CSPBankability Project Report

Draft for an Appendix N – Financial Evaluation

to the SolarPACES Guideline for Bankable STE Yield Assessment

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N. Financial Evaluation

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N.1. Introduction

Project finance is a specific form of the more general term *structured finance*. As a financing approach, it became popular during the liberalization and privatisation in the 90's in the UK and USA, when governments decided to privatise many state-run sectors and companies, such as power, telecoms, roads, ports or airports. After that, project financing also became popular for emerging markets, when so-called Structural Adjustment Programs of the World Bank and IMF were applied to achieve economic turnarounds for Central and Eastern Europe, Latin America and Asia. Since the 90's, Project Finance has been an ever growing industry until the 2007-08 financial crisis. In 2008 the global project finance loans market reached a peak at USD 247 bn. In 2013 the project finance market reported an amount of USD 204 bn. [Della Croce, 2014].

In the renewable and in particular in the solar industry, project financing structures have not only been able to mobilise high percentages of inexpensive, long term debt, but also created new types of equity investors in addition to the "usual suspects" like utilities, IPPs or EPC's: a new landscape of financial investors like asset managers, infrastructure and pension funds as well as private individuals of all types have invested into solar as one of the main renewable assets classes. They all appreciate long term cash flows with stable dividends over long terms. As a consequence, both debt and equity of project financing have reduced the capital cost for solar PV to a large extent. This is one of the main factors for the increasing competitiveness of solar power in many countries.

As one of the key requirements for the bankability of a power generation technology, lenders are requesting a so-called "proven technology" status. In the PV sector, many equipment suppliers and EPC's have reached this status today. Track records of many thousands of MWs in operation can be looked at. For CSP technologies today, this cannot be claimed in a similar dimension. Parabolic trough projects have successfully operated in GW amounts for many years today. As a consequence, this is the technology most relied upon or considered as most trustworthy. Yet due to dynamic technological developments, most of CSP projects that are being presented to lenders to seek financing have significant technological improvements or design innovations that cause lenders to raise doubts in the reliability and performance predictability. Even small items can severely endanger the project performance and impact cash flow. Hence, banks often find it difficult to concede the "proven technology" status. As a consequence, in order to reach bankability, commercial lenders require extensive guarantees from equity investors to cover identified risks, in excess of equity contributions.

Further, the technology has significant effects also on the equity investment appetite: As long as a technology does not qualify as "proven", the investor landscape remains sparsely populated: only strategic investors such as utilitites, IPP's, large developers or EPC's would be willing to look at accepting risks resulting from innovations. In project finance, they do not only have to assess the risks for their own equity invested, but in addition need to be prepared to provide comfort to lenders, mainly as additional guarantees. Financial investors instead would shy away from getting involved for both reasons.

The financial section of this guidebook has the following line of argument: initially, in section N.2 we describe the basic characteristics of project finance, such as definition, involved parties, structures, methods, mechanics and key figures, to help understand the project finance approach. In N.3, we explain the various approaches to financial evaluation, key figures, perspectives such as Investor's, Lender's, or EPC's. In section N.4 the factors for risk assessment and success are given, and the main issues for CSP financing are elaborated.

Eventually, in section N.6, we give a practical example from an emerging market, South Africa, which is one of the most attractive emerging markets for CSP. This case study gives us a good overview of real life project finance with all key elements and issues.

N.2. Basic characteristics of cash-flow based lending and project finance

N.2.1. Definition, history and application

Project Financings are loans provided to a special purpose vehicle (SPV) on the basis of the assessment of its future cash flows. A solar SPV uses these funds together with a portion of equity to finance the construction of a solar power plant. After construction, the power plant generates cash flows by selling power (and/or heat or certified emission rights). These Cash Flows are used to pay O&M cost and cover the debt service for the loans, i.e., interest and principal. Cash Flows exceeding the above mentioned cost items can be used to disburse dividends to equity providers or shareholders, who in the Project Finance business also are called *Sponsors*. The Project Company (SPV) acts as an economically independent entity. For lenders, key to so-called bankability of the SPV is a secure assessment of future cash flows and their likelihood of realization. The project cash flows are the main source for lender's debt service payments, therefore their secure assessment is the key to a bankable transaction. As collateral for the loans, lenders usually rely on the project's assets and shares. Unlike in corporate financing (balance sheet finance), lenders have no or very limited entitlement (non-recourse or limited recourse) to other assets or cash flow of sponsors. Hence, project financings are often also regarded as *off-balance sheet finance*.

By contrast, corporate finance usually provides funds from the balance sheet of the investing firm. With capital intense, long term fixed assets, the impact to even strong balance sheets is noticeable and enduring and can have significant impacts on key balance sheet ratios, limiting further borrowing power. Historically, project finance evolved first during the development of railroads in America between 1840 and 1870. Later, in the 1930s project finance was used to finance the exploration of oil fields. The capability of the producers to repay principal and interest from cash generated through the sale of raw oil formed the basis to offer funding for these types of activity. Long-term supply contracts often served as guarantees for the lenders. In 1987 the Public Utility Regulatory Policy Act (PURPA) was passed in the United States. The new act promoted energy production from alternative wells and obliged utilities to purchase all electrical output from qualified power producers. This fostered a broader implementation of project finance techniques for the construction of conventional as well as renewable power plants. Until today, project financing is dominant in the energy and power sector, compared to other sectors. Between 2003 and 2006, energy and power represented nearly 50% of the total global value of project finance initiatives. Followed by industrials with about 25% and materials with about 8% of total global value. Hence, one can assume that energy and power related projects have a particular significance for the application of project finance [Gatti, 2012].

N.2.2. Involved parties

There is a key philosophy that is valid to each and every Project Finance Transaction:

"Strive to allocate every risk to the party that can best manage and assume it."

For instance, construction risk should be contracted and guaranteed by a reputable and capable construction firm, the operation risk with the O&M contractor and so forth. Typically, all parties have contracts that clearly rule their obligations and commitments as well as interests with the SPV in a way that the risks are well balanced to ensure a safe implementation of the project. The following Figure N-1 illustrates the main parties that are typically involved in a project. In the following, we will describe these parties and their roles in detail. For a detailed description of possible contractual structures, please refer to chapter N.2.5 Contractual structure. The individual financial perspective of each party will be evaluated from chapter N.3.3 to N.3.6.

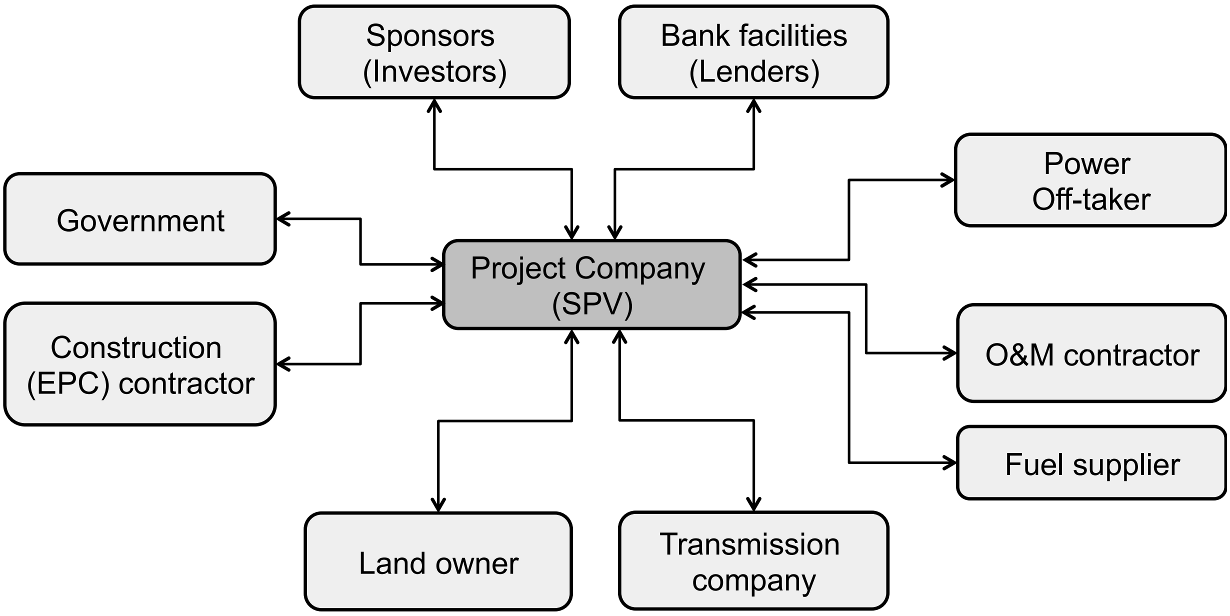


Figure N-1: Typical structure of project finance

N.2.2.1. Offtaker

All business cases for Power Project financing starts with power sales. In order to reach bankability, long term energy sales contracts with creditworthy offtakers are required. A long term energy sales agreement with a creditworthy unit secures the reliability of revenues of the SPV and therefore is the key contract for the project. Traditionally, in the renewable energy sector, many countries have introduced policies that offer so-called Feed-in Tariffs (FIT) for renewable energy producers. These provide predictable revenues in form of government set tariffs. After many years, a debate on the subsidies involved on pro's and con's, however, FIT's have come somewhat out of fashion. Instead, the entire renewable industry has entered into a more competitive age. In many countries today, long term tariffs of Power Purchase Agreements (PPA's) are being offered in competitive bids or auctions, or negotiated bilaterally (with a private offtaker).

For non-dispatchable renewables such as wind or PV, this PPA usually only has an energy element that fixes the price for the energy unit, like USD/MWh. It also includes often the obligation of a take or pay obligation for the offtaker to take all energy produced whenever it is produced, or at least to pay for the energy even if not used (deemed supply).

For CSP however, the tariffs could look similar, but may also have an element of price differentiation for certain times of delivery. An example is South Africa, where the tariff that CSP plants obtain has a base tariff fixed in the bid. During a certain time of the day, however, like between 5 pm and 9 pm, when demand peaks in the grid due to consumption patterns, the base tariff is multiplied with a factor of 2.7, acknowledging that CSP with storage is a dispatchable technology. Since CSP with storage or co-firing (gas, biomass etc.) is a dispatchable technology, the tariff could also be structured in analogy to conventional fossil fuels plants: in such cases, a so-called capacity payment is paid for the availability of a capacity of x MW of a CSP plant, and an energy payment whenever it is actually dispatched. In conventional power, rules of thumb say that the capacity payment should cover the capital cost and the energy payment the variable or marginal cost for the units actually produced.

The PPA is the foundation of the entire Project Financing Scheme. Its most important elements are the creditworthiness of the offtaker and the pricing structure. The offtaker needs to fulfill for his commitment to buy the energy over the period agreed (classically around 20 to 25 years). The pricing of the energy units produced (or, as may be the case together with any capacity payments) together with the predicted energy yield of the plant form the essential basis for the revenue calculation of the entire project.

Offtakers can be either government-owned utilities such as for instance Electrobras in Brazil or Eskom in South Africa, but also large industrial corporations or even the Spot Market. For a government-owned offtaker in an investment grade country, a long term offtake contract usually enables long term financing. For Offtake agreements with industrial corporations this is not as easy, since the corporate risk in only few cases would comfort the banks in regard of their payment capability over a tenor exceeding 10 years. Most banks would not lend directly to such corporates for tenors exceeding 10 years, so their lending tenors under a project financing scheme will hardly exceed that.

A third alternative does not have a single contractual offtaker, but many instead: a so-called Merchant Power Project (MPP) sells its energy to a functioning electricity spot market. Spot market sales are much shorter in nature than long term contracts, so lenders do not have the security of a long term agreement. Instead, both Sponsors and Lenders need to analyze the relevant underlying electricity market patterns in-depth to deeply understand supply and demand patterns, growth rates, possible changes to supply structures and external shocks (fossil fuel market prices, grid availability etc.). Above all, a functioning, transparent spot market needs to be in place. The first financings of solar power projects that sell under merchant conditions can be noted in the PV sector in Chile, Panama and Mexico. In total, approx. 70 to 100 MW have been financed and built on a so-called merchant basis in these countries. While spot market sales have upside potential in case the power market prices rise, they do have downside risks. Bank lending to merchant power plants is therefore usually much shorter and the portion of debt in relation to overall investments (leverage) is much lower (50% to 60% of debt).

