MSc Program
Renewable Energy in Central & Eastern Europe

PROJECT FINANCE RISKS FOR WIND AND PV POWER PROJECTS IN GERMANY FROM A BANK'S PERSPECTIVE

MASTER THESIS SUBMITTED FOR THE DEGREE "MASTER OF SCIENCE"

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Aumühle, March 2012

AFFIDAVIT

I, Mag. **Leopold Reymaier** hereby declare

1. that I am the sole author of the present Master Thesis, "*Project finance risks for wind and PV power projects in Germany from a bank's perspective*" 76 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted this Master Thesis as an examination paper in any form in Austria or abroad.

Aumühle, 20.03.2012

Date

Signature

ACKNOWLEDGEMENTS

First of all I would like to thank Dr. Marek Kobialka for supervising my master thesis and his professional advice.

The team of the Continuing Education Centre has been of great help during the two years of the master programme especially the programme managers DI Andrea Würz, DI Ralf Roggenbauer and Martin Schestag who always organized perfectly well the courses and excursions. I would also like to thank Univ.-Prof. DI Dr. Reinhard Haas for the interesting programme and the organisation of such high profile of speakers and teachers for the courses.

I want to thank my superiors and my colleagues at HSH Nordbank AG who supported me in many aspects during the master programme.

I am very specially and greatly thankful to my wife Mag. Karin Kuschnig-Reymaier and my son who both showed a lot of patience and understanding especially for the extensive travelling and absence from home for educational purposes additionally to my demanding job and my extensive travelling for job purposes. My wife was also of great help in focusing on the finalization of this master thesis which I cannot express enough thankfulness for.

ABSTRACT

For a financial institution providing debt capital for renewable energy projects may provide economic benefit but it may also provide benefit to the financing institution itself as this could raise its social acceptance to a higher level through its engagement in ecological matters. Project finance as such and project finance for renewable energy projects in particular is highly complex and requires for financial institutions specific and detailed expertise in both financial modelling and technological issues related to the technology which is used for wind and solar photovoltaic (PV) projects.

The core questions raised within this thesis are whether there are differences in risks and mitigations between PV and wind power projects, at what phase of the project they occur and what the basic tools and mechanisms are to mitigate such risks. The objective of this master thesis is to provide an overview of risks which banks need to assess when approaching project financing of wind and solar projects. The risks are identified and compared one with each other according to the phases of projects.

As both power production methods depend on natural resources the general approach for wind and solar project financing is definitively comparable. The similarities and the differences will be elaborated within this thesis.

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ACRONYMS

BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit
Cf	From Latin: confer - compare
DSCR	Debt service coverage ratio
DSRA	Debt service reserve account
EEG	Erneuerbare Energien Gesetz
E.g.	Example given
EPC	Engineering Procurement Construction
EPIA	European Photovoltaic Industry Association
EURIBOR	European Interbank Offer Rate
EWEA	European Wind Energy Association
FiT	Feed in tariff
KW	Kilowatt
MW	Megawatt
O&M	Operation and Management
PV	Photovoltaic
RES	Renewable energy sources
SPC	Special Purpose Company
SPV	Single (or special) purpose vehicle
TIC	Total Investment Costs
WT	Wind Turbine

TERMINOLOGY

Lender	A bank or similar financial institution providing debt capital for the project.
Risk	The negative deviation of a planned value which potentially leads to a loss for the project.
Sponsor	A company which initiates and executes the project.
Feed in tariff	The statutory tariff (price) at which power producers are eligible to sell their electricity to the grid operator or utility.

1 Preamble

1.1 Motivation

For a financial institution providing debt capital for renewable energy projects may provide economic benefit but it may also provide benefit to the financing institution itself as this could raise its social acceptance to a higher level through its engagement in ecological matters. In recent years banks needed to reflect about their social acceptance more than they were used to do before the financial- and the banking-crisis. And there is an undisputable ecological benefit in general for providing capital for renewable energy projects.

Still there are only a few banks (e.g. Deutsche Bank, LBBW, Bayern LB, Unicredit, Societe General, HSH Nordbank, Nord LB, Banco Santander, NIBC, HSBC) in Europe which are actively focusing in this business field. There is considerable potential for project financing of renewable power projects in commercial banks. Even if project financing is considered as being daily routine for German banks[1] there are only a few banks (also in Germany) which specialise in the project financing of renewable energy projects.

The reason why there are only a few banks active in financing renewable energy projects might be in the need of deep understanding of technology and the deep understanding of risks which a financing institution needs to build up in order to be capable of successfully developing the highly complex financing structures for such project financing ventures. Due to the highly regulated environment which banks are acting in they need to build up the expertise not only for a number of few employees but the expertise needs to be built up in the whole organisation from origination of deals to structuring and execution, continuing to risk management and loan syndication. Nevertheless the number of banks active in renewable energy financing in Germany is considerably higher than in the neighbouring countries which might reflect the importance of renewable energy business in Germany. Germany and the German banks could be the frontrunner in this business field.

[1]Cf: Schwer 2007: p. 5

Renewable energy is a comparably young industry and this might be one of the reasons why there is not much literature coping with project financing of renewable energy power plants and wind and solar power projects in particular. But the fact that wind and solar PV are among the most important renewable energy sources currently in Germany[2] together with the lack of literature and the lack of banks active in renewable energy are motivation for this Master Thesis.

1.2 Objective

Both technologies wind and Solar PV are applied for a number of years already and there is a stable regulatory framework with a feed in tariff for wind and solar projects in Germany. Still there are only a few banks in the market providing project financing for these projects due to the high complexity and the risks involved. Lenders in project financing take a large risk in the project as they provide the majority of capital. Thus lenders must be aware of and understand the risks which they are willing to take.

The objective of this master thesis is to provide an overview of risks which banks need to assess when approaching project financing of wind and solar projects. Furthermore the risks, their assessment and their mitigation will be compared for these two different technologies in order to find out whether there are huge differences or if it could be useful for banks to approach both technologies simultaneously and potentially open a new business field for project financing both as the similarities prevail.

1.3 Core Questions

The core questions which are raised in this thesis are:

- What is the difference in risks and mitigations between solar PV and wind power projects?
- What types of risks can be identified and in which phases of a project do they occur?

[2] See below: Chapter 1 Introduction

- What are the basic mechanisms and tools to mitigate risks in PV and wind power project financing?

1.4 Methodology and literature

Due to the complexity of project financing for renewable energy projects the basis of this thesis is an in depth literature research. The main literature which is very helpful for comprehending the complexity is the series of books by Jörg Böttcher (2006, 2009, 2011 and 2012). Christian Babl et.al. (2011) "Projektrisiken und Finanzierungsstrukturen bei Investitionen in erneuerbare Energien" provides further useful information. A good overview in the complex matters of renewable energy project financing is also given in Markus Gerhard et.al. (2011) "Finanzierung erneuerbarer Energien".

The statistics which are used were mainly taken from European Photovoltaic Industry Association (EPIA), Deutsches Wind Energie Institut (DEWI) and the German federal association of wind energy (Bundesverband Wind Energie).

The findings in the literature are compared with each other and compared with practical experience. The conclusion is derived from the consolidation of findings for PV and wind power projects.

1.5 Structure

The Introduction in chapter 2 displays the importance of wind and solar power resources in Germany also in comparison to other renewable resources in order to understand why these two technologically completely different power sources are compared.

Important for understanding risks and their mitigation in project financing is to understand project financing itself and the key differences to corporate finance. For that purpose an overview is provided in chapter 3 where the key differences to corporate finance are briefly described, the application of project finance will be displayed and the major characteristics of project financing are described.

As projects pass through various phases which are also important for identification and mitigation of risks the chapter 4 deals with the three phases of a project: the development phase, the building phase and the operational phase, which are important for wind and solar PV project financing. It is important to understand the phases as also the risks in project finance for power plants can be identified relating to these phases.

Risks can furthermore be classified as endogenous risks which can be influenced by the project parties directly and as exogenous risks which cannot be influenced directly by the project parties. The classification and description of risks can be seen from chapter 5.

The economic feasibility of a project is a basic prerequisite for a sponsor to initiate a project and for the lender to engage in project financing. The economic feasibility is discussed briefly in chapter 6.

In chapter 7 and 8 the risks and their mitigation in PV and wind power projects are discussed in detail. The structure in both chapters is set up accordingly to the phases of projects: Introducing initially the risks during development phase, then displaying the risks during the construction phase and risks during the operational phase and finally concluding with the mitigation of risks through cash flow covenants and equity requirements. Within these chapters it is shown where the peculiarities for each production method are.

The conclusion in chapter 9 consolidates the differences in risks and their mitigation between wind and solar projects. For reason of traceability and transparency the structure of this chapter follows the structure of chapters 7 and 8 respectively.

Chapter 10 provides a Summary and outlook for banks which are willing to enter into this business field and for other countries which are willing to follow Germany's example.

2 Introduction

This introductory chapter displays the importance of PV power resources and wind power resources in Germany. In comparison to other renewable resources their dominance becomes evident as the statistic in chapter 2.3 verifies. Their dominance together with their mutuality that both are using resources which cannot be influenced by human provides an explanation why these two production methods are chosen to be compared in this master thesis.

2.1 The importance of PV power in Germany

Germany is one of the countries with most experience in Europe in both large solar power plants and onshore wind power plants. According to a survey conducted by Deloitte in 2009 almost 90% of executives in Germany's financial services industry consider the country as being cutting-edge in relation to climate protection.[3] Mainly because of its "Erneuerbare Energien Gesetz" (EEG) Germany is still the fronting country for renewable energy.

The cumulative amount of installed PV capacity in Germany reached 24.7 GW in 2011. This is as much as the following five countries accumulated (Italy, Japan, USA, China and France) (See: Illustration 1). The figures in the illustration 1 display impressively the dominance of the German market in PV worldwide.

[3] Cf: Deloitte 2009: p. 68

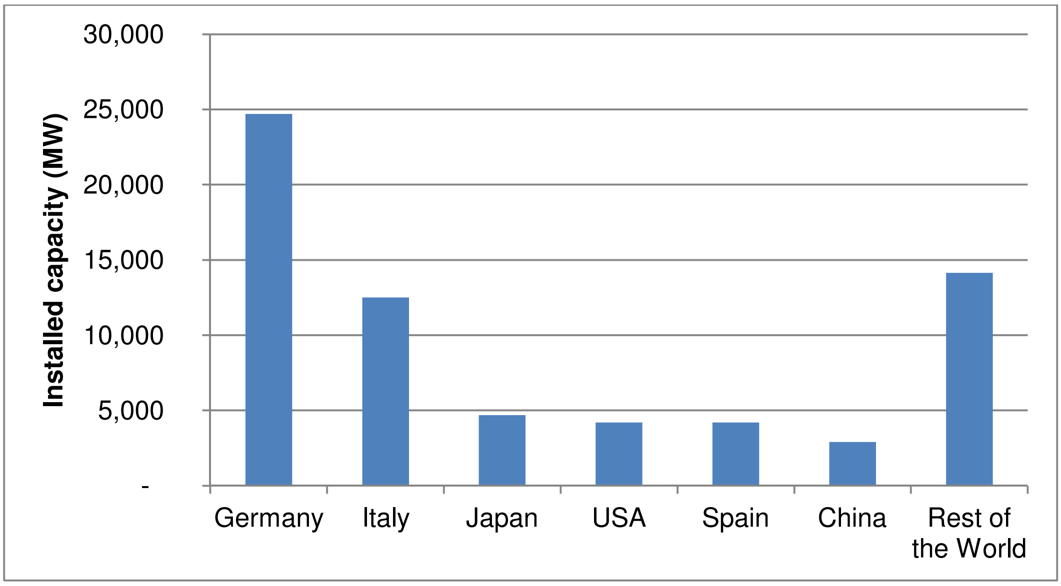

Illustration 1: Cumulative installed PV capacity (MW) in 2011 (Source: Author's illustration based on: EPIA 2012: p. 4)

Newly connected capacity of PV power plants in Germany reached 7.5 GW in 2011. The higher amount of newly installed capacity in Italy (9.5 GW) (See: Illustration 2: was most probably a one-off effect caused by the regulatory framework in Italy where (too) high incentives forced a boom in the year 2011 and the year before.

A similar boom was seen in Spain in 2007 and 2008. Such boom periods raise political risks which accumulated in cutting the tariff in Spain (partly even retroactively) and introducing a cap for newly built PV power plants in Italy. Such political risks cannot easily be taken in a project financing structure which is discussed in chapter 5.2.2. The German regulatory system of stable and foreseeable decrease of tariff and a predictable political decision making proofed more efficient in creating a stable growth of installation of PV capacity.

