – List of case documents

Indicative term sheet	Yield report from independent engineer 3
Loan agreement	Technical taking over protocol
Financial model	Transfer of rights agreement
Technical due diligence report	EPCI contract
Legal due diligence report	O&M contract
Profit shortfall insurance	Amendments to the O&M contract
Facility insurance	Land lease agreements
Third-part liability insurance	Land use agreements
Description of insurance	Contract with the grid operator
Yield report from independent engineer 1	Building permit
Yield report from independent engineer 2	

## Appendix 2 – Project financed photovoltaic projects

PV Project finance loans - France, Germany, Italy, Czech Republic					January 2009-April 2010			
Project	Site	Size (MW)	Sponsor	Banks	Total value (€m)	Term loan (€m)	D/V ratio	Terms
	Puglia	2x1	Alerion	Intesa			10	
Lieberose	Brandenburg	53	Juwi Solar, First Solar	DZ Bank, Helaba, KfW IPEX, NordLB, Bremer Landesbank	160	130	81,3 %	17 yrs, margins about 150bps, 50 % linear, 50 % annuity. Debt/equity 84/16
	Puglia	4	Foresight	Centrobanca		17		15 yrs
	Puglia	2	K-Energy	IKB		10		
ErgyCapital S.p.A. Serravalle Scriva	Piemonte	6	ErgyCapital		30			
Portfolio	Puglia, Lecce	5	Helio Capital	Banca Popolare Etruria + (unknown)	22			80-85 % debt
Fortore PV	Apulia	5	Fotowatio	Santander, SMBC		19,2		
NextPower1	Puglia	2x1	Zouk, NextEnergy Cap	Centrobanca	14,5	12,5	86,2 %	
Brindisi PV project	Puglia	5	Enia Solaris	HSH Nordbank	33,6	29	86,3 %	18 yrs
Portfolio	Lazio	11	ErgyCapital	UniCredit, Efibanka	50			
	Puglia	6	Foresight Group	WestLB, Barclays		25		
Fotoware 1	Italy	2	Voigt & Collegen	IKB Deutsche Industriebank		11,1		
Cassiopea PV	Montalto di Castr	24	SunRay	BIIS, SG, WestLB	145	120	82,8 %	19 yrs (construction plus 18,5 yrs)+ ca. 12m VAT facility. SACE guarantee. Margins ca 275bp
Portfolio	South Italy	4	Etrion	Centrobanca	20,7	17,2	83,1 %	non-recourse, D/E = 83/1
Portfolio	Puglia		Solareolica	Banca Popolare dell'Etruria e del Lazio Soc Cooperativa		11		
		10,5	EDF Energies Nouvelle	Auxifip, Credit Agricole	59,1	37	62,6 %	
Portfolio	France/Italy		EDF Energies Nouvelle	EIB 500m, commercial banks (unknown) 500m		1000		
	Rain am Lech	4,6	SAG Solarstrom AG	Deutsche Bank	14	10	71,4 %	18 yrs
Solar Stribro s.r.o.	Czech rep.	13,65	SAG Solarstrom AG	Youmex AG (fin. advisor)		20		
Walter Konzept Rain am Lech, refinancing	Germany	4,6	SAG Solarstrom AG	Deutsche Bank	14	10	71,4 %	18 yrs
	Landes	24 of 76	EDF Energies Nouvelle	Dexi, BNP Paribas, SG + ? (unknown)		70		
Portfolio	Italy	15+	Sorgenia	MPS, UniCredit		70		18 yrs
	Brandenburg	24,5	FinowTower	Commerzbank	58	48	82,8 %	17 yrs
	France	33	GDF Suez, Eurofideme	Caisse d'Epargne Provence-Alpes-Corse, SG		90		
	Fiumicino, Rome	10	Fotowatio, Solesa Gre	Santander, SMBC				
Les Meer 1 and 2	Provence	12+11,6	Solaire Durance, Caiss	Natixis Energéco, Credit Agricole	101	83	82,2 %	18 yrs
Portfolio	Puglia	16,5	Veronagest	MLAs Dexia, SG, UniCredit		75		19 yrs
	Puglia	42x1	Global Solar Fund	CDP, UniCredit, Intesa, WestLB, Santander, BancaNova, MPS		200		18 yrs
SunProject C1	Planichka	1,3	Clean Energy and Pow	LBBW Bank	7,8-8,8	ca 6		15 yrs, interest 5.5 %
Il Primo/Cellino San Marco PV	Puglia	43	AES Solar Energy Ltd.,	SC (doc), UniCredit (doc), BNP Paribas (insur.), Credit Agricole CIB, Dexia Crediop.	200	172,25	86,1 %	18 yrs

**The list of project financed photovoltaic projects is based on news from the following sources:**

New Energy Finance - <http://bnef.com/>

NREL Hotline [http://www.nrel.gov/pv/news\\_hotline.html](http://www.nrel.gov/pv/news_hotline.html)

Photon International – [www.photon-international.com](http://www.photon-international.com)

Project Finance International – issues 401-430

Project Finance Magazine – issues 297-309

Solarbuzz – [www.solarbuzz.com](http://www.solarbuzz.com)