N.2.2.2. Sponsors

In each project finance transaction, a legally independent project company (also called Special Purpose Company or Special Purpose Vehicle, SPV) will be established. With the sources of project finance debt and equity, the SPV is funded, purchases the equipment from a construction firm and operates the

plant. The major shareholders in this SPV are called Sponsors in a project finance transaction. Sponsors are key elements to enabling the bankability for two main reasons: first, they need to be able to provide a major share of the equity funding and second, they need to be capable to manage all necessary issues to implement the power plant during financing, construction and operation. Lenders have neither the knowledge nor the management resources to fix a malfunctioning turbine or reject claims from an EPC supplier. Lenders want the Sponsors to fix these types of issues. Evidently, CSP as a technology is much more complex than for instance PV or wind generators, such that Sponsors do have a considerably higher importance to lenders to get comfortable with the overall financing structure. The more complex the project structure and technology is, the more important the Sponsor's track record and experience to manage the risks related to construction and operation of the plant is.
For large-scale CSP projects, typical Sponsors are large Developers or Independent Power Producers (IPP's). Also, local, national or international utility companies could act as sponsor, taking a major stake in the equity and striving for construction and operation of the CSP plant to happen as scheduled.
Similar to other renewable industries like PV or Wind, a popular business model in the CSP sector is what we call "the Spanish Trinity Approach" with Developer=EPC=IPP, three usually different business models in one firm. The construction firm fulfils all essential roles in one firm, examples are Abengoa or ACS Cobra. This approach has all sorts of overlaps and conflicts of interest between the business models of Developer, EPC and IPP. In the CSP industry, however, we need to concede that it has proven quite successful for a number of reasons. The main reason in our context here however is that the construction firm, which is also the IPP in the medium to long run, can comfort the banks with significant guarantees for whatever risk identified on the technology side. In particular for all sorts of innovative elements in CSP, this model provides lenders with additional gurantees, if not guarantees that cover the entire amount of debt service to Lenders (also called *Full Recourse).* Instead of lengthy discussions and negotiations with Lenders about technological risks, the Lenders can be satisfied with guarantees until sufficient track record is installed and in operation so that the technology enters the proven technology status.

N.2.2.3. Lenders

Sponsors usually provide a major stake in equity of a project, often complemented by financial investors. The major part of the overall investment however is being sourced from debt. Debt bears usually lower interest rates and overall cost than equity. Now if Lenders analyse a solar project scheme with long term offtake contracts (e.g. with a national or large private utility) they consider the project revenues (Cash Flow) as highly predictable and stable. Evidently, also the solar irradiation and energy yield predictability and reliability plays a big role in this risk assessment. A highly predictable and stable Cash Flow enables Lenders to provide high portions of debt (expressed in the debt to equity ratio or also called leverage or gearing, see chapter N.3.2). The larger the portion of debt and the lower its cost in form of interest rates is, the lower the cost of capital of the overall project, and the more competitive the power tariff can be. Depending on the environment of the project, debt is provided either in hard currency like USD, EUR, YEN, or GBP etc. or local currency. The currency basket of funds should match the revenue streams, derived from power sales, so that any mismatch in form of currency movements can be avoided.

Debt providers or Lenders are usually project financing banks - commercial and investment banks. For developing countries and emerging markets, development agencies and multilaterals like the World Bank or KfW provide additional loans. Some large emerging markets also have their own local government-owned lending institutions that play an important role in lending to solar and other renewables. Examples are the Indian Renewable Energy Agency IREDA, India's Power Finance Corporation PFC, Brazil's Banco Nacional de Desenvolvimento Economico e Social BNDES or South Africa's Industrial Development Corporation IDC and Development Bank of Southern Africa, DBSA, to name a few.
In a relatively minor part of the overall project financing landscape, capital markets also come into the field, when projects are capable to issue project bonds to capital market.

N.2.2.4. Engineering, Procurement and Construction (EPC) firm

Lenders want to see the risk of a project being constructed on time, within budget and within the technical specifications required to be addressed by a single construction firm. To allocate these risks, the Project Company enters a Contract that encompasses Engineering, Procurement and Construction, an EPC Contract. Counterpart for the contract is a construction firm (EPC Contractor) that commits to assume the risks related to this critical phase until commissioning and successful start of operation. The EPC contract usually is a fixed-price, date-certain, turn-key construction agreement, allocating all risks related to this period to the Contractor. Such an EPC contract includes the specifications of the CSP plant in every detail, cost budget for the specified technology, time of delivery and penalties for non-performance. The penalties for non-performance should be backed by respective guarantees. All of these should be on a back-to-back structure with the obligations a project has under its PPA. In the real world, Lenders identify shortfalls in many aspects they would like to see covered in addition.
During the construction period, all that Lenders can rely on under a true project financing scheme (non-recourse) is the EPC contract, its mechanisms and guarantees as well as the Contractor's long term experience, resources and track record to implement projects of a comparable size and complexity. In the PV or Wind sector today, multiple EPC Contractors are considered capable of providing comfort to Lenders that they can successfully implement respective constructions. Many MW's of track record are available. In today's CSP industry, there is only a handful EPC companies worldwide that would be considered bankable. Most of them offer parabolic trough technology. For new technologies such as Central Receiver systems, there may be three companies worldwide that have the track record and the balance sheet to provide the financial strength. For Linear Fresnel, there is none left, since ABB stepped out of Novatec and Areva withdrew from their engagement in Ausra's Linear Fresnel technology. This is one of the principle obstacles to the scaling up of CSP. The scarcity of bankable EPC firms in the CSP sector severely limits the bankability of CSP and - somewhat related - also limits the competitively of equipment prices, due to lower competition among potential EPCs.

N.2.3. Selected other parties

Project Financing is a cobweb of contracts, with multiple agreements and multiple parties. To name all of them at this place would trespass the boundaries of this guideline. In addition to Offtaker, Sponsors, Lenders and the EPC, a number of other parties are essential to set up and implement a project finance transaction. Suppliers and product purchasers are also important participants. To name one of the most important after the ones mentioned above, the Operation and Maintenance Contract should ensure a reliable operation of the plant over the term of the agreements. Similar to the EPC, Banks expect from an O&M firm a seasoned track record in the respective technology, the necessary resources to set up the operations for CSP plants in characteristically remote or arid areas and the maintenance over the contractual period. As is the case with the construction of technology, O&M is key for the fulfilment of the energy yield production and thus a key element for the revenues of the project. Typical structures are either an external, third party O&M supplier or an O&M contract fulfilled by one of the Sponsors, who have a vital interest to maintain the plant availability at highest levels.

Further contractual parties include the Fuel supplier, in case the CSP plant has a co-firing option. Another important cost element and security element is the land contract that should cover the period of the PPA, perhaps including extension options. Land contracts can either be purchase or rental agreements, the important element again is that the duration matches the loan lifetime or moreover the lifetime of the PPA agreement.

N.2.4. Typical transaction setup and recourse variants

Each project finance transaction is a complex network of different contracts that are arranged around a project company. Contracts negotiated between the SPV and its counterparties all refer to either the pre-completion phase or the post-completion phase of the project. It is essential that the contract design encourages all parties to act in a way that is beneficial for the project objectives. On the other side, all counterparty's interests need to be equally considered [Gatti, 2012]. Depending on the risk profile of the project, the objectives of the sponsors as well as the negotiating positions and power of all involved parties, there are three main emanations of Project Finance in practice, non-recourse, limited recourse and full recourse. These distinctions in essence refer to the extent that Sponsors get involved into the transaction and provide guarantees to protect the lenders from any risks involved.

The purest financing of Project Finance is the so-called *non-recourse* alternative. *Non-recourse* means that lenders do not have any other security for the repayment of their loans (and the respective interest payments) than the project shares and assets itself. Sponsors can strictly limit their involvement to the amount of equity they provide (usually 20 to 30 % of overall sources/funds). Lenders rely on Project Cash Flows only. While this is the purest and textbook quoted idea of Project Finance, it rarely happens in reality. Only if Lenders are fully comfortable with the overall risk profile of the Project, the offtake structure, the construction firm, technology and resource risk, they would concede a purely *non recourse* structure. In addition, a helpful element to achieve non-recourse structures is a buyer's market constellation for borrowers, in which high competition leads banks to offer more aggressive structures in order to win the transaction. In case *non recourse* can be achieved, a big advantage is that no guarantees exceeding the equity are required. Hence, the community of sponsors finds these structures attractive because they do not have to enter providing guarantees to Lenders for risks they themselves find hard to manage.

The second, most frequent form is a so-called *limited recourse* Project Financing structure. In reality, this is the most practised form. Banks, assisted by their legal and technical advisors, find a certain number of risks that are not mitigated by the cobweb of contracts of the project. For instance, the PPA may stipulate penalties for a delayed start of operation and delivery of energy that are not exactly covered by the EPC contract, creating a mismatch in what should be a back to back structure in the contracts. The amount of the mismatch may be quantified and can lead to the renegotiation of the EPC contract. If that is not the case, Lenders will ask Sponsors to provide additional guarantees in case that this particular risk happens. Such additional Sponsor's guarantees dilute the "pure" *non-recourse* to a "limited recourse" structure: Sponsors obligations - or at least contingent obligations for the risk case - exceed their equity engagement. Since guarantees are costly - in particular the most required bank guarantees - and limit Sponsor's borrowing power, they come with an additional cost. If for construction only, these guarantees may be temporary but nonetheless they have the effect that Sponsors have additional risks, commitments and cost.

In a *full-recourse Project Financing*, the transaction may initially be set up in form of a Project Financing, with all mechanisms, contracts and securities. For a certain period - in most cases construction phase - however, Sponsors will provide Lenders with guarantees fully covering the debt service i.e., repayment of principal and interest. Such structures are helpful to facilitate financing if Lenders risk perception differs to a large extent from those of Sponsors. This can be the case for a new, innovative technology used, like a new storage mechanism or a new hybridisation with biomass or other fuels, a new collector type or the like. Until the Project is constructed and in operation (also called *Physical Completio*n), and fulfils certain agreed financial performance criteria (also called *Financial Completion*) the lenders are fully reliant on the Sponsor's creditworthiness. As soon as *Financial Completion* is reached, Sponsors are allowed to withdraw their extended guarantees and the structure enters into a *non recourse structure* for the remaining lifetime of the loans.

Since many CSP technologies are still far from being acknowledged as proven technologies with satisfactory track record, the strategy to provide full recourse to Lenders during construction can be successful in the sense that Lenders are willing to enter the financing of CSP technologies with innovative elements, they would otherwise not be willing to lend to. Likewise, *Full Recourse Project Financings* are limited to Sponsors that have sufficient liquidity and strength on their balance sheets to provide comfort to banks and equally have a strong interest to implement new technologies. Again, this is often the case for equipment suppliers or EPC who have a strong interest to create a showcase for a new technology and help it to enter onto commercial levels.