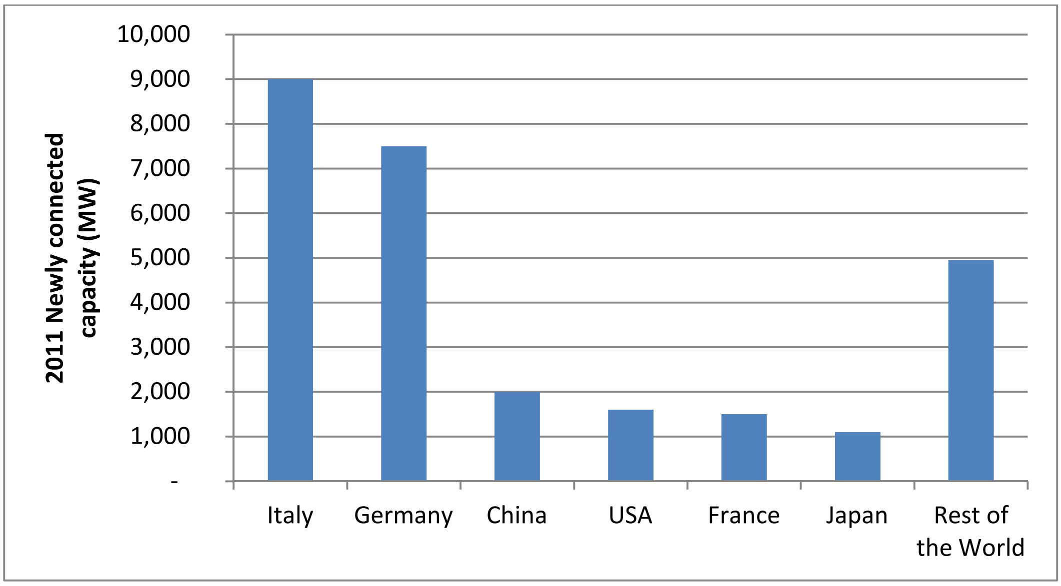

Illustration 2: Newly connected PV capacity (MW) in 2011 (Source: Author's illustration based on: EPIA 2012: p. 4)

Even if the regulatory framework under the German Eneuerbare Energien Gesetz (EEG) which regulates the feed in tariff (FiT) for renewable power plants foresees a yearly reduction of feed in tariff for PV and even if the regulation prohibits PV power plants on arable farm land a further increase of installed capacity is expected in Germany. Large power plants are only allowed on so called "Konversionsflächen" – areas which terms of use are converted e.g. areas which were used for mining or used for military purposes. There is still a significant amount of Konversionsflächen available and further large projects require financing and project financing in particular.

2.2 The importance of wind power in Germany

In regards to wind power projects Germany is not the world's leading country but by far the leading country in Europe. The total amount of installed wind power capacity in Germany reached 27 GW in 2010 and 29 GW in 2011[4] which marks the highest total installed capacity in Europe. Please refer to Illustration 3 for the five biggest markets.

[4] Cf: Bundesverband WindEnergie e.V. (2011)

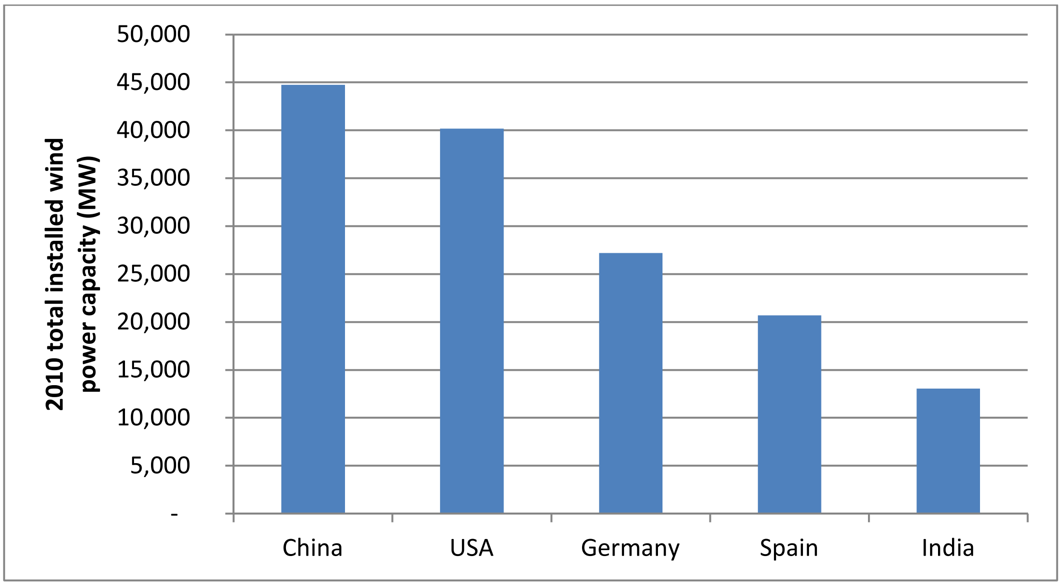

Illustration 3: Cumulative installed capacity of wind power (MW) in 2010 (Source: Author's illustration based on: Bundesverband Wind Energie e.V. 2011)

Newly connected capacity of wind power plants in Germany reached 1.5 GW in 2010 and 2 GW in 2011. Illustration 4 displays that Germany was in 2010 among the top five markets for newly installed wind power. Only China, USA, India and Spain had a higher capacity installation in 2010.

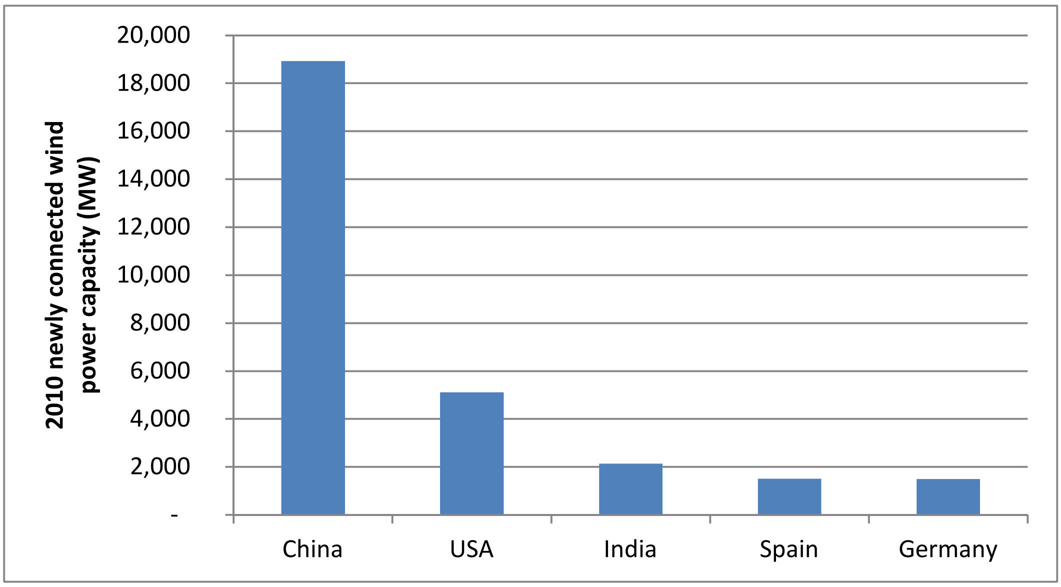

Illustration 4: Newly installed capacity of wind power (MW) in 2010 (Source: Author's illustration based on: Bundesverband Wind Energie e.V. 2011)

These illustrations display impressively the importance of the German market for wind power within Europe. And the further development does not seem to stop in the near future:

> *„Nach den Plänen der Landesregierung sollen 1,5 Prozent der Landesfläche – das sind rund 23,600 Hektar – als Eignungsgebiete für die Windenergie genutzt werden.“*[5]

According to plans of the government of the German federal state of Schleswig Holstein approx. 1.5% of the state's area - which is approx. 23,600 hectare - shall be used as potential area for wind power. This would represent almost doubling the current area eligible for commissioning of wind power plants. Similar plans were announced by governments of other German federal states as well. These plans imply a further increase of wind power in Germany, with further windmills to be erected and further power plants which need financing and thus seek project financing.

2.3 The importance of wind and PV power compared to other renewable resources in Germany

Wind power is the dominant power source in Germany in regards to renewable energy. In 2007 approximately 40% of power generation from renewable energy sources (RES) accounted for production from wind farms. This was approximately 5% of total power consumption in 2007.[6] In 2010 the share of wind in renewable power production dropped to 35.5% also caused by the significant increase of electricity production with PV. In the northern German federal states like Schleswig Holstein, Niedersachsen and Mecklenburg-Vorpommern which profit from strong winds from the North- and the Baltic Sea the figures for shares of wind power are significantly higher. The share in total electricity consumption for wind power is at 6.2% in 2010.

[5] Innenministerium Schleswig-Holstein 2011: 1

[6] Cf: Bayerische Hypo- und Vereinsbank AG 2007: 7

Solar power increased its share in renewable power production to 11%. This represents a share in total electricity consumption of 2% which is a remarkable increase compared to 0.3% in 2006.

The total power production from renewable energy sources reaches a share of 17 % of total electricity consumption in Germany in 2010. Illustration 5 underlines the importance of wind and solar power.

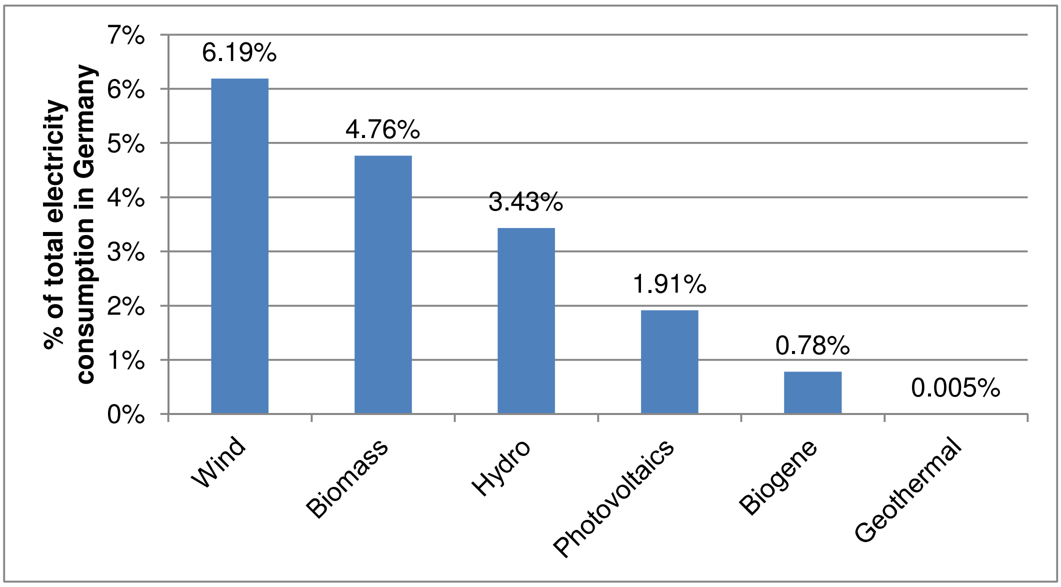

Illustration 5: Proportion of renewable power production to total electricity consumption in Gerrmany in 2010 (Source: Author's illustration based on: Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (BMU))

Project finance does not play a dominant role yet in offshore wind projects. These are mainly built by large power utilities which finance them on balance. Thus rather corporate finance is applied for offshore wind parks[7] and offshore wind projects are left aside within this thesis. Even though meanwhile four or five projects are currently in the market this would also exaggerate the scope of this thesis.

[7] Cf: Bayerische Hypo- und Vereinsbank AG 2007: 13

3 Overview of project finance

The increased complexity of renewable energy projects, increasing investment volumes and increasing coordination needs, makes the development of individual finance concepts with specially adopted organisational structures necessary. In that respect project financing became an established financing method.[8] This is particular true for wind and solar projects.

Important for understanding risks and their mitigation in project financing is to understand project financing itself and the key differences to corporate finance. For that purpose an overview is provided within this chapter. In the first section of this chapter a description of project financing is followed by the key differences to corporate finance which is essential for understanding project financing. The application of project finance will be displayed in the section 3.3 and the major characteristics of project financing are described in 3.4.

3.1 Description of project finance

Project financing has a remarkably long tradition even though it is considered a young financing practice. Already in ancient Greece the missions of mercantile ships travelling the Mediterranean were financed with debt capital, which was only repayable once the ship returned from its mission. The modern concept of project finance has its roots in the financing of oil exploration in the USA in the 1930ies.[9]

High investment volumes which are typical for project financing usually can't be raised by a company alone. The reason might be that either raising large capital amounts is simply not possible for the company or the wish of risk limitation. Project financing either opens the company the possibility of executing the project which otherwise would not have been possible or to execute several projects simultaneously.