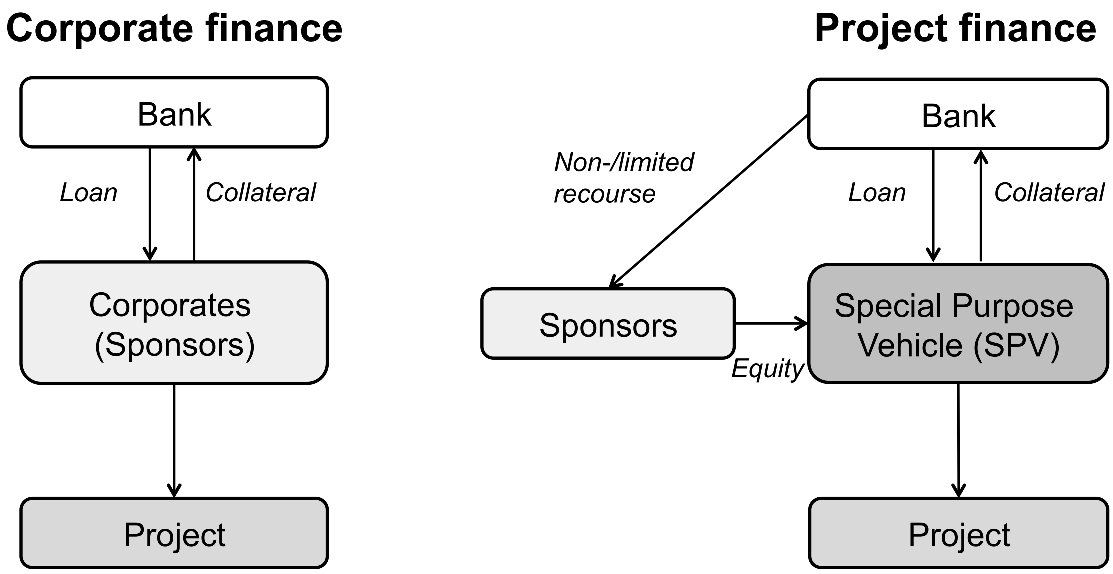


Figure N-2: Corporate finance and project finance

To distinguish between Project Finance and Corporate Finance, a few aspects may be useful: In Project Finance, a special company is being created that has only one single purpose of investment, in our case, to invest into the CSP plant. In Corporate Finance, the funds come from the balance sheet of a company, the company will use its funds for different types of investments. Lenders provide their loans to the corporation as an entity, not with a special purpose of the usage. While Lenders in Project Finance can only rely on project cash flows to repay their interest and debt, in Corporate Finance they can recur to the company's assets and other cash flows the company generates from other businesses or investments. A cross-collaterization between assets and cash flows of different investments of the corporation takes place. Corporate Financing is much easier to set up as the entire contractual structure is not required such as in project finance. On the other side, it also has disadvantages: by assuming the debt on the balance sheet, the leverage of the balance sheet goes up and deteriorates the company's rating and creditworthiness, i.e., its potential for further borrowing. By limiting its investments to equity only in non-recourse project financings, a company can realise multiple investments by borrowing on its balance sheet and investing the respective funds as equity contributions into project financing. This is typically the case for Independent Power Producers (IPP's), who by applying this strategy leverage their financing power, spreading their risks to multiple projects and share their risks with banks as well as co-investors, who may enter at different stages into the investment. In the Corporate Financing structure, such co-investments are more difficult to structure as co-investors need to also run the same financing approach, raise debt on their balance sheets to co-inject the capital into the projects. For financial co-investors, this is not preferable as it reduces their equity return significantly.
[Böttcher, 2009], [Gatti, 2012]

N.2.5. Contractual structure

It is utterly crucial and a prerequisite for successful negotiations of project financing that the intentions and objectives of the key participants are clear and well understood. It is obvious that the interests of

the different participants may not always be aligned. Therefore, the structuring of a project finance transaction is particularly challenging. The contrary interests and objectives have to be balanced in order to ensure that every key participant benefits from the project and is therefore committed to its success. Hence, the network of contracts around the project company has to ensure the conventional balancing of the opportunities and risks of all parties over the long term. The different contracts into which the SPV enters, with the parties committed to a project finance transaction, refer to the phases in the life cycle of a project. These phases are illustrated in the following figure and are also briefly described in this chapter. However, a focus will be set on contracts mainly relevant in the construction and operational phase of a project.
[Dewar, 2011], [Böttcher, 2013]

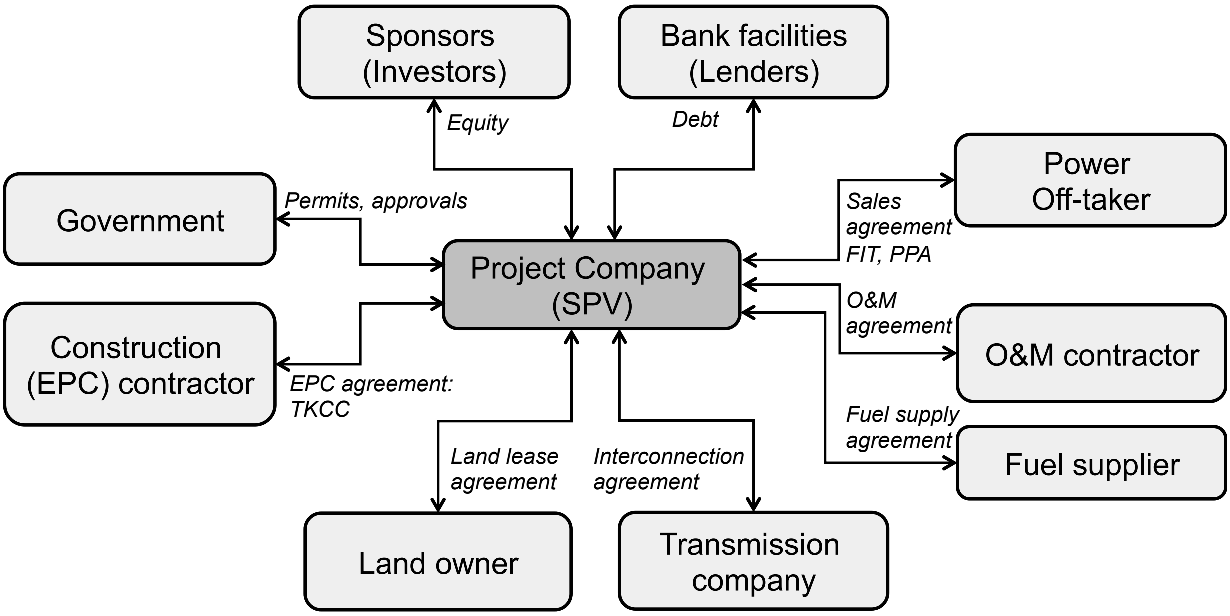


Figure N-3: Typical structure of project finance

Typically, the project implementation phase encompasses engineering, procurement and construction. Between these individual working sections and even within a single phase like construction, significant intersection issues can arise. A relatively small supplier or element of the overall construction can lead to significant delay or malfunction of the overall power plant. A small supplier would not be able to assume the risk and provide a guarantee that covers the risk in all consequences. For instance, a small but specialized sub-supplier does not deliver the specified element that is essential to the function of the turbine, leading to a significant delay in the commissioning of the overall power project. As a consequence, the project runs into delay of construction and into heavy penalties. Since the sub-supplier is small company, its financial capability to come up with the compensation is limited.
In order not to run into this type of risks, Lenders usually insist on a single contract that covers Engineering, Procurement and Construction (EPC) and provides a full wrap guarantee for the Construction of the project to happen on time, in budget and with the specified performance. In an EPC contract it is usually regulated that the contractor holds responsibility for costs resulting from a delayed

completion of the plant and equipment. Moreover, the contractor must guarantee certain performance levels (e.g. of the power plant), which have to be certified after completion. If the contractor does not meet the obligations a penalty fine is applicable.

After construction is completed, other contractual agreements pertaining to the operational phase come into play. If the sponsor does not operate the plant himself, it may enter into an Operations and Maintenance (O&M) agreement with the dedicated (third party) operator. An O&M agreement must contain clauses regulating that the sponsor is provided with a facility that operates as agreed upon performance levels and at fixed or at least at reasonably foreseeable costs.

In order to ensure revenue flows over the long term, it is essential to enter into long-term sales agreements with an off-taker. In the case of a power plant, there is often only a single off-taker, usually an industrial user or a local utility company that is under obligation to purchase a minimum of electrical power and pay a respective fee. In turn, the project company has to make a certain amount of power available per day. This Power Purchase Agreement, as mentioned above in section N.2.2.1, forms the basis of the overall investment and needs to be negotiated at an early stage of the project development. The manner by which the PPA is stipulated essentially determines the bankability of the project. Most off-take agreements are set up on a take-or-pay basis. In such an agreement, the off-taker is obliged to take off a defined volume of electricity daily. In case it cannot take off the volume agreed upon, it has to pay anyway. A Power Purchase Agreement (PPA) price agreed upon could be either at a base rate escalated with the inflation rate, or at a levelized flat rate for the entire duration of the PPA. In the levelized case, Sponsors would usually anticipate the inflation rate of the currency in which the contract is denominated and include it into the tariff calculations. For the indexed version, as the tariff is adjusted for whatever inflation rate the currency experiences, this would not be necessary, so just a base rate for the initial tariff in year 1 of operations needs to be fixed. Economics for Sponsors, i.e., equity returns should lead to similar results. As a consequence, LCOEs or the flat tariff is higher than the usual inflation rate of a country. An indexed initial tariff is always lower and compared better to a tariff of conventional fossil fuel plants, for which, the indexation is not only to inflation rates but also to fuel prices, as is the rule.

If the project company enters into a PPA agreement, any electricity market risk passes on to the off-taker. Hence, the off-taker’s creditworthiness is key to Lenders. In this context, the question whether the off-taker is a (private) industrial or a public off-taker is crucial. If the off-taker is a public utility company, this can be beneficial since the off-taker’s credit-risk may then be perceived similar to sovereign risk, especially if the utility offtake contract is backed by a government guarantee, such as for instance in South African REIPPPP program, where the ESKOM obligations are backed by guarantees of the national Treasury Department.

In fossil fueled power projects, power purchase agreements (PPA) are linked with a fuel supply agreement (FSA), and any increases in fuel costs can be passed through to the offtaker in the PPA. The off-taker takes the risk of fuel price escalation. In the case of CSP plants the relevance of FSAs is limited to co-firing options, where the boiler of the plant can be additionally heated with gas, coal or biomass etc. On the main "fuel", solar irradiation from the sun no price escalation needs to be expected. The same is true for raw material supply agreements (RMSA), which have certain significance for conventional power plants (e.g. coal) or biomass, but are of minor relevance in the case of solar power plants.

Additional contracts with additional parties may be necessary, such as insurance agreements, land lease agreements or concessions. In fact, a typical project financing can involve 15 different parties conjoined through 40 or more contractual agreements. Larger deals can even have a considerably higher number of contractual agreements, due to which project finance is sometimes also called contract finance. While in the context of this study we only focus on the project agreements that rule the contractual structure between the constructing and operating parties, there is a second-tier contractual structure on top that rules the financing agreements. Among these, we find, for instance, a Common Terms Agreement that rules the overall Project Financing structure, security agreements, account agreements that rule the waterfall (see section N.3.1 below), direct agreements that enable banks to step into the main project agreements in case the company runs into a default situation, intercreditor agreements that rule lender's right in respect to access of collateral and the relationship between lenders and their hierarchy, agent agreements on different roles such as security agent, syndication agent, insurance agent, and so on. In short, Project Financing is an El Dorado for lawyers.

[Hoffman, 2007], [Gatti, 2012], [Esty, 2003]

N.2.6. Rationale

Considering the required extensive contracting in project finance transactions one has to question the reasonableness of using project financing rather than corporate finance in order to implement a certain project. Without doubt, it is much more time consuming to set up a project company and transaction costs are essentially higher in project financing when compared to corporate financing. For infrastructure projects, the total transaction costs are on average between 3% and 5% of the total investment. For smaller, unique or pilot projects it can be even up to 10% of the amount invested. However, under the assumption that a project finance entity has a finite life and the respective (free) cash flow generated will be paid directly to the investors, there are a number of motives to choose project finance rather than corporate financing.