[8] Cf: Bayerische Hypo- und Vereinsbank AG 2007: 5

[9] Cf: Horsch 2004: p. 512; and: Böttcher 2006: p. 2

The term "sponsor" is commonly applied for the company which is executing the project. The sponsor initiates the project, decides about the execution and thus stands in the centre of focus.[10]

The most common definition of project financing can be found in Nevitt Project Financing (2000):

> *"...the term has evolved in recent years to have a more precise definition:*
> *A financing of a particular economic unit in which a lender is satisfied to look initially to the cash flows and earning of that economic unit as the source of funds from which a loan will be repaid and to the assets of the economic unit as collateral for the loan."*[11]

This definition is quite focused on the lender and indeed it shows that the main difference to corporate finance structures can be identified in the specific role of the lender. The key differences to corporate finance are discussed in chapter 3.2.

Another definition explains the term "non-recourse financing" which is always related to project financing:

> *"…the financing of a project or other asset or undertaking which is repaid principally from the cash flow generated by the project or asset being financed. Typically the lending banker will have little or no recourse to any other assets of the project sponsor. Hence the alternative descriptions - "limited- (or non-) recourse financing or "off-balance-sheet-financing…"*[12]

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[10] Cf: *Böttcher 2006: p. 4*

[11] Nevitt 2000: p. 1

[12] Mills op. 1993: p. 207

Essential for successful project finance structuring is:

- Identifying the project's risks and then
- analyzing,
- allocating, and
- mitigating them.[13]

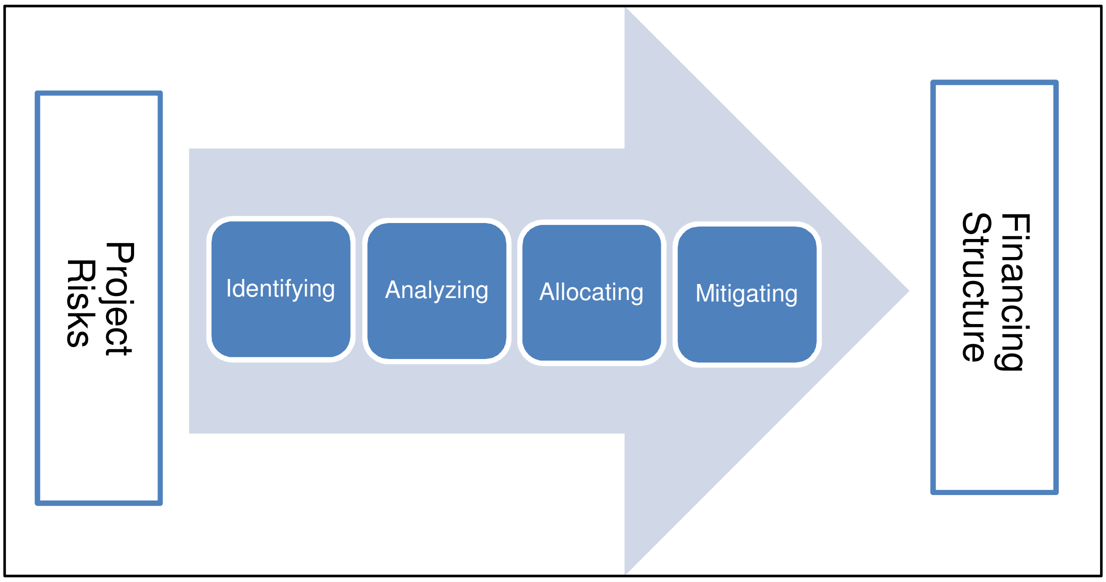

Illustration 6: Successful project finance structuring (Source: Author's illustration)

Illustration 6 displays the process flow of successful project finance structuring. It is an iterative process nevertheless it has to be stated that the different steps are often overlapping and gear into each other.

3.2 The key differences to corporate finance

Even though formally there is no difference between a corporate finance and a project finance structure there are quite remarkable differences in the liability and in the possibility of recourse for the lenders to the sponsor. The sponsors of project finance decline unlimited liability for the debt capital. For that reason, the realization of project finance needs the incorporation of an independent project company through the sponsors. Such a special purpose company (SPC) (other expression: single purpose vehicle (SPV)) has only one single purpose: the establishment and the business of the project. The SPC is the borrower of the loans and is unlimited

[13] Cf: Ahmed 1999: p. 38

liable with all its assets. Formally this again represents a corporate loan. But the lenders expect the repayment of the loan only from the cash flows of the SPC. The assets and the cash flow are at disposal as security and collateral for the lender.[14]

In corporate finance practice the investment project is contemplated as part of the company. The assessment of credibility is based on the credibility of the corporate and not only on the expected cash flows which are generated by the investment project. In contrast: when realizing a project finance the assessment of the project is nearly only based on the ability of the project to generate cash flows which are used to repay the invested capital (both equity and debt capital).[15]

With the number of large utility-scale companies becoming active in the sector also on-balance sheet funding became more employed within the last years, mainly for the construction of projects. On-balance funding means in comparison to project financing a parent or sister company of the project owner provides all the necessary financing for the project and/or secures debt. If debt is used it is usually a term loan for the time when the project is operational rather than for the initial construction loan. The basis for the loan is then the entire business portfolio and balance sheet of the company. Thus the debt is not project specific. The project's assets and liabilities are directly accounted for at company level. This type of debt financing structure is also referred to as full recourse financing. The term loan lender can enforce payment of the debt also by the bigger (parent- or sister-) company that has effectively underwritten the loan via its balance sheet.[16] Thus the major difference between project and corporate finance is found in the way how debt can be used and how lenders insist on certain collateral, influence on the project and influence on the money flows.

3.3 The application of project finance

Due to the high capital intensity of most project financings debt capital is essential for the success of the project. Wind and large solar PV projects are very capital intensive which makes them attractive for project finance.

[14] Cf: Böttcher 2012: p. 7

[15] Cf: Böttcher 2012: p. 7

[16] Cf: Rajgor 2011: p. 70

In general two advantages of project finance can be identified from the sponsor's point of view: it can

- increase the availability of finance, and
- reduce the overall risk of major project participants and bring it down to an acceptable level.[17]

Project financing is attractive for banks due to typically higher credit margins than in corporate business and the opportunity of further cross selling other services like advisory or structuring. But also from a risk perspective it makes sense for a bank to evaluate the risk of financing a transparent investment project than evaluating the rather non-transparent risks of a comparably non-specific lending to a corporate.[18]

> *"The characteristics of project financing like stability, long terms, predictable project structures, low operational risk and options for collateral fit well to investment projects in renewable energy."*[19]

Also practical experience shows that project financing is a useful and common financing structure for wind and PV projects.

3.4 Characteristics of project finance

3.4.1 Cash flow related lending

The focus on the cash flow of the project and its ability to service the debt is called cash flow oriented lending.[20] The capability of a project to fulfil its obligations towards the lenders is derived from the prospective cash flows.

3.4.2 Risk Sharing

Another key characteristic of project financing is risk sharing. It is the basis for a capable financing structure. This means that the risks need to be shared among the

[17] Cf: Ahmed 1999: p. 5
[18] Cf: Böttcher 2006: p. 5 - 6
[19] Finance 2009: p. 14
[20] Cf.: Böttcher 2006: p. 14

project partners. The sharing of risks is agreed upon in contracts between the project partners. [21]

In risk allocation the following question needs to be answered: Is the involved party prepared to carry a contractually predefined amount of risk?[22] The motivation of each party in carrying a risk is heavily depending on its individual structure of compensation for risk. Each risk-taking party needs to consider its balance of risk and compensation for risk positive in order to enter into contracts which oblige the party to take the risk.

A general rule in project financing indicates that: A risk should always be carried by the project partner who can best assess such risk or who can even manage such risk. [23] Ways how to share the risk between the project partners are shown in chapter 7 for PV projects and chapter 8 for wind projects respectively.

3.4.3 Special purpose vehicle

Typically in project financing the project company is structured as a single purpose company.[24] The reason can be found in the limited liability which a project sponsor is willing or capable to take. The sole purpose of the company is the erection and the operation of the project. Another common abbreviation is SPC (Special Purpose Company or Single Purpose Company).

3.4.4 Involved parties in project financing

Typically at least 7 parties are involved in a project financing structure. The parties with capital involvement are:

- the SPV which is set up by the sponsor to execute the project,
- the sponsor providing the equity,
- the bank providing debt capital,
- insurance providing various insurance services.

[21] Cf: Böttcher 2006: p. 15

[22] Cf: Böttcher 2006: p. 35

[23] Cf: Neugebauer 2008: p. 61

[24] Cf: Böttcher 2006: p. 17

The following parties are involved with services or obligations towards the SPV but without providing capital:

- the EPC contractor building the project,
- the management company operating the project and,
- the utility which is purchasing the electricity in Germany on basis of the Erneuerbare Energien Gesetz (EEG).

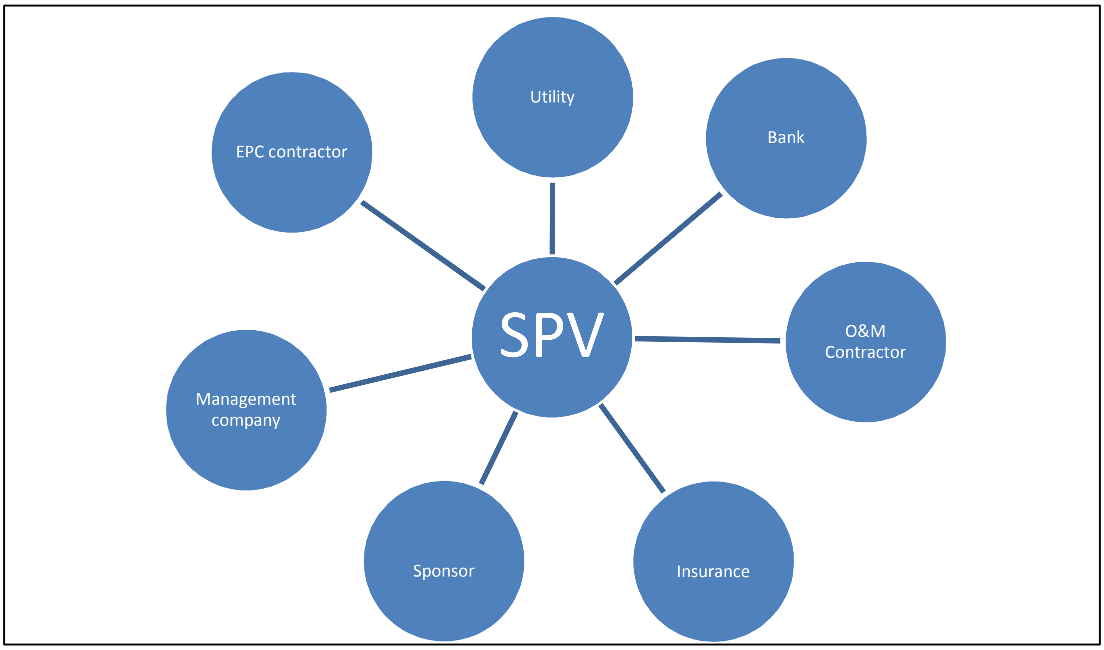

Illustration 7: Involved parties in project financing (Source: Author's illustration)

There is a natural discrepancy in interests of the involved parties. The sponsor wants a return which is as high as possible. The banks want their debt to be repaid together with interest on the loans. The insurance needs insurance premiums in order to cover the risks. The EPC contractor wants a high purchase price.

As described in Illustration 6 within chapter 3.1 there is an iterative process in project financing which involves all the mentioned parties in order to find the right balance between risk and return which is acceptable for each project party. Illustration 7 provides an impression of how complex this process typically is due to the involvement of so many parties with diverging interests each.

4 The project phases

As projects pass through various phases which are important for identification and mitigation of risks this chapter 4 introduces three phases of a project: the development phase, the building phase and the operational phase. These phases are important for wind and solar PV project financing as they mark the milestones within a project. It is important to understand the phases as also the risks in project finance for power plants can be identified relating to these phases.