Since investors have the right to control reinvestment of the free cash flow, the agency costs of free cash flow can be diminished. Moreover, project finance can mitigate the opportunity costs of underinvestment by sponsoring companies, which can arise when the company has risky outstanding debt and is therefore not willing or in the position to invest in a certain project on their balance sheet. Therefore, the possibility to arrange borrowing for a project, which will favor the sponsors without impairing their balance sheet or affecting their credit standing, is one of the major benefits of project financing.

Additionally, a company might be reluctant to invest in a high-risk project due to potentially arising distress costs in case the project fails. However, through extensive risk sharing and allocation among all participants in a project financing structure, the potential collateral damage that a risky project can impose to the sponsoring company can be reduced. Hence, the project company can create creditworthiness in cases where it is hardly to be achieved or where a different credit standing of the sponsor was required if the corporate loan logic were to be assumed. In other words, the SPV is a means

created to enable financing with no or limited recourse. Furthermore, through the risk allocation in project financing, a debt-to-equity ratio can be achieved that was not possible in the case of corporate financing. This leveraging has a significant (positive) influence on the internal rate of return (IRR) for sponsors. The higher degree of leverage produces a tax shield benefit for the sponsor that is adequate to offset the higher transaction costs as elaborated above and the yield premium that lenders will require in case of a project financing. Hence, project finance reduces the net costs of financing the assets of a project, compared to a direct corporate financing.
[Esty, 2003], [Gatti, 2012], [Finnerty, 2013], [Nevitt, 2000], [Bodnar, 1996]

Table N-1: Comparison of project finance vs. corporate finance

Dimension	Project finance	Corporate finance
Financing vehicle	Single-purpose entity	Multi-purpose organization
Type of capital	Finite - time horizon matches life of project	Permanent - an indefinite time horizon for equity
Dividend policy and reinvestment decisions	Fixed dividend policy - immediate payout; no reinvestment allowed	Corporate management makes decisions autonomous from investors and creditors
Capital investment decisions	Highly transparent to creditors	Opaque to creditors
Financial structures	Highly-tailored structures which cannot generally be re-used	Easily duplicated; common forms
Transaction costs for financing	Relatively higher costs due to documentation and longer gestation period	Low costs due to competition from providers, routinized mechanisms and short turnaround time
Size of financings	Might require critical mass to cover high transaction costs	Flexible
Basis for credit evaluation	Technical and economic feasibility; focus on project's assets, cash flow and contractual arrangements	Overall financial health of corporate entity; focus on balance sheet and cashflow
Cost of capital	Relatively higher	Relatively lower
Investor/lender base	Typically smaller group; limited secondary markets	Typically broader participation; deep secondary markets
Risk sharing	Sharing of risk and allocation among all project participants; higher debt-to-equity ratio possible	higher collateral damage to corporate; can affect credit standing of corporate

N.3. Approaches of financial evaluation

In a project transaction many parties can be committed to the project as described in chapter N.2. The key participants may look at the project from different perspectives according to their individual interests. Hence, one can assume that for the evaluation of the financial viability of a project there is no single approach that equally fulfils the expectations of all the involved parties. Each party may use different indicators to assess whether a project is financially feasible. At the end, the various interests have to be harmonized in a way that all parties are satisfied. However, the individual success of every involved party is strongly correlated with the success and financial viability of the project.

N.3.1. Cash Flow Waterfall

Before having a closer look on the interests of the project parties, a short description of the most important financial parameters used in the clarification of each project participant is given hereunder. In order to understand the idea of Project Finance as Cash Flow Based lending, the image of the Cash Flow Waterfall is essential to understand the fundamental structure of each project financing. The Cash Flow Waterfall rules the hierarchy of the "Cash Flow Food Chain". From the operative revenues of a solar power project, there is a clear ruling of which cost elements are being covered, and in which order. First, operative cost and maintenance cost are paid, together with taxes and insurance, since without these, the plant would stop operating and generating cash flow. The remaining amount is called the Cash Flow Available for Debt Service (CFADS). CFADS is used to cover first senior debt, and then possibly junior debt such as subordinated debt, in that order. Any remaining amount of Cash Flow would then be, after all reserve accounts are filled to the satisfaction of lenders, be available for the distribution to sponsors as dividends (see Figure N-4).

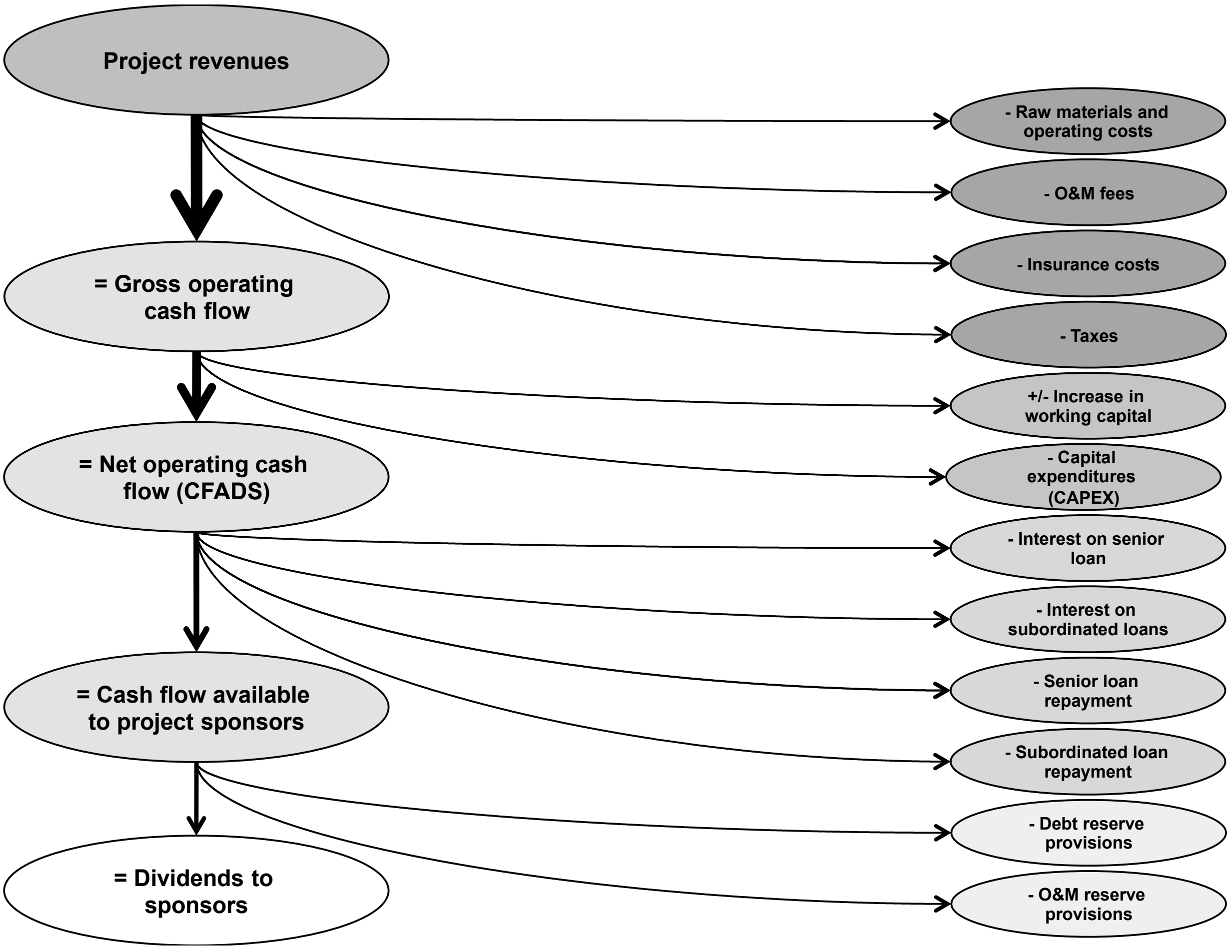


Figure N-4: Summarizing waterfall structure from sale revenues to sponsor dividends

[Gatti, 2012], [Yescombe, 2013]

N.3.2. Financial basic parameters

The **net present value (NPV)** is used to analyse the profitability of a future investment or project. It is defined as the difference of the present value of cash inflows or the investment and the present value of the initial costs, hence:

$$NPV = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_0 \tag{N.1}$$

With:

NPV	net present value, in ¤ (currency)
t	number of time period, unitless
T	total number of time periods, unitless
C_t	cash flow during the period t, in ¤ (currency)
r	discount rate, unitless
C_0	initial investment cost, in ¤ (currency)

The **internal rate of return (IRR)** is defined as the discount rate at which the net present value of all cash returns to an investment or project over the lifetime of such investment equal zero. In other words, at this rate the present value of all positive future cash flows and benefits is equal to the initial investment costs and negative cash flows (i.e. investments). For power projects, the two most important ones are the Project Internal Rate of Return (**Project IRR**) and the Equity Internal Rate of Return (**Equity IRR**). The Project IRR indicates the interest the project generates on the overall capital and the Equity IRR indicates the return on the transaction for sponsors.
The higher the IRR, the more desirable to undertake is a project. An investment with an IRR less than the discount rate should be rejected. The definition of IRR can be expressed as follows:

$$NPV = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_0 = 0 \tag{N.2}$$

with:

NPV	net present value, in ¤ (currency)
t	number of time period, unitless
T	total number of time periods, unitless
C_t	cash flow during the period t, in ¤ (currency)
r	return, IRR, unitless
C_0	initial investment cost, in ¤ (currency)

The **debt ratio** (also called leverage (am.) or gearing (brit.)) illustrates the proportion of the company's assets that are financed by debt and thereby measures the extent of its leverage. Generally, a higher debt ratio indicates a more leveraged company with a greater financial risk, but debt ratios vary widely across different industry sectors and businesses. The debt ratio is calculated by the following formula:

$$DR = \frac{Total\ debt}{Total\ assets} \tag{N.3}$$

with:

DR	debt ratio, unitless or in %

Another parameter of a company's financial statement that is closely related to leveraging is the **debt-to-equity ratio** or **D/E ratio**. Similar to the debt ratio, it varies widely depending on the industry sector. Indicating the proportions of equity and debt used by a company to finance its assets, the ratio is calculated as follows:

$$Debt - to - equity\ ratio = \frac{Total\ debt}{Shareholders\ equity} \tag{N.4}$$

For calculating the **weighted average cost of capital (WACC)**, the categories of a company's capital are weighted proportionately. The possible sources of capital include equity, common and preferred stocks, bonds and other long-term debt. The WACC can be determined using the following formula.

$$WACC = \frac{E}{E+D} * r_E + \frac{D}{E+D} * r_D * (1 - T_C) \tag{N.5}$$

with:

$WACC$	weighted average cost of capital, unitless or in %
E	present value of equity, in ¤ (currency)
D	present value of debt, in ¤ (currency)
r_E	cost of equity, unitless or in %
r_D	cost of debt, unitless or in %
T_C	corporate tax rate, unitless or in %

The **operating cash flow (OCF)** is a measure for the amount of cash generated by a company's daily business operations. It is defined as earnings before taxes and depreciation, minus taxes. The OCF may become negative over short periods, but should usually be positive as it indicates if a company can generate sufficient positive cash flow to maintain and grow its operations or whether it will require external financing.

The **debt service coverage ratio (DSCR)** illustrates the relationship between the cash flow available for debt service (CFADS) and payments on principle and interest for each period (typically semi-annual). The DSCR varies with each period of the project lifetime. Typically, the lowest DSCR values can be expected at the beginning of a project.
A project has enough income to meet debt obligations with a DSCR of 1. However, on top, banks require a buffer, so that a typical min. DSCR values ranges from 1.2 to 1.4, depending on the Lender's risk perception of a project cash flow. The calculation can be done as follows:

$$DSCR = \frac{Cash\ Flow\ Available\ for\ Debt\ Service\ (CFADS)}{Total\ debt\ service} \tag{N.6}$$

with:

$DSCR$	debt service coverage ratio, unitless or in %

The **loan life coverage ratio (LLCR)** is, similar to the DSCR, a measure of a company's ability to pay an outstanding loan, but taking into account the whole tenor of the project, respectively the senior debt. The term "NPV of money available for debt repayment" may be also referred to as "net operating cash flow" or "cash flow available for debt service" (CFADS). The LLCR can be determined as follows.

$$LLCR = \frac{NPV\ of\ money\ available\ for\ debt\ repayment}{senior\ debts} \tag{N.7}$$

with:

$LLCR$	loan life coverage ratio, unitless or in %

N.3.3. Project company's perspective

Main investors (or Sponsors) are usually the ones who initiate and care for implementation of a project, their individual interest is of essential importance. For Sponsors, the key figure is usually the return on their investment (mainly equity). To measure economics, a range of figures can be used. For solar projects, however, the two most important ones are the Project Internal Rate of Return (Project IRR) and the Equity Internal Rate of Return (Equity IRR). The Project IRR indicates the interest the project generates on the overall capital. This figure disregards any financing scheme or the sources of such capital, and hence is a measure for the economic strength of the overall project. Now if – as usual - the cost of debt (interest rate) is lower than the Project IRR, and the Lenders would be willing to provide a portion of debt to the overall sourcing of the project, there are two principle effects for equity investors: first, equity investors or Sponsors only have to provide the balance of the total funding, for example a 30% of total funds. Second, since the debt costs are lower than the Project IRR, the remaining portion of Project IRR Cash Flow that is not needed to cover principle, and interest of Lenders can be used to pay dividends. As a consequence, the Equity IRR is higher than the Project IRR. This is called the Leverage Effect. It is one of the main reasons for the application of project (and other structured-) financing and helps to optimize the capital structure.

The IRR can be defined as the interest rate that makes the net present value (NPV) of all cash flow equal to zero. The NPV is the present value (the value at the date of evaluation) of all future cash flow minus the present value of the costs of the project. Hence the IRR equals the present value of a project's negative and the present value of its positive operating cash flow and gives an initial view on the economics and financial viability of the project. In a project finance transaction, the negative operating cash flows are the costs incurred during the construction phase, whereas the positive operating cash flow is generated throughout the operating phase.

Consequently, the following formula can be derived:

$$\sum_{t=0}^{COD} \frac{OCF_t}{\left(1+IRR_p\right)^t} = \sum_{t=COD}^{n} \frac{OCF_t}{\left(1+IRR_p\right)^t} \qquad \text{(N.8)}$$

with:

COD	commercial operating date, date
n	last year of project's life, date
OCF_t	operating cash flow in year t, in ¤ (currency)
IRR_p	internal rate of return for the SPV, in ¤ (currency)

[Gatti, 2012], [Ross, 2013]

N.3.4. Investors' perspective

Since Sponsors are usually the ones who initiate and care for implementation of a project, their individual interest is of essential importance. Sponsors' return on their investment is usually measured with the IRR. Most Sponsors would initially calculate the expected Project IRR without any external financing applied (i.e., on an unlevered basis) to get an initial feeling for overall project economics. In a second step, Sponsors would then estimate a financing strategy that includes the quantity of debt, its structure and cost to calculate their return after financing. This is the equity return that derives from applying debt finance, considers a respective amount of equity and the cash flow that is being disbursed to equity investors after debt has been served. Usually, as debt cost should be below the Project IRR, a certain amount of debt financing increases the remaining cash flow to shareholders, so that the equity IRR should be higher than the Project IRR.

By applying debt finance, a project can achieve several types of improvements for the Equity Investors: first, the amount of debt applicable limits Sponsor's equity investment to the equity portion, e.g. typically a 20% to 30% of the overall investment. Second, debt financing can create the Leverage Effect, lifting equity returns above the Project IRR, provided that financing cost is below the Project IRR. Third, debt usually reduces the tax burden as interest payments reduce the project profit and thus the taxable basis.

For Sponsors, an investment is attractive if the Equity IRR exceeds the so-called Hurdle Rate. A Hurdle rate is a minimum return rate for the Investor that is required by the project in order to be attractive for investment. It is usually composed by Sponsor's own capital cost (measured in Sponsor's Weighted Average Cost of Capital or WACC), plus an adequate margin or spread for the project, that should reflect the project risk as well as the risk of the country the project is located in.

N.3.5. Lenders’ perspective

Lender's prime motivation is to earn an adequate return on investment on the debt that underlies the loans they provide to project financing. Hence, lender's IRR calculation differs from the way Sponsors calculate their IRRs. In the Lenders case, negative cash flows are drawdowns on funds, whereas principal and interest repayments, as well as fees represent positive cash flows for the lenders. Lenders also need to evaluate whether the return they can expect is consistent with the degree of risk inherent to the project, which they are exposed to. The amount of equity banks need to calculate for the loans provided depends on the type of loans - in this case, project financing - and the risks entered into. On a global basis, the Basle III rules apply also to lenders under project financing schemes. Basle III rules determine the amount of underlying equity the banks have to calculate for their loans.

From a risk point of view, Lenders’ main concern is that the project generates sufficient funds at all times to service debt. In other words, in addition to the potential return, lenders also evaluate the financial sustainability of a project. In order to assess whether sufficient debt service for every period throughout the loan tenor will be available, lenders use cover ratios as indicators of financial sustainability.

The Debt Service Cover Ratio (DSCR) is one of the most important figures as it illustrates the relationship between the cash flow available for debt service (CFADS) and payments on principal and interest for each period. The ratio is an indicator of the projects ability to cover debt service in any given period of operation and is calculated on a periodical basis, for each repayment period, e.g. quarterly or semi-annually. In order to sufficiently serve debt at all times, a theoretical DSCR of 1.0 would be sufficient. In such case, the entire amount of Cash Flow remaining after O&M cost and taxes would be used to serve

debt, not leaving any cash for dividends to shareholders. For two reasons, the banks are looking for higher amounts in this ratio - first, they want Sponsors to stay committed to the project over the loan lifetime, which would not be the case if Sponsors did not earn dividends and would only have losses for the project. Second, banks require a certain buffer to avoid that even small risks would deteriorate the cash flow and endanger the debt service capability of the Project. The required dimension of what Banks consider to be an acceptable DSCR depends on the risk inhered in the initiative. In the power sector, where long-term off-take agreements can be implemented, lenders usually do accept a minimum DSCR of around 1,3. For Photovoltaic in stable environments and project structures like Feed in tariffs, for example, banks may allow the minimum DSCR to go down to 1.1, allowing a significant leverage in the Project. For significant project risks, as in CSP or in merchant environments (see chapter N.2.2.1), the required minimum DSCR may be required at 1.4, requiring much more equity in the project to give Lenders comfort. A higher amount of equity lowers the project leverage and hence the debt service, improving the DSCR to required minimum levels. On the other hand, inexpensive debt is being substituted by more expensive equity, increasing the capital cost.
Another cover ratio frequently used by lenders is the loan life cover ratio (LLCR). In contrast to the DSCR, the LLCR is not calculated on an annual basis but for the entire lifetime of the loans. The LLCR expresses the relationship between the sum of present values of future cash flows available for debt service and the outstanding debt at the time of assessment [Gatti, 2012]. Hence, the LLCR does not quantify the financial robustness of a project in any given year, but it shows the overall robustness of the project over the considered lifetime. For instance, if the DSCR in a particular year is below the acceptable minimum value, perhaps due to a temporary effect, the LLCR can still demonstrate overall strong values of CFADS for debt service. This signalises to lenders and Sponsors that there is an opportunity to consider a rescheduling of repayment schedules to iron out the weakness of Cash Flow in a single time sequence. To give an example: for a CSP project, it would be typical that project availabilities and thus cash flow in the first one or two years are below optimum values. During the first year or two, technical and operational issues still need to be fixed, so that certain periodical energy performance and with it cash flow generation may still move below average levels. If Lenders concede a one or two years grace period, where interest is being paid but not the principal yet, the denominator, i.e., the debt service payments required in this period are lower so the DSCR is within acceptable levels. For Lender's return calculations however, this leads to an increase of average loan lifetimes as the repayment is slightly shifting backwards, having an effect on their return calculations.
[Böttcher, 2013]

N.3.6. EPC's perspective

The EPC contractor is usually responsible for building the project, for example to construct a power plant on the basis of a turn-key construction contract (TKCC) as elaborated in chapter N.2.5. The EPC is therefore the party to assume the completion risk, and guarantee certain performance levels of the plant after completion. Hence, besides the costs for material, engineering, construction and the profit margin the EPC contractor asks for, the price for the TKCC will also include an additional risk margin. The contractor will aspire not to assume any risk for which he is not adequately compensated. By implication, it is clear that the EPC contractor will seek to maximize the price for the TKCC, since his assessment of the financial feasibility and convenience will depend on the TKCC price and subsequently on the margin he can earn. The prices for the construction, i.e. the costs that arise to construct the project, form a major part of the required financing and has one of the strongest impacts on project economics. Since in the CSP industry, several successful EPC companies are equally developers and IPPs, they usually carefully allocate their returns between the individual business models involved: while the developer earns his reward usually at Financial Closing and start of Construction, an EPC earns his margins during construction phase. In the CSP sector, this is mostly a 2 year period. After that period, the EPC should have finalized the construction works in most cases, and recuperated his expenses and profit margin. The IPP though invests over a long term, earning his returns by dividend payments from the SPV, after all other costs are covered. While it can take five to seven years to pay off the investment cost, there will be another 10 years necessary to achieve the planned return on equity for the IPP investor, so his involvement is significantly longer than the EPC or the Developer's.

In the PV industry, the huge price decrease during the last decade heavily contributed to the competitiveness of solar and wind in many power markets and applications world wide. Most of this has happened because of increased capacities and increased competition among suppliers and EPCs. In CSP, unfortunately, we could not observe a similar development. To the contrary, large, capable players like Siemens, Areva and ABB entered the playing field, teamed up with or invested into technology firms and thus were exactly the solution that Lenders were looking for, with strong balance sheets, strong track record in complex construction management and performance, but after a few years all of the above decided to pull out again. As a consequence, the EPC field today is dominated by Spanish construction firms who have built track record and expertise in CSP and, more recently, US developers and constructors such as Solar Reserve or Bright Source. While this is still an oligopoly, it is not sufficient to create sufficient competition among EPC firms to exercise pressure on equipment prices, similar to what has happened in the PV and Wind sector.

[Dewar, 2011].

N.4. Criteria determining the success

The question whether a project should be implemented and consequently financed or not, is closely linked to the feasibility and the economic viability of the project. It is obvious that the project must be generally feasible in order to convince lenders and other key parties to participate. In project financing it is essential to diligently analyze and evaluate potential risks. Only if certain risks are identified and considered, can appropriate measures to manage and mitigate the risks be adopted.

N.4.1. Feasibility and economic viability

N.4.1.1. Conceptual phase

This is the initial identification of an opportunity: The idea of a possible business case forms the beginning. The first document can be a Letter of Intent, a Memorandum of Understanding or, for example, a Cooperation Agreement that might include certain exclusivity provisions between developer and offtaker. It should include the general understanding of both parties, the business case, and the first project approach. In case of an industrial offtaker, the cooperation agreement shall contain a section that gives the developer the exclusivity to start negotiation on a PPA contract for a certain time. In case a general feed-in tariff scheme is applicable within the country, such an agreement might not be necessary.

N.4.1.2. Pre-feasibility

This is the first assessment of the potential project. It is a high-level review of the main aspects including fatal flaw and red-flag analysis. The study undertaken at the pre-feasibility stage should include assessment of:

- the project site and boundary area;
- a conceptual design of the project, including an estimation of installed capacity;
- the approximate costs for development, construction and operation of the project and predicted revenue;
- the estimated energy yield;
- the grid connection or offtaker – cost and likelihood of achieving connection; and
- permitting requirements and the likelihood of achieving these.