Nevitt's definition of the risk phases is widely spread:

> *"Project financing risks can be divided into three time frames in which the elements of credit exposure assume different characteristics:*
>
> *Engineering and construction phase;*
> *start up phase;*
> *operations according to planned specifications.*
>
> *Different guarantees and undertakings of different partners may be used in each time frame to provide the credit support necessary for structuring a project financing."*[25]

As banks focus in (onshore-) wind and PV projects rather on economic and legal risks the nomination of the phases within this thesis will slightly differentiate to Nevitt's definition. Within this thesis the phases will be split according to the following segmentation:[26]

1. The development-phase
2. The construction-phase which (in contrast to Nevitt's definition) integrates the start-up phase
3. The operational-phase

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[25] Nevitt 2000: p. 9

[26] Cf: Thumfart 2011: p. 625 - 626

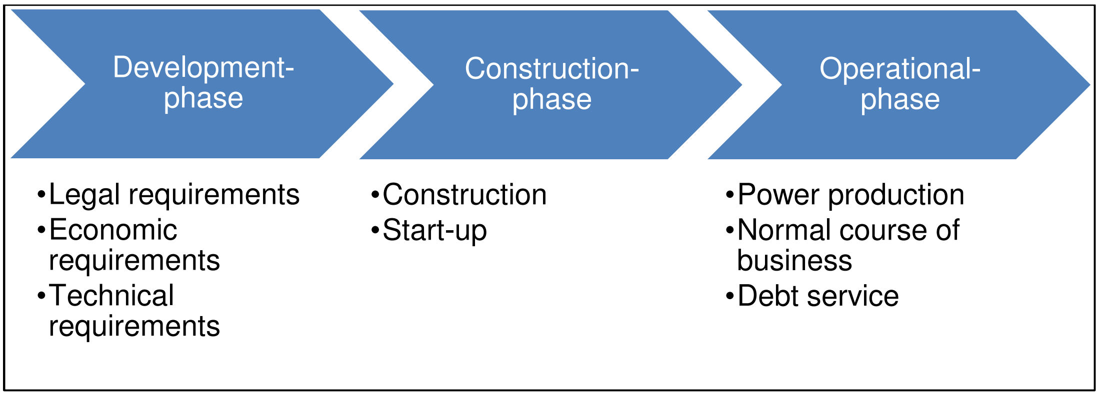

Illustration 8: The phases in projects (Source: Author's illustration)

Illustration 8 provides an overview of the flow of the phases and the major tasks which need to be fulfilled by the Sponsor or the project company in each phase. In the next paragraphs the phases will be described in more detail as it is important to understand which risks are related to which project phase.

4.1 The development-phase

According to Nevitt's definition of project financing the initial phase is the planning and engineering phase:

> *"Projects generally begin with a long period of planning and engineering. Equipment is ordered construction contracts are negotiated and actual construction begins."*[27]

In wind and solar projects an important part in planning takes the authorization process in which many legal risks are concealed which need to be taken care of. For both wind and solar projects this is the most critical phase in planning as it represents a binary risk:

- Either all the necessary authorizations are achieved and the project can be built or if this is not the case
- the development costs need to be written off.

Thus the development phase represents clearly equity risk which is usually perceived as not bankable.[28]

[27] Nevitt 2000: p. 9

The technological risks are manageable if the project is not in a very exposed or remote area and if proven technology is used. But administrative decisions cannot be foreseen easily so these take a critical part in project due diligence.

Another important task in the development phase is to secure the economic requirements. Equity capital needs to be raised or secured and ideally negotiations with banks for project financing start in this phase. The technical requirements are also secured in this phase.

4.2 The construction-phase

The construction-phase may start once all the legal and economic requirements are met.

> *"After commencement of construction the amount at risk begins to increase sharply as funds are advanced to purchase material, labour and equipment. Interest charges on loans to finance construction also begin to accumulate."*[29]

It is also the phase in which from beginning of construction until to the grid connection of the power plant extensive investment costs accrue without any income generated. The plant must be erected in such way that

- all administrative licensing requirements are met; and
- the timely grid connection is secured.[30]

In project financing practice the start-up marks the last point in the construction-phase. It's the period when the projects run to be checked for technical acceptance by the experts, technical advisors and the banks. The start-up period for solar projects takes typically only a few weeks. For wind projects it is slightly longer as there are much more mechanical parts involved which need surveillance.

Project lenders do not regard a project as completed upon conclusion of the construction of the facility. They are concerned that the plant or facility will work at

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[28] Cf: Thumfart 2011: p. 625

[29] Nevitt 2000: p. 9

[30] Cf: Thumfart 2011: p. 625

the costs and the specifications which were planned when arranging the financing. Failure to produce the product or service in the amounts and at the costs originally planned means that the projections and the feasibility study are incorrect and that there may be insufficient cash to service debt and pay expenses.

> *Project lenders regard a project as acceptable only after the plant or facility has been in operation (...). This start-up risk period may run from a few months to several years."*[31]

In wind power projects such a start-up phase may take a few months whereas in solar PV projects the start-up phase takes only four weeks due to the less complex technology used in a PV project.

4.3 The operational-phase

Once the project is built and running according to its specifications, the third phase which is commonly found in literature is the operational phase.

> *"Once the parties are satisfied that the plant is running to specification, the final operating phase begins. During this phase, the project begins to function as a regular operating company. If correct financial planning was done, revenues from sale of the product produced or service performed should be sufficient to service debt, interest and principal, pay operating costs, and provide a return to sponsors and investors."*[32]

In wind and solar projects the service performed is the production of electricity. The sales proceeds for the selling of energy should then be sufficient to pay the operating costs, service the debt, and leave a sufficient return for the investors.

The risk profile in this phase is comparable to other infrastructure investments with long-term stable income with manageable default risk. [33] That's also the reason why this phase offers the most possibilities of financing both via equity and debt.

[31] Nevitt 2000: p. 9

[32] Nevitt 2000: p. 10

[33] Cf: Thumfart 2011: p. 625

4.4 The capital deployment

The capital deployment is diverging in the risk phases of a project (Please refer to: Illustration 9:). Whereas the development phase is mostly financed with equity capital the construction phase and operational phase are financed by both equity and debt capital. The illustration displays vividly the importance of debt for the project. As without debt the project most probably would not be financeable. Debt finance provides the largest proportion of capital and is also involved in the project on a long term basis.

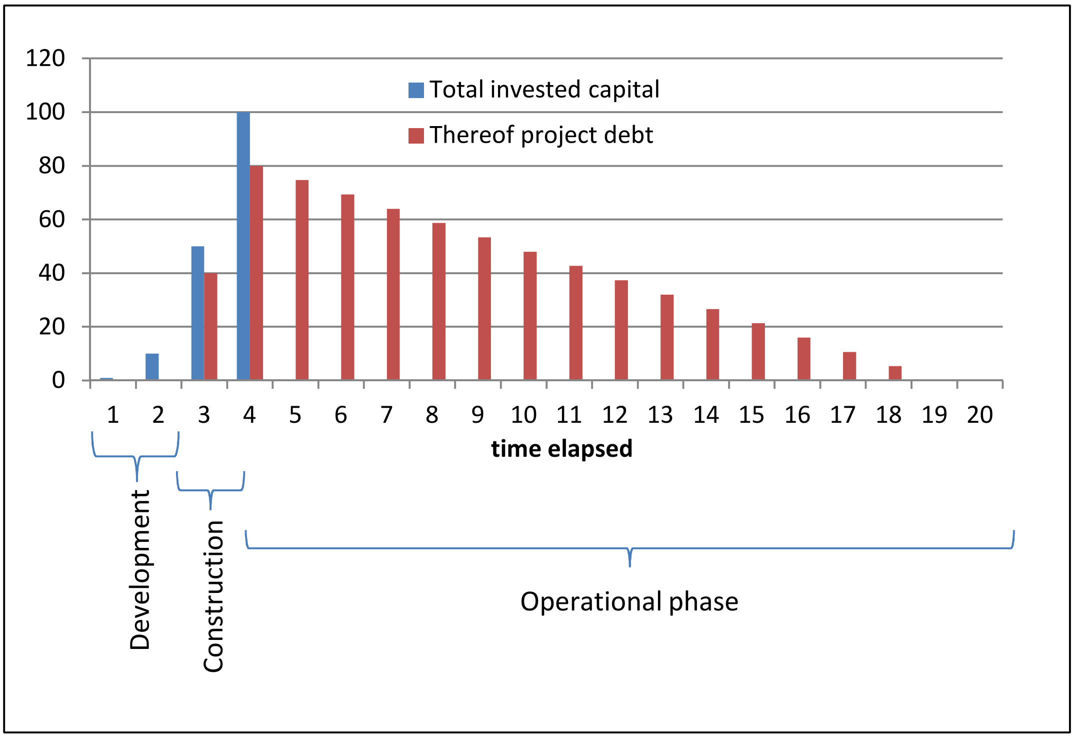

Illustration 9: The capital deployment in projects according to the project phases (Source: Author's illustration)[34]

In the amount of capital and in the capital deployment lies again a discrepancy in the objectives between sponsors and lenders: While a sponsor strives for quick return of its equity capital the banks strive for debt repayment. Typically a bank sets higher priority into getting repaid in full over the lifetime of the loan than producing higher income through higher financing margins and taking a higher risk instead.

As a project will bring only limited cash flows these need to be split in portions which reflect the risk adversity of lenders and the return driven sponsors. The peculiar

[34] Cf.: Böttcher 2006: p. 28

risks which a bank wishes to avoid or share among other project partners will be discussed within the next two chapters.

5 Types of risks

Risks can be classified as endogenous risks which can be influenced by the project parties directly and as exogenous risks which cannot be influenced directly by the project parties. Endogenous risks which need to be taken into account in wind and solar PV project financings are discussed in chapter 5.1 and the exogenous risks are discussed in the subsequent chapter 5.2.

Project risks are those risks which threaten the operation of the project and thereby threaten repayment of the lender's loan to the project.[35] In general two types of risks can be identified:

- Endogenous risks are risks which can be controlled by the SPV or other project partners.
- Exogenous risks are risks which influence the project but cannot be controlled directly by the company or by other involved partners.[36]

Both types of risks need to be taken care of individually as they need different attention and different parties to take them over.

5.1 Endogenous risks

Endogenous risks are risks which can be influenced directly by the project or by the involved parties. In the following paragraphs endogenous risks for wind and PV power project finance will be introduced.

5.1.1 Sponsor risk

Banks usually require an equity contribution of between 15% - 50% of the project investment to ensure the sponsor's continued commitment. But banks are not only interested in the financial "depth" of a sponsor but also on another level: does the sponsor provide substantial technical expertise? The value of a sponsor who can commit not only financial resources but also technical resources to turning around a

[35] Cf: Benoit 1996: p. 11

[36] Cf: Gröhl 1990: p. 81

problematic project is very great.[37] The expertise of a sponsor in the business he is pursuing does not only provide guarantee to the bank, that its loan gets repaid it is also in the sponsors own interest as it might increase its return and profit.

5.1.2 Completion risk or late completion risk

Completion risk is:

- The risk that the construction of the project will not be completed within the required time frame as a result of contractor delays, or
- the risk that the completion will involve cost overruns, and
- the risk that the project fails at its commissioning to meet the required performance specifications. [38]

The non-completion risk is one of the endogenous risks during the construction-phase. Lenders focus upon cost-overrun and time-delay aspects of the completion risk in great detail. This is the period of highest risk for the lender: The lender may face a total write-off in respect to a project which never produces cash flow.[39]

The non-completion may have various reasons for example late completion or completion not according to the pre-agreed standards by a supplier or the EPC contractor.[40] It will have a direct impact on the performance of the project: The performance of the project will be negatively influenced if production cannot start at the expected time. Such a delay will cause higher costs e.g. for interest to be paid and it will cause lower income or income which will be generated later than expected.

5.1.3 Technical risks

Another important endogenous risk is technical risk which arises once the project is completed and running. The technical risk that a project is functioning comprises of

- the availability of the plant and

[37] Cf: Mills op. 1993: p. 209

[38] Cf: Benoit 1996: p. 12

[39] Cf: Mills op. 1993: p. 209

[40] Cf: Neugebauer 2008: p. 19

- the functioning according to specifications.[41]

When either of the risks occur the power plant does not provide the expected output (i.e. electricity production), which leads to fewer sales proceeds and less ability to service the debt and provide the expected return to the investors.

These risks arise especially when technology is used which is new or not proven. If new technology is used in a project the technical risk needs special consideration or the financing structure will not reflect the non-recourse principle of project finance.

The technical risks in PV are rather minor. But for wind projects due to the nature of wind power generators consisting of mechanical parts this risk is much higher.[42]

5.1.4 Management risks or risks in plant management

The management risk comprises of all risks which result in interruption, shutdown or production with less efficiency than expected.[43] The risk that the project does not operate with the desired efficiency may also result from deficiencies in personnel.[44] The plant management needs to secure the availability and the performance of the project. In order to secure the performance qualified operating personnel is needed. Risks arising out of this are risks in plant management. [45]

5.2 Exogenous risks

As highlighted above exogenous risks are risks which influence the project but cannot be controlled directly by the company or by other involved partners. In the following paragraphs the exogenous risks for wind and PV power project finance will be introduced.

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[41] Cf: Böttcher 2009: p. 81

[42] Cf: Babl 2011: p. 15

[43] Cf: Böttcher 2011: p. 32

[44] Cf: Benoit 1996: p. 13

[45] Cf: Neugebauer 2008: p. 25

5.2.1 Resources Risk

Risks in resources arise when quantity or quality of resources which are needed for the production of energy are behind expectations. The production factors are mainly determined by the chosen location as they depend on wind and solar resources.[46] The blowing of the wind and the sunshine are the only fuel for wind and solar power plants. The advantage of this fuel is that it is freely available to everyone. Thus no variations in fuel costs can influence the project's performance. The disadvantage is obvious: The projects are only producing power once the sun is shining respectively the wind blowing. That's the reason why choosing the right location is so important in wind and solar power projects. In chapters 7 and 8 the approach will be discussed how to address these risks and what possibilities can be found to mitigate such risks.

5.2.2 Political risk

Wind and solar power projects need stable regulatory frameworks in order to be calculable. Opposed to the regulatory framework is the political decision making process which is changing from time to time. The most important motivation for governments to act in respect of energy matters is the security of energy supplies at acceptable prices and to reach targets in regards to climate policy. [47]

The importance of a stable regulatory framework could be seen in 2008 in Spain and 2011 in Italy when an exaggerating feed in tariff made these two countries to boom-destinations for PV developments. Compared to Germany where one can see a stable growth of PV installations the boom did not last long and in the case of Spain even led to frustration in the investment community as feed in tariffs were reduced and capped even retrospectively.

5.2.3 Force majeure

Force majeure risks are not manageable by the project partners. There is no definite definition of force majeure[48] but typically it comprises of natural disasters like fire,

[46] Cf: Babl 2011: p. 17

[47] Cf: Babl 2011: p. 17

[48] Cf: Neugebauer 2008: p. 48

storms or floods on the one hand and events caused by human like expropriation, war, sabotage. Whilst the former can be covered by insurances the latter are typically not covered and thus need a country specific assessment.[49]

Generally banks can neglect the country risk when they do business in their home country. This is especially true if the country's risk as perceived low. The country risk of Germany can be considered as being low.

5.2.4 Interest rate risk

The interest rate on debt capital is an important cost factor for a project. Rising interest rates can represent an additional burden which might hurt the economic success of a project if this risk has not been mitigated.[50] Wind and solar PV projects profit from low operating costs as their fuel is free of charge. Thus the interest rate is an important cost factor for these projects.

[49] Cf: Babl 2011: p. 17; and: Benoit 1996: p. 13-14

[50] Cf: Neugebauer 2008: p. 44

6 The economic feasibility

The economic feasibility of a project is a basic prerequisite for a sponsor to initiate a project and for the lender to engage in project financing. Thus a key question to both lenders and sponsors is whether the project is economically feasible. Lenders will then take a closer look at the bankability of a project. To enable lenders to analyse whether the project is capable of supporting a particular loan value a cash flow model is used to review the project from a banking perspective. Such a model is used to test the economics of the project and its sensitivity to changes in various parameters. Financial Institutions evaluate and assess the respective technologies and their impact on cash flow in order to model the predicted cash flows.[51]

Within such a model certain cover rations relating to the expected cash flow generated to debt outstanding are reviewed. The loan amount will be calculated such that minimum cover ratios are met throughout the term of the loan. According to the debt level the equity requirements of a project can be derived in order to cover total investment costs (TIC).[52]

Once the bank has decided to pursue a project as economic feasibility from a banks perspective is met the detailed conditions of the loan structure are set out to protect the banks position. These provisions involve:

- the taking of formal security interests in the assets of the project (mortgage on the property, pledge on the equipment, pledge on the shares in the company),
- cash flow restrictions (cash flow waterfall) and
- other restrictive covenants.

These covenants or restrictions may involve for example the maintenance of a reserve account for debt service purposes (DSRA). The DSRA is typically required to be built up to a pre-agreed balance before any cash flow is released to the

[51] Cf: Deloitte 2009: p. 68

[52] Cf: Mills op. 1993: p. 211

sponsors.[53] The implications of the DSRA are discussed in the next two chapters in the sections "stabilizing cash flow for seasonal fluctuations".

[53] Cf: Mills op. 1993: p. 211

7 Risks in PV power project finance and their mitigation

Within chapter 7 and 8 the risks and their mitigation in PV and wind power projects are discussed in detail. The structure in both chapters is set up accordingly to the phases of projects: Introducing initially the risks during development phase, then displaying the risks during the construction phase and risks during the operational phase and finally concluding with the mitigation of risks through cash flow covenants and equity requirements. Within chapter 7 it is shown where the peculiarities for solar PV projects can be found.

In project finance the risks are shouldered by and shared between the involved parties. Sponsors take the equity risk and benefit from any upside potential of the project. I.e. if a project runs better than expected, then the sponsor will receive a higher compensation through dividend payments during lifetime of the project or a higher than expected sales price at the end of lifetime. But sponsors also risk the total loss of capital as equity is ranking behind debt capital.

Lenders typically do not participate in any upside potential of a project. Their risk is also limited to losing their debt capital but in case a project fails the lender's claims will be satisfied before the owners of the equity position. Thus their risk is lower than equity providers' risk but also their risk premium is typically lower. The lender's risk premium is the debt margin which is usually fixed over the lifetime of the loan. In contrast to that the premium of the sponsors is not fixed at all.

When approached with a project financing opportunity lenders will usually seek to address three key areas:

- *"Are the economics of the project bankable?*
- *What are the project risks, are these risks acceptable and if not how can they be mitigated or allocated to acceptable third parties?*

- *Is it worth the effort to try to answer the first two questions and put together an acceptable deal structure?'*[54]

Successful project financing requires appropriate contractual integration of all project parties. In that respect each party should shoulder the specific risk which it can influence most. Typically a trade-off between risk-sharing and risk-premium takes place. There are situations where it does not pay to set incentives for actions as the risk premium would be too high. At the end of the day it is not relevant to achieve the maximum risk transfer but rather the optimal risk transfer. The optimal risk transfer can be described as the one that is just sufficient to set the required incentives for action.[55] How this risk transfer can be set out is discussed subsequently and according to the phases of a project.

7.1 Risks during the development phase

The risks during development phase are not only risks which arise during development phase but also risks which should be identified already in or before the development phase.

7.1.1 Resources risk

The resources risk is essential for the economic feasibility of wind and PV projects.[56] That is the reason why the resources risk is already taken care of during the development phase of a project. To mitigate the risks of resources the location of the project needs to be assessed thoroughly. Technical experts provide solar radiation studies in order to mitigate the risk of resources.

The economic feasibility of a PV project is mostly influenced by the expected energy yield. The energy yield is essential for the success of the project. In order to reduce the natural risk at least two independent radiation assessments are required.

[54] Mills op. 1993: p. 207

[55] Cf: Böttcher 2012: p. 14

[56] Cf: Staab 2012: p. 89

> *"The uncertainty in the radiation is at around 4 %. (...) The standard deviation for solar radiation is at 5 % in Germany."* [57]

Even though this figure seems to be quite low there are variations in sun radiation from year to year which need to be taken into account. The uncertainty of radiation is implemented into the cash flow model either through discounts or scenarios are calculated which reflect the variation.

7.1.2 Technical risks

Banks always seek to avoid accepting risks which should properly be taken by the equity owners of the project. Once a technology becomes established banks may become comfortable with the predictability of the processes involved and begin to accept the inherent technical risks which then seem to be manageable.[58] In order for technologies to be acceptable for lenders they should prove:

- that the technology has a satisfactory track-record;
- that the contractor building the project has experience of the technology;
- the adequacy of guarantees / warranties which have been negotiated.

However lenders will not only rely on the information given by the sponsors and still need additional comfort which only third party experts can provide. The exhausting assessment of technical risks is for a lender typically in most aspects not possible without the advice of a technical expert. Great importance is thereto attached to the experts conducting a survey for the lender. Such a survey should not only give evidence about the functional capability of the project but also about possible problems and their implications. These implications will then be assessed by the lenders and consequences can be modelled financially in order to draw conclusions on the future cash flow.[59]

According to information of FRAUNHOFER ISE a study showed that the energy output of approximately 50 % of solar modules lies within the measured tolerance but below the nominal capacity given by the module producer.[60] This explains why

[57] Böttcher 2012: p. 15

[58] Cf: Mills op. 1993: p. 209

[59] Cf: Neugebauer 2008 : p. 55

[60] Cf: Böttcher 2012: p. 16

banks typically require sample flasher testing of solar modules which are used in the project. Further tests may be asked for by banks and often depend on the technical layout of the project. The testing requirements are developed in cooperation between the lenders together with the technical advisors.

7.2 Risks during the construction phase

As power projects are typically constructed by EPC contractors the risks during the construction phase can be limited to one risk of major concern: the completion risk.

7.2.1 Completion risk

The completion risk comprises of all risks and losses arising from non completion, late completion, completion with lower than expected capacity or higher costs. When the terrain, duration of construction and regulatory regimes are considered thoroughly the completion risk can be considered as being manageable in solar projects.[61]

Still the lender will seek to minimise this risk by looking at such aspects as whether high value items can be built under fix price turnkey contracts. Lenders also analyse whether the various contractors are financially sound and whether their obligations are covered by performance bonds or third party securities.

An alternative to mitigate such risks is subject to the robustness of the project economics to pre-agree a debt-funded cost overrun contingency facility or to require additional equity up-front.[62]

One completion risk is peculiar for power plants which plan to sell the produced electricity under a feed in tariff. The Feed in tariff under the German EEG for PV is decreasing continuously at certain effective dates. A PV project is (subject to certain other preconditions) eligible to receive the tariff which is due on the date of its completion. This brings further completion risks into PV projects: If a project is not completed at the pre-agreed date and if a decrease in the tariff should be effected due to such a delay in completion the project not only suffers from the lack of

[61] Cf: Böttcher 2012: p. 19

[62] Cf: Mills op. 1993: p. 209

income until the beginning of power production but it will suffer from reduced than initially expected income for the term of the feed in tariff.

In general the completion risk is mitigated by:

- Completion guarantees or an
- Investor undertaking which obliges the investor to provide additional equity to finalize the project. [63]
- Price adjustment clauses in the EPC contract for the case of late completion and reduction of feed in tariff due to late completion.

The specific design and definition of the guarantees which are needed is negotiated between the lender and the borrower and then stipulated in the loan agreements.

7.3 Risks during the operational phase

The operational phase is the phase in which the capital is tied for the longest time in a project financing structure. A typical loan term of PV project financings is 18 years which leaves a two years tail for the time when the FiT finishes (20 years after completion of the project). Thus the operational phase is the phase in which banks need to take special attention to as their repayment depends on a successful operational phase.

7.3.1 Technical risks

A basic principle is that project financing can only be applied for proven technology. If not-proven technology is applied the lenders would engage in non-predictable cash flows because of technical performance which is not calculable. Lenders set a high value to comparable reference projects. Sponsors, EPC contractors and equipment suppliers are also not willing to take over functional risks if not-proven technology is used.[64]

[63] Cf: Böttcher 2012: p. 20

[64] Cf: Böttcher 2009: p. 82

Still the technical risks for a plant in operation need to be analyzed by the lenders. Following issues are specially examined[65]:

- The capability of functioning over a longer period at certain conditions;
- The ease with which maintenance and if necessary;
- The ease at which component replacement can be carried out;
- Whether the availability- and efficiency-levels predicted can be easily reached.

Again the assessment of these risks will be taken into consideration for the cash flow modeling and debt sizing of the project.

As Illustration 10: displays the module efficiency of commercial PV modules increased steadily and is expected to increase in future.