Fatal flaw and red flags could appear at any stage of the project, such as:

- Site: topography not suitable for CSP technology, soil
- conditions could lead to prohibitively high CAPEX;
- Environment: archaeologically significant remains;
- Solar resource: not sufficient due to local effects from river, lake, mountains, shadowing etc.;
- Energy yield insufficient;
- Grid capacity at substation insufficient and / or too costly to upgrade;
- Water for cooling and/or cleaning not available and/or too expensive;
- Economics: cash flow below threshold to be feasible or IRR too low to trespass hurdle rates or
- Permitting: difficult/impossible to get a specific permit/license by legal means.

Finally, the decision whether the project is feasible or not is based on several criteria and parameters and differs from country to country and project to project. For further details see Appendix L - Local Site Conditions.

N.4.1.3. Feasibility

The feasibility analysis continues seamlessly from where the pre-feasibility analysis concludes. The aim of the feasibility analysis is to obtain more detailed information on a project that has a high chance of realization, and by doing so clarify most of its aspects and address most of the concerns associated with it. An abundance of data, which may have been taken as qualified assumptions or on the basis of educated guesses, will need to be verified and made more detailed during the course of this analysis. For the feasibility analysis, specialist studies will be required: a solar/wind measurement campaign and resource assessment, the use of these measurements in combination with long- term satellite time-series and other available data, site assessment, engineering for technical concept and energy yield modelling, financial modelling, etc. Many of these processes address the results of the higher-level analyses produced during the prefeasibility phase once again, but at this point are much more detailed and more granular.

Just as during the pre-feasibility stage, the process is not straightforward: Results in one area could influence conclusions drawn from results in another area to a certain extent. The whole approach remains iterative, working through a continuous feedback loop. Through several rounds of iteration, the conclusions will be refined as shown in Figure 3.2 for a CSP project example.

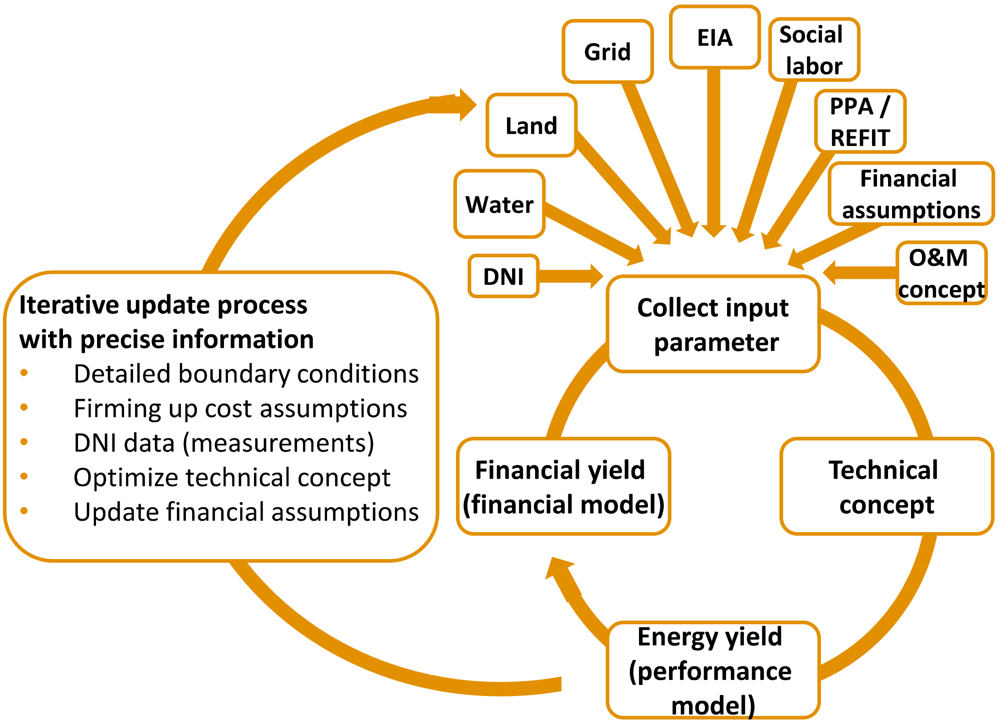


Figure N-5: Process from pre-feasibility to a bankable project through iteration

The economic viability of a project is essential to determine whether investors take a positive decision or not to implement it. It is obvious that the project initiative must be generally feasible in order to convince lenders and other key parties to participate in the project. Usually, upfront the viability of a project is assessed in steps, the first of which are the pre-feasibility and the feasibility analyses.

N.4.2. Risk analysis and management

In a CSP project financing, it is essential to diligently analyse and evaluate potential risks. Only if certain risks are identified and considered, can the appropriate measures to manage and mitigate the risks be adopted. In the context of this chapter, risk shall be deemed as the negative deviation of a factor from a targeted value. In a project financing, particularly those factors influencing the cash flow are of great significance.

There are different approaches for risk breakdown models. In order to cluster the risks according to their type, we can outline the following categories:

1. **Construction Risks**
   a) Cost overrun
   b) Time overrun
   c) Technical Performance
2. **Market and Operational Risks**
   a) Sales and Revenue Risk

b) Energy Yield Risk - Solar Resource Risk

c) Operative Cost Risk

d) Competition Risk

3. **Financial and Credit Risks**

a) Interest Rate Risk

b) Foreign Exchange Rate Risk (FX Risk)

c) Inflation Risk

4. **Political Risks**

a) Expropriation

b) Change in Law

c) Convertibility Risk

5. **Force Majeure Risk**

These five clusters describe the main risk types and in project financing, they usually have multiple subgroups and sub-risks that need to be evaluated, allocated in the project agreements and project financing contracts and addressed in order to avoid any risk event that is incurable. Most risks can be sensitised in the financial model. A downside of revenues for a construction failure of technical malfunction or a solar irradiation overestimation, for instance, can be run in the financial model and the effect on Cash Flow, debt figures as well as on equity figures can be exactly measured. Other risks may lead to a more binary impact, such as an expropriation of the project (a nationalization), that takes away all property rights and prohibits the further ownership and operation. An equal effect may take place if a national offtaker is being advised by the local government not to pay its dues under the PPA contract. Another risk would be the scarcity of water that is needed for cooling, or a change in the interest rate during the lifetime of the loans. In order to see how most of the aforementioned risk categories would typically be addressed and allocated, we use a risk matrix in the following to show a typical risk analysis and structure.

All threats during the operational phase that disrupt or stop the production can be pooled as operational and management risk. Causes for an operational and management risk include poor planning, organization or execution of operational procedures. Hence, the experience of the management personnel is crucial. Possible limitations of production have a negative impact on the output quantity and consequently on generated income.

The supply risk can be described as the threat that the project will not be provided with all the raw materials needed for the production process. In the case of CSP projects the delivery risk is of less significance since most of the primary raw material (the solar irradiation) is free of charge. However, CSP plants also need water for cooling and cleaning, as well as supply of power for operation, where a shortfall can lead to underperformance or even a stop in production.

Negative deviations regarding price and volume of the output compared to the respective assumptions can be described as the market risk. Losses, caused by too optimistically calculated sales volumes or wrong assessment of selling prices, can jeopardize cash flow and subsequently the debt repayment capability of the project.

In the case of a CSP project, the resource risk can be described as the threat that solar irradiation (the resource) does not meet with respective assumptions. If less solar irradiation is available this may cause lower income, possibly during the entire project lifetime, so this is an extremely sensitive risk aspect. While seasoned solar resource assessments and energy yield estimations can provide a high element of certainty, an emanating risk immediately leads banks to recourse to Sponsors in order to fix the issues, mostly by additional investments in equipment in order to boost energy yield.

Table N-2: Risk matrix with selection of risks typical to CSP projects

Category of Risk	Risk manifestation event	Allocated to Party	Mitigation
Construction risk	Cost overrun	EPC-Contractor	Fixed price, turn-key contract, experienced contractor
	Time overrun	EPC-Contractor	Fixed completion (Date certain) in EPC contract
	Failure to satisfy specified performance	EPC-Contractor	Performance guarantees in TKCC (penalty applicable)
Technological/ Functional risk	Relatively new technology	Sponsor	Full recourse to sponsors until completion
Operational & Management risk	Disruption in production, malperformance	Operator	O&M contract with incentives and penalties; Operator = Sponsor, incentivized by dividend shortfalls or overperformance
	higher cost than scheduled for instance, migrating sand dunes or higher cost for cleaning	Operator, Sponsors	Contingent equity (guarantees) to come up for curing measures (e.g. sand dune walls)
Supply risk	e.g. fuel price escalation or non delivery of co-firing fuels (gas, LPG, biomass)	Fuel supplier	Long-term supplier contract at defined costs, quantities and quality, penalties exceed market price mismatch to fuel contract OR pass through of fuel cost to offtaker
Market risk	Lower sales volume	Power off-taker	Long-term PPA with defined purchase volume OR merchant plant risk, in which case higher equity in project as buffer to banks
	Lower prices	Power off-taker	Long-term PPA with defined prices or merchant plant risk, in which case higher equity percentage as buffer to Lenders
Energy Yield Risk and Solar Resource risk	Less solar irradiation than predicted	Sponsors	Contingent equity injections from Sponsors, that could be used e.g. to enlarge solar field
Financial risk	FX risk	Sponsors/ Lenders	Hedging, local currency funding in debt and equity
	Interest rate risk increases during lifetime of loans	Sponsors	Hedging - mostly mandatory in Project Finance
	Inflation risk	Off-taker	PPA tariff escalated with inflation rate, or anticipation of inflaction rate over PPA lifetime (LCOE approach)
		Sponsor	In fixed PPA tariff, risk falls to dividends/equity
Political & Sovereign risk	Changes in law, expropriation	Political Risk Insurance	Political Risk Insurance like OPIC, DIA, Export Credit Agencies (Hermes etc.) and/or Multilateral Development Agency involved (World Bank, Asian Development Bank et.)
	Restricted transfer of Dividends	Sponsors	Political Risk Insurance for Equity
	Expropriation	Sponsors	Political Risk Insurance for Equity
Force Majeure	Earthquake, Tsunami, Thunderstorm, Sandstorms.	Insurance or PPA Offtaker	Force Majeure Insurance or regulation/stipulation in PPA

Losses caused through variations in exchange rate, interest rate or through inflation can be pooled as financial risks. Some of these can be hedged, such as most interest rates, others need to be considered upfront in the overall contractual structure between the PPA and its denomination in currency and the financial sources in either the same or another currency. Any mismatch may have a severe impact on project economics.

All actions taken by the host country or its authorities that have a negative impact on the project can by described as political and sovereign risks. Examples include, changes of law, restrictions regarding transfer of means and expropriation.

The force majeure risk includes all risks that cannot be influenced by any of the project participants. There is no general meaning of force majeure but it has to be clearly defined and contracted specifically for the project, by the project parties. Usually all kinds of natural events fall hereunder like thunderstorms, sand storms, earthquakes, volcano eruptions, tsunamis etc., sometimes also civil unrest, strike and war, depending upon the definition in the project financing contracts. A mitigation is always difficult, but can be regulated to a certain extent in the PPA ("deemed delivery" clauses) or via insurance, as and if available and affordable.

[Böttcher, 2012], [Dewar, 2011], [Hoffman, 2007], [Haskell, 2005], [Gatti, 2012]

N.4.3. Issues for CSP project finance

In today's renewable energy market environment, subsidies for renewables are clearly phasing out. Electricity tariffs for solar PV and Wind are entering into a new, clearly commercial field, where they compete with their conventional, often fossil fuel power generation alternatives. And they are interrelated. CSP in particular and PV in general are highly applicable in most countries on the global Sunbelt. On the same page, most of these countries will not be in the position to afford nor offer significant subsidies for renewable power, because many of them are lower income countries or have competitive electricity markets. Globally, willingness to provide subsidies is low and decreasing. To CSP as well as in solar PV, Capital expenditure (CAPEX) is the principal cost element of power, similar to Wind. In order to achieve competitiveness, long debt tenors, moderate interest rates and high leverages are needed on the financing side to create a viable business case. On the other side, the CAPEX themselves and here in particular the system cost are a key driver and possibly a more quick win than the equipment industry would find easy to admit. If we want to know the key issues of CSP project finance, we need to understand both sides, financing and system cost, how these factors are being suboptimal and how they could be improved.