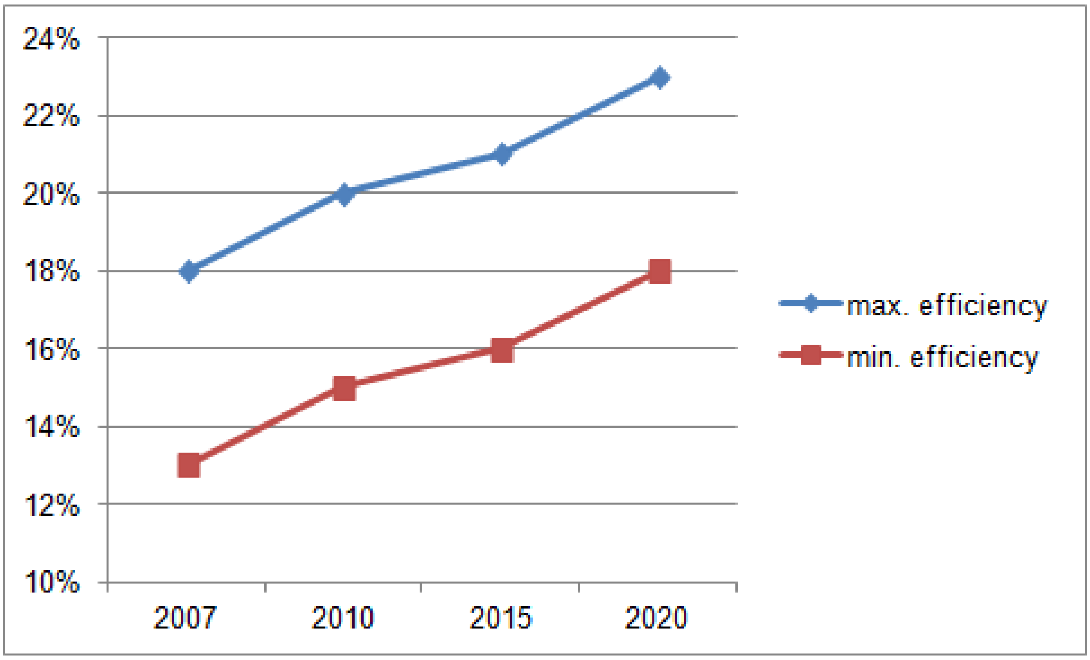

Illustration 10: The development of efficiency ranges of typical crystalline silicon PV modules (Source: Author's illustration based on data from: EPIA)[66]

Such an increase will always raise the question for lenders whether they are financing new technology or proven technology which is simply developed further by the manufacturer. As PV modules are produced in mass production the answer can be given easier than with wind turbines which are manufactured in much lower

[65] Cf: Mills op. 1993: p. 209 - 210

[66] EPIA 2010: p. 7

quantity. Still banks want to see a track record of the certain module of several MW installed and producing power in order to accept a module as proven technology.

7.3.2 Force majeure

Force majeure risks are not directly manageable by the project partners. They can be either natural hazards like fire, storms or floods or they are caused by human like expropriation, war, sabotage. Whilst the former can be covered by insurances the latter are typically not covered and thus need a country specific assessment. [67]

Lenders will even insist on insurances against natural hazards and similar events. Thus the quantification for this risk is rolled over to the credit-worthiness of the insurance company. [68] As insurance companies typically have external ratings the assessment of such risk for banks is quite easy. Often banks require a certain minimum rating of an insurance company in order to be accepted as a counterparty.

7.3.3 Interest rate risk

Due to the capital intensity of solar power projects they react very sensitive on changes in interest rate.[69] The interest rate on debt capital is an important cost factor for a project. Rising interest rates can represent an additional burden which might hurt the success of a project if this risk has not been mitigated. In general there are two alternatives of mitigating interest rate risks.

Fixed interest rate over the lifetime of the loan: This alternative is due to regulatory reasons in Germany only for a term of ten years possible. Another disadvantage is that capital repayments for the debt must be fixed over the term of the fixed interest rate. Otherwise prepayment losses need to be paid by the borrower.

The other alternative is a floating interest rate based on EURIBOR and an interest rate hedging via derivatives. Here often Swaps are used. In a swap the payments of the floating EURIBOR rate is exchanged (swapped) to a predetermined fixed rate over a determined lifetime. This alternative has the advantage that it can be cleared at any time. Of course the risk implied is that the Swap is out of the market meaning

[67] Cf: Babl 2011: p. 17; and Benoit 1996: p. 13 - 14

[68] Cf: Neugebauer 2008: p. 59

[69] Cf: Böttcher 2012: p. 22

that the borrower has to pay a premium for the clearing of the swap. Also the opposite is possible, meaning that the clearing of the swap provides additional income to the borrower.[70]

The interest rate risk is implemented into the cash flow model either through the fixed rate what is the result of an interest rate swap or through scenarios which reflect a variation in the interest rate over the lifetime of the loan.

7.3.4 Risks in plant management

Due to the long lifetimes of PV power projects the risk arising out of the plant management cannot only be rolled over to the management company. Indeed the management company is the first to be addressed for these risks but also an assessment of the inherent risks needs to be carried out. Also for this risk assessment an experienced technical expert is consulted by lenders.[71]

An experienced company should be assigned for the management of the power plant. The management company should be able to check at any time the operating conditions and the output of the plant in order to being able to react quickly in case of disturbances or malfunctions. The management company needs to detect irregularities in the production which might be caused by a deficient module. Also the site needs to be inspected regularly in order to being able to react to temporary shadowing effects.[72]

Beside the risks in management itself also the discontinuation of the management company is a risk which needs to be assessed. Therefore it is necessary to consider if in such case an alternative is available and at which costs. A quantitative assessment can then be implemented in the cash flow model.[73]

When a long term operation and management (O&M) agreement with a contractor is concluded this risk will be taken by the contractor. Lenders then will assess the financial strength of such a contractor. Banks will also satisfy themselves that the operating team engaged to run the project is skilled in the employment of the

[70] Cf:Neugebauer 2008: p. 44

[71] Cf: Neugebauer 2008: p. 56

[72] Cf: Eden 2011: p. 728

[73] Cf: Neugebauer 2008: p. 57

relevant technology and able to deal with all foreseeable situations whether they are routine or require additional inputs of skills and resources to maintain operation and cash flow generation. [74]

Due to the long term character of projects and even if the financial strength of the contractor is doubtless lenders will assess and analyze the technology which is used. Such an analysis will again be conducted by a technical expert for the lenders.[75] Such an assessment provides input for scenarios which can be taken into account in a cash flow model as was seen also from other risks above.

7.3.5 Market risk

The market risk is negligible for projects which sell their electricity under the feed in tariff regime of the EEG. However this risk could convert into a governmental risk when the legislation changes. [76]

The example in Spain in 2009 and 2010 showed that such a risk can realize also under a constitutional democratic government when the government in Spain cut the tariff in Spain (partly even retroactively) and introduced a cap for newly built PV power plants in Italy. Such political risks cannot easily be taken in a project financing structure. That is why banks are hesitant in financing in countries with political instability. In such cases there are mitigation mechanisms like export guarantee or country risk insurances which are not discussed further in this thesis as they do not apply for German projects.

7.4 Mitigating risks through cash flow covenants

Each project party has a different appetite for risk and return, and tries to lay claim to the cash flows which it finds most attractive - and is prepared to pay for. Lenders are particularly keen to avoid risks, but are prepared to accept lower returns as a result. Thus lenders want to get their hands on the revenues before anyone else does, via accelerated repayment schedules.

[74] Cf: Mills op. 1993: p. 210

[75] Cf:Neugebauer 2008: p. 56

[76] Cf: Neugebauer 2008: p. 59

Thus the revenues of the initial years of a project will be spent building these accounts, with dividends to equity sponsors and developers only commencing in the following years.[77]

If there is any doubt about the reliability of cost forecasts, lenders want to see money put aside in reserve accounts to cover all eventualities. The aim of these reserve accounts is to leave all risks with the project developer and equity sponsors.[78] Equity sponsors, in turn, want to get their equity investment out of the project with as high returns as possible.

The balancing of the different risk appetites is done during the negotiations between the lenders and the sponsor. The market is here again a regulating element as only such risk will be able to be mitigated which finds a project party who is willing to take such risk.

7.4.1 Stabilizing cash flow for seasonal fluctuations

As the power production in solar projects depends on natural resources which are subject to seasonal fluctuations also the cash flows underlie fluctuations. It is crucial for the economic success of the project that the financing solution reflects this. For example, the output of the PV power plant will be lower in the winter, which is naturally the case, the debt repayment schedule should mirror that, rising again in the summer - or using reserve accounts to smooth the fluctuation.[79]

The debt service reserve account helps stabilizing the cash flow also in any other event of a pending shortfall on debt service.

Debt service reserve accounts typically need to be funded up to an amount of approx. 50 % of annual debt service. Before the financial crisis these amounts were significantly lower.[80]

The lower DSRA requirements before the financial crisis are a typical example of the risk adversity of lenders which obviously increased during and after the crisis. This

[77] Cf: Liebreich 2005: p. 19

[78] Cf: Liebreich 2005: p. 19 - 20

[79] Cf: Liebreich 2005: p. 20

[80] Cf: Unicredit AG 2010: p. 18

increase of risk adversity is also evident in other requirements and ratios which are discussed in the next two sections 7.4.2 and 7.4.3.

7.4.2 Stabilizing cash flow for O&M and warranty reasons

Reserve accounts may also help stabilizing the cash flow for other reasons:

- An Operations and Maintenance (O&M) reserve account for any event where maintenance and repairs are necessary if these risks are not covered by insurance or by the O&M contractor.
- A reserve account to provide back up when the manufacturer's warranty ends.
- Decommissioning reserves for the deconstruction of the plants are also required by banks. [81]

Such reserve accounts are subject to long and intensive discussions between the lenders and the sponsor during the loan agreement negotiations and are commonly used as trade-offs in order to underpin certain positions.

7.4.3 Debt service coverage ratio (DSCR)

The evaluation of economic viability of a PV project and the credit decision for project financing of such a project is based upon the cash flow and the achievable DSCR. The DSCR is presumably the ratio which is most common within project finance. The DSCR conveys the relation between cash flow and debt service: [82]

$$DSCR = \frac{Cash\ flow\ of\ the\ relevant\ period}{Debt\ service\ of\ the\ relevant\ period}$$

The DSCR is calculated already in the planning phase of the project and is the key financial figure in relation to debt. The importance of DSCR as a figure for project financing is explained due to the characteristics of project finance: The loan which is taken to finance the project is solely repaid through the cash flow generated by the project. Thus it is self-evident to analyze the cash flow progression over the lifetime

[81] Cf: Unicredit AG 2010: p. 18

[82] Cf: Böttcher 2011: p. 305; and Unicredit AG 2010: p. 17 - 18

of the project in respect of its capability to fulfill the debt service. The DSCR indicates at which factor the expected cash flow of each relevant period covers or shortfalls the debt service of each relevant period.[83]

The DSCR serves as an early warning system for the lenders. The DSCR is checked periodically between once and four times a year. The DSCR of each period is then compared with the target DSCR which has been negotiated between the lender and the borrower in advance. A negative deviation between the targeted value and the actual value is interpreted as a lower than expected performance of the project. Depending on the grade of deviation various sanctions will enter into force. These sanctions are as well negotiated before entering into a loan agreement between the lender and the borrower. If the DSCR falls below 1.0 the project will not be able to cover its debt obligations. [84]

Banks require a DSCR for PV projects in the range of 1.05 to 1.15. The range is determined by definition of additional covenants, collateral, dividend lock-ups and or reserve accounts. The lower ratios of DSCR compared to wind projects can be explained due to the lower volatility in expected radiation compared to wind prognosis. Typically a discount of 5% to 10% on the predicted cash flows is taken into account for PV projects.[85] Also degradation of modules (0.2% – 0.5%) is taken into account. This finance practice was tightened with higher risk discounts and higher DSCR requirements in and after the financial crisis.[86] This tightening is also seen in the DSRA requirements and can be seen also in the equity requirements in the following chapter 7.5.

7.5 Mitigating risks through equity requirements

Higher equity participation means (at unchanged total investment costs) reduced debt in a project. This might be at a first glance a simple formula but it has manifold effects. Not only the debt portion at the beginning of a project is reduced but also the resilience of a project over the lifetime of the loan is increased significantly. The cost

[83] Cf: Böttcher 2011: p. 305

[84] Cf: Böttcher 2011: p. 305

[85] Cf: Bayerische Hypo- und Vereinsbank AG 2007: p. 15

[86] Cf: Unicredit AG 2010: p. 17 - 18

for such lower risk profile for the lenders is of course paid-off by investors who in return must accept reduced returns as equity capital is presumably more expensive than debt capital.

Indeed there is a high discrepancy between the sponsor and the lender in regards to the debt equity ratio. In that respect the lender might be quite atypical project partner as at the end of the day the lender carries a majority of risks because its reimbursement is contributed only by the project. On the other side the lender is not entitled to any participation on higher (than expected) earnings out of the project in case the project is performing better than expected.

Sponsors limit their risks with the amount of equity they provide in the project, which is ranking behind the debt capital but which in general is also a much lower amount than the debt capital. The sponsors though are entitled to the full upside of the project. Therefore sponsors strive to minimize their equity contribution and receive a return which is as high as possible through distribution of dividends as early as possible. If the distributions should reach the amount of injected equity already in a short period of time after start of the project, the risk of losing capital is only on the lender's side (after the sponsor has regained its equity). This is a situation which lenders are highly reluctant to as the support and commitment of sponsors in difficult situations may decrease in such a situation dramatically.[87]

Both capital providers have a similar interest in the success of the project but they have different claims on the success: While lenders have a fixed claim on the debt service irrespectively of the success of the project, the sponsors have a claim on the remaining free cash flow which thus depends on the success of the project.[88] The remaining free cash flow which can be used for distribution of dividends is over the lifetime of the project an indicator for the success of the project.

The balance needs to be found between lenders and sponsors in order to find the right financing structure for a project. And the balance is found through market mechanisms. How far a sponsor is able to realize its demands is determined by the lender who is willing to accept such requested risk structures. The balance shifted towards the lenders risk-awareness during the financial crisis. The effect of the

[87] Cf: Neugebauer 2008: p. 61

[88] Cf: Böttcher 2012: p. 25

financial crisis in regards to finance practice seems to be that banks take project risks higher into account than before the financial crisis. As a consequence the achievable leverage decreased noticeably.[89] The required equity was in 2007 at around 20% - 30% for PV projects [90] whereas equity requirements in 2012 are at above 30 %.

This balancing is what makes project finance so special. Each project has to be evaluated individually with its special peculiarities in order to find exactly the financing structure which suits both the equity providing sponsor with its risk appetite and the debt providing lender with its risk adversity.

[89] Cf: Unicredit AG 2010: 17; and Cf: Neugebauer 2008: p. 61 - 62

[90] Cf: Bayerische Hypo- und Vereinsbank AG 2007: p. 15

8 Risks in wind power project finance and their mitigation

Comparably to chapter 7 above the structure in chapter 8 is set up accordingly to the phases of projects: initially the risks during development phase are introduced, then displaying the risks during the construction phase and risks during the operational phase and finally concluding with the mitigation of risks through cash flow covenants and equity requirements. Within this chapter the peculiarities for wind power projects are elaborated in more detail.

8.1 Risks during the development phase

8.1.1 Resources risk

To mitigate the risks of resources the location of the project needs to be assessed thoroughly. Technical experts provide wind resource assessments in order to mitigate the risk of resources.[91]

The economic feasibility of a wind project is mostly influenced by the expected energy yield. The energy yield of wind power projects is just as essential for the economic success of the project as in PV projects and it is crucial for the detailed layout of the power plant.[92]

In order to reduce the natural risk banks require at least two independent wind assessments with at least one long time measurement on the site. The wind assessments should consider reference data from neighbouring and operational wind energy plants. Ideally the data should be based on similar or even the same installed systems. The geographical conditions as well as possible shadowing should be examined in respect to the specific location of the planned power plant.[93]

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[91] Cf: Babl 2011: p. 17

[92] Cf: Böttcher 2011: p. 23

[93] Cf: Ostendorf 2011: p. 673; and Böttcher 2011: p. 25; and Bayerische Hypo- und Vereinsbank AG 2007: p. 12

Compared to PV projects it can be stated that wind projects have a much greater variance in their resources risk. Banks typically make a flat deduction of approximately 20 % of the energy yield to account for this risk. Even though experts propose to rather focus on the characteristics of the specific location and further differentiate this is a practice which only slowly finds its way into financing practice.[94] The risk deduction was lower before the financial crisis. Banks made a deduction in the range of 10 – 15 %.[95] This shows again the influence of the financial crisis on the project financing markets.

The uncertainty and variance of wind resources is implemented into the cash flow model either through discounts or scenarios are calculated which reflect the variation.

8.1.2 Technical risks

Similar to PV projects also for wind power projects banks will always seek to avoid accepting risks which should properly be taken by the equity owners of the project. Once a technology becomes established banks may become comfortable with the predictability of the processes involved and begin to accept the inherent technical risks which then seem to be manageable.[96] In order for wind power technologies to be acceptable for lenders they should prove similar to PV technology that:

- the technology has a satisfactory track-record;
- the contractor building the project has experience of the technology;
- the guarantees / warranties which have been negotiated are adequate and according to other similar projects.

However also in wind power project financing lenders will not only rely on the information given by the sponsors and still need additional comfort which only third party experts can provide. Just as for solar projects also for wind projects the exhausting assessment of technical risks in all details is for a lender not possible without the advice of a technical expert. As stated for PV projects also here great importance is attached to the experts conducting the wind resources study and he

[94] Cf: Böttcher 2011: p. 27

[95] Cf: Bayerische Hypo- und Vereinsbank AG 2007: p. 12

[96] Cf: Mills op. 1993: p. 209

technical feasibility study for the lender. Such a survey should not only give evidence about the functional capability of the project but also about possible problems and their implications. These implications will then be assessed by the lenders and consequences can be modelled financially in order to draw conclusions on the future cash flow.[97] Such conclusions result again in discounts or scenarios which are calculated in the cash flow model.

8.2 Risks during the construction phase

What applies for PV projects in regards to construction also apply to wind projects whose construction is even much more complex and needs experienced contractors: As wind projects are typically constructed by EPC contractors the risks during the construction phase can be limited to one risk of major concern: the completion risk which is discussed next.

8.2.1 Completion risk

The completion risk for wind projects is considerably higher than in solar projects but still manageable. As wind power plants consist of giant and massive prefabricated components which are finally mounted on the site the possibilities for transportation and the terrain needs to be considered thoroughly for the special requirements.[98]

The lender again will seek to minimise this risk by looking at such aspects as whether high value items can be built under fix price turnkey contracts. Lenders also analyse whether the various contractors are financially sound and whether their obligations are covered by performance bonds or third party securities.

Comparable with PV projects an alternative to mitigate such risks is subject to the robustness of the project economics to pre-agree a debt-funded cost overrun contingency facility or to require additional equity up-front.[99]

In general the completion risk for wind power projects is mitigated by:

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[97] Cf: Neugebauer 2008 : p. 55

[98] Cf: Böttcher 2011: p. 31

[99] Cf: Mills op. 1993: p. 209

- Completion guarantees or an
- Investor undertaking which obliges the investor to provide additional equity to finalize the project. [100]

What applies for PV projects in regards to the specific design and definition of the guarantees which are needed also applies for wind projects. The guarantees are subject to negotiations between the lender and the borrower and then stipulated in the loan agreements.

8.3 Risks during the operational phase

The typical loan term of wind project financings is 15 years which leaves a five years tail for the time when the FiT finishes (20 years after completion of the project). The longer tail to PV projects reflects again a higher volatility in the wind resources. Thus the operational phase for wind projects is just as in PV projects the phase in which banks need to take special attention to as the repayment of debt depends on the income generated during a successful operational phase of the wind power project.

8.3.1 Technical risks

As mentioned before a basic principle of project financing is that project financing can only be applied for proven technology. This applies as well for wind power projects.

Still the technical risks for a wind power plant in operation need to be analyzed by the lenders. Comparably with PV projects the following issues are especially examined for wind projects[101]:

- The capability of functioning over a longer period at certain conditions;
- The ease with which maintenance and if necessary;
- The ease at which component replacement can be carried out;
- Whether the availability- and predicted efficiency-levels can be easily reached.

[100] Cf: Böttcher 2011: p. 31

[101] Cf: Mills op. 1993: p. 209 - 210

The capacity of wind turbines was continuously increasing over the last decade. This is setting higher requirements to material but on the other hand it also increased the efficiency of turbines. The challenge for lenders is that they should finance equipment for 15 years and more whereas only a few years of track record exist for such equipment.

Illustration 11: displays the increase in average turbine capacity which doubled between 2000 and 2011. A similar increase is expected also for the near future.

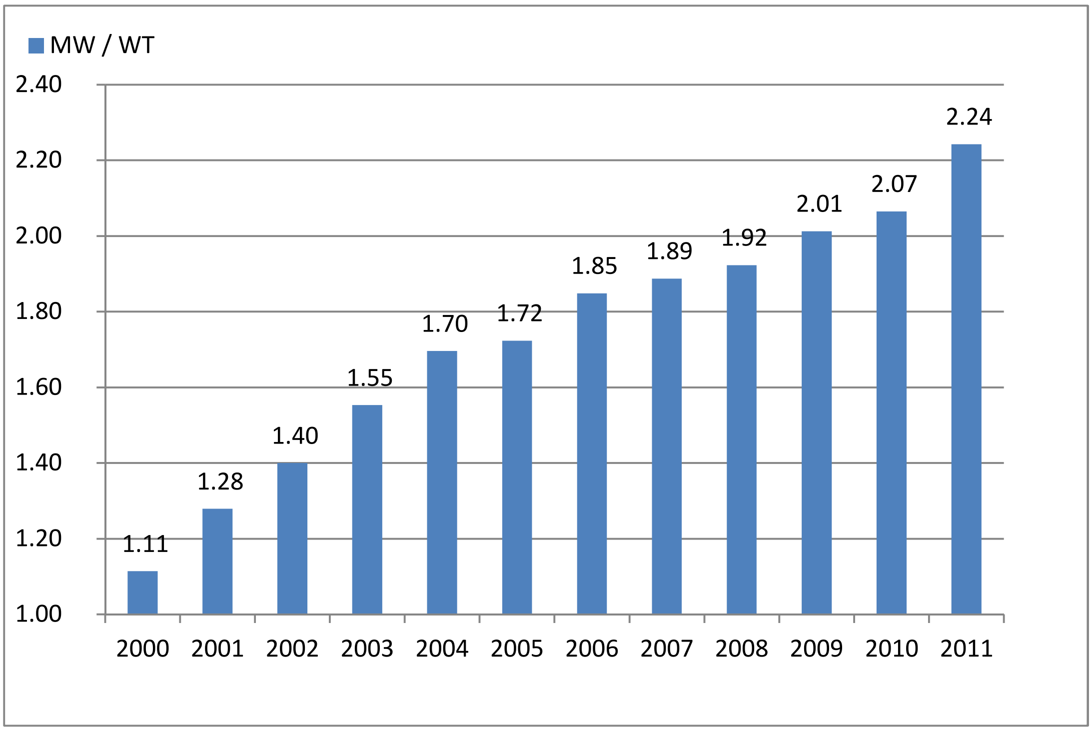

Illustration 11: Increase in average capacity of newly installed wind turbines (Source: Author's illustration based on data from: DEWI GmbH 2012)[102]

The installation of such equipment is only possible due to the fact that producers are running long term test series with their newest turbines in order to provide a certain track record and the turbines are rather continuously developed further than completely new concepts.[103]

Again the assessment of the technical risks will be taken into consideration for the cash flow modeling and debt sizing of the project.

[102] DEWI GmbH - Deutsches Windenergie-Institut 2012

[103] Cf: Böttcher 2011: p. 30

8.3.2 Force majeure

For the Force majeure risk the same applies what was said before for this risk in regards to PV power plants.

8.3.3 Interest rate risk

Also wind power projects are very capital intensive. Thus they also react very sensitive on changes in interest rate.[104] Comparable to PV projects also for wind projects the interest rate on debt capital is an important cost factor. Rising interest rates can represent an additional burden which might hurt the success of a project if this risk has not been mitigated. In general comparable to PV projects the same two alternatives for mitigation of interest rate risks can be applied:

- Fixed interest rate over the lifetime of the loan or
- A floating interest rate based on EURIBOR and an interest rate hedging via derivatives.[105]

Also for wind projects the interest rate risk is again implemented into the cash flow model either through the fixed rate what is the result of an interest rate swap or through scenarios which reflect a variation in the interest rate over the lifetime of the loan.

8.3.4 Risks in plant management

Also wind projects have a considerable long lifetime. Thus the conclusion of long term O&M agreements with adequate partners is an indispensable precondition for most banks to enter into project financing.[106] Due to the long lifetimes of wind power projects the risk arising out of the plant management cannot only be rolled over to the management company similar to PV power plants.

So also for wind projects an experienced company should be assigned for the management of the wind power plant. The management company should be able to check at any time the operating conditions and the output of the plant in order to

[104] Cf: Böttcher 2011: p. 25

[105] Cf:Neugebauer 2008: p. 44

[106] Cf: Ostendorf 2011: p. 674

being able to react quickly in case of disturbances or malfunctions. The management company needs to detect irregularities in the production which might be caused by a deficient turbine.[107]

Comparable to PV projects also the discontinuation of the management company is a risk which needs to be assessed for wind power projects. The same conclusions as for PV projects apply for wind projects and it needs to be assessed if an alternative is available and at which costs such an alternative can be implemented.

In regards to long term operation and management (O&M) agreement with a specific contractor this risk will be taken by such a contractor. Also in such case lenders will assess the financial strength of such a contractor for wind power projects. Banks will due to the higher technical complexity of wind projects compared to PV projects satisfy themselves even more that the operating team engaged to run the project is skilled in the employment of the complex wind turbine technology and that the team is able to deal with all foreseeable situations whether they are routine or require additional inputs of skills and resources to maintain operation and cash flow generation. [108] Thus Lenders take especially into consideration:

- The reputation of the company;
- The ability of the company to manage a power plant;
- The experience in operation and maintenance of comparable plants;
- The ability to allocate adequate personnel. [109]

Due to the long term character of wind power projects and even if the financial strength of the contractor is doubtless lenders will assess and analyze the technology of the wind power project which is used. Such an analysis will again be conducted by a technical expert for the lenders. [110] Such an assessment provides input for scenarios which can be taken into account in a cash flow model as was seen also in other risks above and comparable to PV projects.