In order to provide favorable financing terms such as low interest loans, high leverages and long repayment periods, banks need to be fully confident that the technology delivers energy as predicted, over a long term and at competitive terms. If a PPA tariff is not within usual market pricing levels ("in the money"), banks suspect that such PPA sooner or later will be challenged, either by political (next government) or via arbitration lawsuits, because the offtaking party realises the high amount of subsidy they are paying.

Today, a number of issues related to project financing hamper a stronger scaling up of CSP. First, certainly among the main obstacles is the technological immaturity of CSP. Compared to wind and solar PV, CSP does not have a long track record with the equipment that is being applied today. Some technologies, such as Parabolic Trough do have long periods of successful technical operation, however even these plants installed today very often have elements of technological innovation, which is an expression of the relatively young technology: storage systems, hybridization with fossil fuels, new cooling elements, new collectors etc. Innovation, as necessary as it is in a developing industry, makes project-financing banks shy away and reluctant.

As a consequence, the perceived risk of CSP plants is still relatively high among lenders and other participants. Since every party will seek to receive an adequate compensation for the assumed risk, it is clear that financing costs may be less favorable when compared to mature technologies that have already been proven on a large scale [Hoffman, 2007].

Second, the low competition amongst contractors. When the commercial CSP projects currently under construction are analysed, it reveals that from approximately $2.008*10^9$ W of cumulative global CSP capacity under construction, only 4 EPC contractors share a cumulative capacity of $1.612*10^9$ W [NREL, 2013]. From these figures it can be concluded, that only very few bankable EPC contractors with sufficient experience in CSP projects to assume the completion risk, are currently active on the global CSP market. The fact that major EPC companies continue to exit the CSP business, as Siemens did in 2012 [Siemens, 2012], ABB in 2013 or just recently the French nuclear and renewable giant Areva [CSP-World, 2014], even amplifies this issue. The reduced competition among experienced and bankable EPCs keeps the specific costs on a high level, compared to both conventional and other renewable power plants. This again is a key obstacle to the upscaling of CSP, since the high prices prevent CSP from entering into new, more ample market segments in a global USD 250 bn (and ca. 250 GW) annual market.

As a consequence, comparatively few potential offtakers or Sponsors such as IPPs or utilities today seriously plan CSP projects, because almost the entire renewable industry is quickly shifting from its subsidized cradle to more and more commercial, competitive environments, whereas for CSP still many demonstration plants are erected first, to test whether they also work "here". Query is whether CSP can still jump on this commercial train. Many investors and strategic investors express their doubts, have exited the business, reduced and reshuffled their CSP departments and budgets, all of which is not exactly an expression of confidence that the technology can deliver on competitive terms in the mid term future.

In addition and related to that, many finance institutions have a deep lack of confidence in renewable energy offtake contracts with significant elements of subsidies, and are also doubtful after the experiences made in many countries in Europe, where even retroactive cuts in tariffs have jeopardized the entire economic structure of the projects, eventually also those of CSP in Spain.

Part of the technology risk, a key issue and evidently one of the key objectives of this study is the certainty of energy yield predictions, starting with accurate solar resource assessments followed by technology model calculations that translate the solar resource into energy yield curves. As for solar resource assessments the missing standardization is a key issue to banks as well as to Sponsors who both do not have a common standard to refer to. Elaborating best practice standards in this area will certainly improve a common denominator for the financing parties (including EPC and O&M) to "speak the same language" and obtain more comfort in the technology, its viability and eventually also the bankability.

N.5. Financial Model – structure and requirements

In project financing, a spread-sheet-based Financial Model structures complex projects and adresses the economic viability and the robustness of the financial structure of the project. It supports the assessment of the different risks of the project. Through the analysis of key performance indicators as DSCR and NPV, it provides the basis for investment decisions and the contemplation of different scenarios. Furthermore, it is an essential element of the documentation for the financial Due Diligence.
In practice, the Financial Model provides a complete overview of the project and is used as a planning tool, considering the projected Uses and Sources. Uses describe the costs of the project or at a later stage the assets of the project company. Source refer to the funding, whether equity or debt financing, in which proportions and the characteristics, as financial terms.
The quality criteria required for the Financial Model to achieve its objectives are accuracy, logical comprehensibility, user-friendliness, robustness but also flexibility for future adaptations. A comprehensive overall structure and a proper calculation of the relevant accounting rules and taxes are essential. Furthermore, it should fulfill the five „Golden Rules of Cash Flow Modeling “:

1. Each project should apply its own customized model.
2. The input data (assumptions and information) should be only inserted in pre-defined input sheets/cells.
3. The formulas in the calculation spreadsheets must be flexible (easy adaptable as assumptions changes).
4. The formulas should be consistent throughout all periods of the project lifetime.
5. Circular references should be avoided.

N.5.1. Scope of application considering different project phases

Project Development Phase

The Model supports the development progress of the project allowing the documentation of the project’s story line. At this stage, the assumptions related to the project country or specific business case might be already known. However, the assumptions related to the plant operation (revenues and costs) as well as the financial conditions are yet to be defined. In the development phase up to Financial Close the overall assumptions will be adjusted and validated step by step.
Regarding the assumptions for the construction period, financial institutions require a periodic calculation of this phase, e.g. quarterly. The accurate calculation of interests during construction and other financing costs derived from this phase are essential to determine the overall financing needs and thus the Total Investment Costs.
In the Operation Period the cash flow projections are calculated taking into account the periodic revenues, operation costs, debt service, depreciation and taxes. Working Capital and Reserve Accounts also belong to the calculations.

Financing Phase

During the financing phase, banks analyse loans primarily in terms of the borrower's ability of servicing the debt. The financial model plays a central role by the identification and allocation of technical (technical due diligence) and financial (financial due diligence) risks within the framework of project structuring and the calculation of financial ratios.

Implementation Phase

At this point the project assumptions will be fixed, based on signed contracts, firm offers (e.g. EPC, O&M contractors) and loan documentation from financial institutions. At this point the role of the financial model changes from financial projections over a lifetime of the project to a tool, which can be used for target/actual performance comparison considering individual cost components or periods. The monitoring of cost overruns during the construction phase, or the comparison of the first operational year with the actual Financial Statements of the power plant are examples of the application of the tool.

N.5.2. Structure of the Financial Model

This chapter describes the main elements of a Financial Model using MS Excel software. The spread-sheet-based calculation is a common tool in infrastructure projects. Nevertheless, project developers and –owners are free to choose any other tool or computer language.

The spread-sheet-based Financial Model[1] comprises different elements: input data, formulas, tables, graphs, control tools as drop-down lists and buttons, macros and output data. The specific CSP Financial Model used for the calculation in the scope of this study has different sections: an input section, an area for calculations and the section to visualize results. The input data is processed throughout the different sections of the model, where standard and constant formulas are used to perform the calculations, as shown is the following graph:

[1] The financial model used in the CSPBank project is not available for download. In case of any questions or queries, please contact info@suntarce.de.

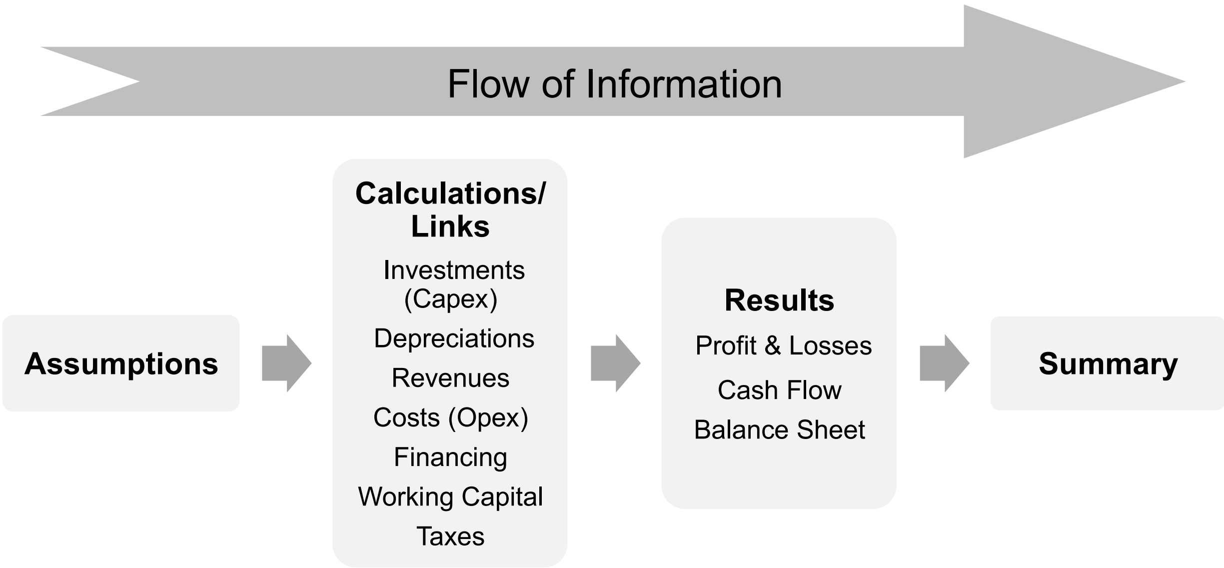


Figure N-6: Schematic illustration of a financial model

N.5.2.1. Techno-Economic Assumptions

The key input parameters for the Financial Model are, beside the project schedule, the technical-economic input data, such as

- Estimated annual electricity yield given in MWh per year (based on site-specific solar irradiation and technical configuration),
- Investment cost (CAPEX),
- Operation and maintenance cost (OPEX),

As well as terms and conditions of the financing scheme.

Table N-3: Example of assumptions overview in the financial model

Annual EQ IRR	8.54%

Update Loans

ASSUMPTIONS OVERVIEW

SCHEDULE

Start of Construction		01/01/2016	dd/mm/yy
Periods (construction)		2	Years
Start of Commercial Operation		01/01/2018	dd/mm/yy
Periods (operation)		25	Years
End of Operation		01/01/2043	dd/mm/yy
Base Year for Escalation Tariff & OPEX		2018	yyyy

OPERATION

Output netto 1st Year including availability:		246 400.00	MWh p.a.
Output netto Year 2+ including availability:		301 840.00	MWh p.a.
Tariff per MWh (Base Year)		200.00	USD/MWh
Degradation First Year		0.50%	p.a.
Periodic Degradation First Year		0.50%	per period
Degradation Year 2+		0.00%	p.a.
Periodic Degradation Year 2+		0.00%	per period
Operating Costs (Base Year)			
Staff Cost	fix	8 500.00	1000 USD p.a.
Insurance and Land Lease	fix	0.00	1000 USD p.a.
Water Consumption	fix	0.00	1000 USD p.a.
Other costs	var	0.00	1000 USD p.a.
Feedstock costs	fix	0.00	USD/MWh

Working Capital

Consumables in Stock (Feedstock)	30	days
Receivables	30	days
Payables	30	days
Days per Year	365	

CAPEX (nominal)

EPC-turnkey-contract	582.00	m USD
Other Investment Costs	3.00	m USD
Start-up costs (rent during constr. etc)	0.00	m USD
CAPEX Scheme	linear	
Up-Front Payment	none	
Final Payment	none	

Discount Factors for Project Sale & NPV of dividends

Discount % for NPV of future dividends	10.00%	
Discount % for Project Sale at completion	10.00%	

DEPRECIATION/TAX/DIVIDENDS

Depreciation Plant and Machinery	25	periods
Others	0	periods
Others	0	periods
Tax Rate	30.00%	p.a.
Distribution of Dividends	100%	p.a.