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[107] Cf: Böttcher 2011: p. 33

[108] Cf: Mills op. 1993: p. 210

[109] Cf: Böttcher 2011: p. 33

[110] Cf:Neugebauer 2008: p. 56

8.3.5 Market risk

The market risks are as well as for PV projects negligible for wind power projects which sell their electricity under the regime of the EEG. However also for wind power projects this risk could convert into a governmental risk when the legislation changes. [111]

Nevertheless due to the lower costs of power production with wind turbines compared to PV power projects the market risk is considerably lower as there is not such a huge gap between costs of power production for wind turbines and the market price level.

8.4 Mitigating risks through cash flow covenants

8.4.1 Stabilizing cash flow for seasonal fluctuations

As the power production in wind projects comparable to PV projects depends on natural resources which are subject to seasonal fluctuations also the cash flows of wind power projects underlie seasonal fluctuations. It is crucial for the economic success of the wind power project that the financing solution reflects this. For example, the output of the wind power plant will be lower in the season with less wind, the debt repayment schedule should mirror that, rising again in the period with more wind - or using reserve accounts to smooth the fluctuation.[112]

Also for wind power projects the debt service reserve account helps stabilizing the cash flow also in any other event of a pending shortfall on debt service.

Debt service reserve accounts typically need to be funded up to an amount of approx. 50 % of annual debt service for wind projects.

8.4.2 Stabilizing cash flow for O&M and warranty reasons

Similar to PV projects also for wind projects reserve accounts may help stabilizing the cash flow for other reasons. Also for wind projects the reserve accounts are

[111] Cf: Neugebauer 2008: p. 59

[112] Cf: Liebreich 2005: p. 20

subject to long and intensive discussions between the lenders and the sponsor during the loan agreement negotiations and are also here commonly used as trade-offs in order to underpin certain positions.

8.4.3 Debt service coverage ratio (DSCR)

The general assumptions about the DSCR and the evaluation of economic viability for a wind power project and the credit decision for project financing of such a project is accordingly to what was said for PV projects in chapter 7.4.3. For wind power projects banks require DSCR in the range of 1.20 - 1.40. The range is determined by covenants, additional collateral and restrictions on dividend distribution.[113] The noticeably higher DSCR requirement compared to PV projects is reflecting the higher volatility in resources.

8.5 Mitigating risks through equity requirements

The same reasons why lenders require equity for solar power projects apply for wind power projects. Equity serves as a buffer for the lender to accommodate risks which the lender otherwise would not be willing or able to accept.

Also wind power projects notice the effects of the financial crisis especially in regards to equity requirements. Whereas equity requirements for wind projects used to be in the range of 10% - 20% before 2007 today equity ratios of 30 % up to 50 % are demanded by some financial institutions.[114] Also for wind projects a tighter financing structure during and after the financial crisis can be evidenced than before.

Also here it is the balancing what makes project finance so special. Each project has to be evaluated individually with its special peculiarities in order to find exactly the financing structure which suits both the equity providing sponsor with its risk appetite and the debt providing lender with its risk adversity.

[113] Cf: Bayerische Hypo- und Vereinsbank AG 2007: p. 12

[114] Cf: Gralla 2011: p. 27; and Babl 2011: p. 30

9 Conclusion

Within the conclusion in this chapter the differences in risks and their mitigation between wind and solar projects are consolidated. For reason of traceability and transparency the structure of this chapter follows the structure of chapters 7 and 8 respectively.

Generally it can be stated that the process from identification of risks to finding a suitable financing structure is similar and comparable for both technologies. First the risks need to be identified. Then an analyzing of the risks leads to the allocation and furthermore to mitigation strategies. The tools which are used during this process are also similar. The central tool for a bank is the cash flow model which helps simulating various parameters which have an influence on the project and are thus reflected in different scenarios of a cash flow model. Also the use of expert valuations and assessments mainly for technological risks and for resources risk is comparable for wind and solar projects.

9.1 Differences in Risks during development phase

Within the following paragraphs the differences between PV and wind project financing are elaborated following the structure of risks identified above.

9.1.1 Resources Risk

For both wind and PV projects the resources risk plays an essential role for the feasibility of the project. For solar power projects banks require two radiation assessments provided by two different expert institutions. Also for wind power projects two assessments are required but one of them needs to comprise of a long term (6 – 12 months) on site measurement of the wind resources. Also reference data from neighboring sites is considered whereas such data is not included in solar radiation assessments.

In regards to the cash flow modeling lenders will make a discount of approx. 15% of the expected energy yield for solar projects and 20% discount for wind projects.

9.1.2 Technical risks

The key difference in risks for wind and solar projects can be found in the technology which is used: PV modules can be considered as mass products whereas wind turbines are manufactured in quantities of 500 – 1000 units per year. Thus testing of PV modules can only be done on random sample basis which explains why proven technology is so important. Wind turbines on the other hand are highly developed mechanical machines which cannot be lab-tested easily. That is why manufacturers test their turbines themselves often on a medium to long term basis. Banks emphasize to use turbines from renowned manufacturers and each single turbine is tested in a test-run on site individually. PV modules are commonly tested externally and sometimes banks require sample testing of the specific modules which are installed in the respective power plants. In general not every single module is tested but a test-run phase of approximately four weeks is required.

9.2 Differences in risks during the construction phase

9.2.1 Completion risk

The highest risk for lenders during the construction phase is the completion risk. Here the approach is similar for both wind and solar projects. Lenders will require a turnkey EPC contract with a renowned contractor. Such a contract shall be backed by completion guarantees and an investor undertaking. The key difference is the price adjustment clause in the EPC contract for PV systems which has its reason in the regulatory framework of the decreasing FiT.

9.3 Differences in risks during the operational phase

9.3.1 Technical risks

For mitigation of technical risks during the operational phase lenders will again rely for both technologies on third party technical experts which provide assessments of the used technology. Such assessment will be taken into consideration for the cash flow model and will provide the basis for further discounts and scenario calculations. This applies for wind and PV projects.

The question of proven technology is crucial for wind and solar projects. Both technologies are steadily developed further by the manufacturers so the separation between new technology and further development of technology is not easy.

9.3.2 Force majeure

Force majeure risks from natural hazards are mitigated through insurances wherever applicable. Thus the insurance company will be evaluated by the lender. Other force majeure risks which are not insurable will be taken by both the lender and the sponsor. Nevertheless it can be assumed that war or expropriation is a risk which is rather negligible in Germany as of today.

9.3.3 Interest rate risk

The interest rate risk is something banks pay a lot of attention to in both wind and solar projects. The interest to be paid for the debt is presumably the highest expense figure in a cash flow model for wind and solar projects. Banks will insist on either fixed or hedged interest rates at least for a majority of the loan and for a long period of time. So in general there is no difference in that respect for wind and solar projects.

9.3.4 Risks in plant management

For wind and solar projects banks require a long term O&M agreement with a reputable contractor. Often the EPC contractors also provide O&M services what secures them a stable income over a longer period of time. For the lender it has the advantage of certain security that the O&M knows the equipment which was applied in the power plant and knows how to handle it.

Here the selection of adequate O&M contractors is definitively more important and also more difficult for wind power projects as they need much more intensive maintenance than PV projects. For wind and solar power projects a 24 hour per day seven days per week surveillance and monitoring is needed so that the O&M contractor can react quickly to any irregularities in power production.

9.3.5 Market risk

As of today the market risk is negligible for wind and solar power projects in Germany as there is a stable regulatory framework providing a guaranteed feed in tariff. Nevertheless as this feed in tariff is more and more questioned especially for large PV systems which are mostly predestinated for project financing the market risk may rise in the near future for the time after a guaranteed FiT.

Without a FiT wind and solar projects will compete with all the other renewable and non-renewable power sources on the market for the sale of electricity. Then long term power purchase agreements between the producer and big utilities will be needed and banks will require them to be concluded for a long term basis to account for the high initial investment costs of wind and solar power projects.

9.4 Differences in mitigating risks through cash flow covenants

9.4.1 Stabilizing cash flow for seasonal fluctuations

Lenders require for wind and solar projects debt service reserve accounts in order to stabilize the cash flow for seasonal fluctuations. For projects in both technologies approximately 50% of an annual debt service needs to be locked up in a debt service reserve account.

9.4.2 Stabilizing cash flows for O&M and warranty reasons

Also for O&M and warranty reasons banks require reserve accounts. The amounts of these reserves are individually depending on the project. The same applies for decommissioning reserves for the end of lifetime of the project.

9.4.3 Mitigating risks with DSCR covenants

As highlighted above the cash flow model is the central tool for banks to analyze and assess the economic feasibility and the debt service capability of projects in particular. The DSCR level can be checked easily with a cash flow model and this is done typically between once and four times per year.

Here one can find a major difference between wind and solar projects. Due to the higher volatility in wind resources banks require a higher DSCR level for wind than for solar projects. Whereas for PV projects a minimum DSCR level of 1.15 over the lifetime of the loan is sufficient the level which is required for wind projects is in the range of 1.20 – 1.40.

9.5 Differences in mitigating risks through equity requirements

Without equity project financing cannot be realized. The requirements for wind power projects are comparable to those of PV projects. In both cases banks require approx. 30% of equity from sponsors in order to be willing to enter into the risks of project financing. Such an equity buffer is typically sufficient to cover the risks which lenders are not willing or able to take. In particular cases the required equity might also be higher to account for risks which are not standard.

10 Summary and outlook

This chapter provides a Summary and outlook for banks which are willing to enter into this business field and for other countries which are willing to follow Germany's example.

The risks and their mitigation in solar and wind power project financing are summarized in the following table. As demonstrated above and in the summary the differences in the approach of mitigating risks are less profound than one could expect when considering the completely different technologies, system sizes and application.

Table 1: Summary of risk mitigation (Source: Author's illustration)

Phase	Risk	Mitigant	
		Solar	**Wind**
Development phase	**Resources risk**	➢ 2 similar assessments by different experts ➢ 15% discount on expected energy yield	➢ 2 assessments, thereof one long term wind measurement on site ➢ 20% discount on expected energy yield
	Technical risks	➢ Only proven technology ➢ Sample random testing ➢ Test run of a completed plant	➢ Only proven technology ➢ Testing each single turbine individually ➢ Test run of a completed plant
Construction phase	**Completion risk**	➢ Turnkey EPC contract with price adjustment clause ➢ Completion guarantee ➢ Investor undertaking	➢ Turnkey EPC contract ➢ Completion guarantee ➢ Investor undertaking
Operational phase	**Technical risks**	➢ Proven technology only ➢ Third party technical assessments	➢ Proven technology only ➢ Third party technical assessments
	Force majeure	Insurance	Insurance
	Interest rate	Fixed or hedged interest	Fixed or hedged interest
	Risks in plant management	Reputable O&M contractor	Reputable O&M contractor
	Market risk	Currently negligible under FiT but considerably higher due to higher production costs than wind	Currently negligible under FiT
	Cash flow covenants	➢ Debt service reserve ➢ O&M reserve ➢ Warranty reserve ➢ Decommissioning reserve	➢ Debt service reserve ➢ O&M reserve ➢ Warranty reserve ➢ Decommissioning reserve
	DSCR covenants	DSCR > 1.15	DSCR > 1.20
	Equity requirements	Min. 30%	Min. 30% up to 50 %

The general approach for wind and solar project financing is definitively comparable. The reason is mainly because both power production methods are depending on natural resources to which human influence is marginal once the decision for the location and the specific layout of the project has been taken. That is also why the planning phase and accurate planning is so important for the establishment of projects in both power production methods.

This is also the similarity in project financing of wind and solar projects: they both need very careful planning from the developer. The process from risk identification via analysis of risk to allocation and mitigating risk in order to finally find an optimal financing structure needs to be gone through very carefully and step by step.

What differentiates them most are the cash flow and DSCR covenants which are higher for wind projects due to the higher volatility of wind resources. Also a higher percentage of equity is required in order to serve as an additional buffer for higher volatility of wind resources.

Whatever the development of FiTs might be, as wind and solar PV power generation will become more competitive due to higher efficiencies and decreasing costs FiTs may not be necessary anymore in the future. Also the political will despite the “Energiewende” and Germany’s nuclear power phase out goes into the direction of reducing, cutting or even dispose of feed in tariffs. Once this is the case banks will have to prepare themselves for the next stage in project financing these power projects. Market risk will then play a much more important role than so far. Individual power purchase contracts will then be concluded between the project companies and the utilities. Banks will then have to analyze these contracts in detail and will have to assess the capability of the utility.

> *“And the skills needed by developers are changing: financial engineering is now as much the name of the game as project management.”*[115]

Coincidental with banks needing to increase their expertise for future aspects of project financing for wind and solar projects also the developers and sponsors will need to increase their skills in regards to financial engineering in order to remain competitive, secure the best financing available and allocate each single risk to each party who can manage such risk best.

[115] Liebreich 2005: p. 20

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