ESCALATION

OPEX	2.00%	p.a.
Actual OPEX Escalation	2.00%	per period
Feedstock	0.00%	p.a.
Actual Feedstock Escalation	0.00%	per period
Tariff	2.00%	p.a.
Actual Tariff Escalation	2.00%	per period

FINANCING

Leverage	60.00%	
EQ Share	40.00%	
Equity Pay-In Option	Pro Rata	
Senior Debt		
Total Debt (Base for Financing Fees)	362.06	m USD
Total Debt for Macro calculation	362.06	
Loan Share of Total Debt	100%	
Required Debt Service Cover Ratio	1.30	
Up-front Fee	0.50%	
Commitment Fee	0.50%	p.a.
Periodic Commitment Fee	0.50%	per period
Debt Service Reserve Account		
DSRA for	6	months
Interest on DSRA (in %)	1.00%	p.a.
Periodic Interest on DSRA	1.00%	per period
Tenor	12	Periods
Grace Period	0	Periods
First Principal Repayment	01/01/18	
End of Tenor	01/01/30	dd/mm/yy
Repayment Profile	Mortgage	
Resulted Debt Service Cover Ratio for Sculpted	1.53	
Cash Related Profile: % oper. CF for Installmen	30%	
Interest Rates for Construction Period		
Annual Interest Base Rate (Construction)	2.00%	p.a.
Periodic Interest Rate (Construction)	2.00%	per period
Annual Margin (Construction)	1.00%	p.a.
Periodic Margin (Construction)	1.00%	per period
Interest Rates for Operation Period		
Annual Interest Base Rate (Operation)	2.00%	p.a.
Period Interest Rate (Operation)	2.00%	per period
Annual Margin (Operation)	1.00%	p.a.
Periodic Margin (Operation)	1.00%	per period

The input parameters and assumptions considered in the financial analysis are described in the next sub-chapters:

N.5.2.1.1. Schedule

The model considers the construction period (e.g. 2 years) and the following operation period (e.g. 25 years). For start of construction and start of commercial operation the full date should be entered (dd/mm/yyyy).

N.5.2.1.2. Operation data

The Financial Model takes into account the annual energy yield predictions in terms of probabilities. The probability of reaching a higher or lower annual energy production at the P50 level is 50:50. Equity investors may use the P50 or even P75 levels for their revenue forecasts. However, as probabilities decreases, yield expectations of the investors will increase. Typically, banks will apply the P90 or P95 level for their revenue forecast in order to determine if the interest cover is sufficient. More uncertainty results in lower PXX levels and therefore higher cost of capital, as banks have to assume more risk.

The model does not take into account the different revenue predictions according to probability (P50, P90), as it must be rather calculated before inserting the energy yield data.
The PPA tariff should be in line with the base year entered in the schedule sections. Output net refers to the total maximum output. With efficiency/availability and degradation, the actual output per year and (if applicable) a possible lower output in the first year due to technical difficulties for instance can also be simulated. Unscheduled downtime or plant down-time caused by external reasons like non-availability of the transmission grid are not directly calculated in the financial model. However, these losses could be considered in the availability factor.
If the project is based on a fixed feed-in tariff or a specific (requested) tariff, the user is able to input the tariff, and the model shall calculate the expected Project- or Equity Internal Rate of Return (Project IRR, EQ IRR). Alternatively, if the user is targeting a return (e.g. 18%), the user shall use the Excel-Tool „Goal Seek“ to calculate the required PPA tariff.

N.5.2.1.3. OPEX – Operating expenditures

This sections sums up all operational expenditures per operation period split into different categories. Also the price escalation over the operating period can be considered.

N.5.2.1.4. Working capital

Working capital represents a more accurate cash flow calculation of the project, the free cash flow calculation. The payment schemes for receivables, payables and the stock are defined according to the service contracts closed with the project. By defining the delays in days for the payment for e.g. water supply, the project shows the projections for incoming (energy payments) and outgoing (water supply) payments, thus giving an accurate idea of the free cash flow available to meet the obligations in every period. To simplify the calculations at this stage, it was assumed a cycle of 30 days, which means that the project pays its suppliers in 30 days and takes 30 days to collect its receivables from the energy payments.

Table N-4: Working Capital assumptions in the Financial Model

Working Capital			
Consumables in Stock		30	days
Receivables		30	days
Payables		30	days
Days per Year		365	

N.5.2.1.5. CAPEX – Capital Expenditures

The capital expenditures – equipment, start-up costs, services and others - assumed for the project are resumed in this section. Together with the development costs, they represent the investments of the project.

N.5.2.1.6. Cost of Equity

The cost of equity is usually expressed as the Return on Equity (RoE) or also the Equity Internal Rate of Return or Equity IRR. The investor, who contributes equity to a long term project such as solar power, calculates his return in summing up the dividends of the project lifetime, each dividend valued and discounted with a discount rate measured according to the project risk. Together with the financing cost of debt, the equity return forms the overall cost of capital or Weighted Average Cost of Capital (WACC) of the projects and is one of the strongest drivers for the electricity cost.

N.5.2.1.7. Depreciation, tax, dividends and discount rate

This section contains the depreciation assumptions for the asset (in this Model, the total turn-key EPC cost is assumed as the asset). Also other financial assumptions can be inputted here, e.g. the discount rate for NPV (WACC), tax rate depending on the country/region and distribution of dividends policy.

N.5.2.1.8. Escalation factors

Here it is possible to set the escalation over the operation period for OPEX (e.g. CPI or inflation rate) and the indexation for the PPA tariff.

N.5.2.1.9. Leverage

As Leverage we define the portion of debt in percentage of the overall sources, also measured as Debt:Equity (sum of which usually would amount to 100% of sources). As long as the financing cost is lower than the overall project return, a higher leverage with lower financing cost on the debt side may either improve equity returns or lower the overall financing cost of the project and thus enables lower power tariffs.

For long term PPA contracts a typical leverage, as required by banks under a commercial financing scheme, would be 70:30, always depending on the cash flow stability of the project. Development banks and Multilateral Agencies may allow higher percentages of debt to create more advantageous financing structures, like up to 80:20 that reflects typical initial debt levels for international renewable energy project finance schemes. In order to facilitate such leverages, even mezzanine or other subordinated financing tranches might be applied.

N.5.2.1.10. Up-front fees

Lenders usually charge up-front fees as an additional one-time fee to cover their administrative cost with the transaction and also the underwriting and syndication risk.

Another kind of up-front fees is the premium charged by Export Credit Risk Covering Agencies (ECA), which covers the export risk as a form of credit insurance.

N.5.2.1.11. Commitment fee

Commitment fees are charged on the committed and on the still undrawn amount of debt, hence usually apply during construction time until the last tranche of debt has been drawn and applied to project uses.

N.5.2.1.12. DSRA account and interest on DSRA account

Debt Service Reserve Account or DSRA is a reserve account from which interest and debt service is being paid if the project is in default and cannot cover the due amounts from project cash flow. The idea is that banks and sponsors gain time to fix an issue with the project financing before the project enters into a full default. Six months would be a standard period for the DSRA. As this is an asset account, a fixed, usually low interest rate on the amount is assumed.

N.5.2.1.13. Tenor

The lifetime of the debt adds an important cost element from the financial side to the MWh tariff, which the project can offer to its offtaker. The longer the loan lifetime the longer the possible repayment period for the principal will be. Longer tenors allow spreading the investment cost over a longer period and thus over more energy yield. Hence, long tenors are essential to keep the individual MWh cost per period low.

N.5.2.1.14. Repayment profile

The “Equal Principle” repayment profile means constant tranches of debt repayment per each repayment period (semi-annual) plus a reduction on interest payments over the loan lifetime of the project. As an alternative, there might be also mortgage-style repayment structures (form of annuity with level repayments), which would extend the average loan lifetime of the project under a commercial financing scheme, however the difference would be much less than the one of an entire concessional loan scheme.

N.5.2.1.15. Bank interest rates

High single digit to low double digit interest rates (all-in) could have a significant impact on the price of CSP tariffs and a negative impact to the competitiveness of solar tariffs, compared to other countries with lower debt rates.
In principle, the model could assume two types of debt financing: a project financing scheme with long-term of senior loans, provided under an Export Credit Agency type of political and economic risk cover (like Hermes or COFACE). While the loans would be provided on a semi-annual roll over basis of LIBOR, we assume an interest rate hedge over the loan lifetime in form of a LIBOR Swap, as would be required by all project financing banks. On top we calculate a project risk margin, as most of the project risk would be covered (85%) by the ECA facility, so the margin should not exceed that rate. The second type could be a concessional financing, which includes a significantly lower all-in financing rate that would be provided as a fixed rate (i.e., the swap would be included) as well as the project risk margin.

N.5.2.1. Calculations of the Financial Model

The linkage between the input data set in the Assumptions sheet and the Financial Statements is the pre-calculation and processing of the data in five spread-sheets: Investment, Financing, Revenues & Costs, Working Capital and a spread-sheet where the project company’s taxes are calculated. The model enables in a more simplified, but not unrealistic way, the calculations according to the project phases and particularly according to accounting rules. All spreadsheets are linked so that changing assumptions on one criterion has an effect on all the further calculations.
The inputs related to the schedule define the whole structure of the model, i.e. when the construction period begins and how long it takes, followed by the operation period and its term. By changing the

construction period to quarterly or even monthly, the calculation accuracy of the interests during construction is increased.

The inputs linked to the construction period, such as CAPEX, its payment scheme and financing are processed in the Investment and Financing sheet. Here the CAPEX payment portions in each year of construction are determined according to the CAPEX payment schedule initially defined as input. Next the required financing is defined, taking into account the leverage and the equity pay-in option. This is a very important step as the required periodic debt financing is defined, along with the financing costs as interest during construction and bank fees. Together they represent the total required debt of the project, which will be repaid in the operation period. In more detailed Financial Models other financing tranches can be also considered, e.g. VAT financing.

In the operation period, several inputs are considered and processed before flowing into the Result sheets “P&L”, “Cash Flow Statement”, “Balance Sheet” and “Summary”. For the revenues, the inputs regarding the operation of the project – the output in MWh, Availability, Degradation and the Tariff per MWh considering possible escalation are calculated for the year-over-year projections. This model does not allow periodic changes in the power projections e.g. reduced annual yield deriving from maintenance, replacement works or technical issues.

N.5.2.2. Results

In order to determine the expected yearly results of the project, the Profit and Loss sheet takes into account the revenues, the OPEX, the depreciation of the equipment, other elements as interest earnings and expenditures as well as the taxes. The result is a profit or a loss in every year of the project’s lifetime.

The contemplation of the project Cash Flows is provided in the Cash Flow Statement. The revenues and OPEX together with the Working Capital represent the Operating Cash Flows. The Debt Service is also calculated in this part of the model. After considering the DSRA, an overview of the resulting dividends is given.

In the Balance Sheet the yearly projected Assets and Liabilities are calculated. For the assets, the book value of the investments is displayed considering the yearly depreciation. Also the current assets as inventories, receivables and cash (bank accounts) are represented. For the liabilities a representation of the sources is given (Equity and Debt).

In terms of resulting key performance indicators, the financial model calculates, by taking into account Profit and Loss, Balance Sheet and Cash Flow Statement as result the Net Present Value (NPV) of the project, the Internal Rate of Return (IRR), or alternatively the Tariff, also named as Levelized Cost of Electricity (LCOE) based on a target Return on Equity.

N.6. Sensitivity analysis of a 100 MW CSP project in South Africa

The question whether a project should be implemented and consequently financed or not, is closely linked to the feasibility and the economic viability of the project. It is obvious that the project must be generally feasible in order to convince lenders and other key parties to participate. In project financing it is essential to diligently analyze and evaluate potential risks. Only if certain risks are identified and considered, appropriate measures to manage and mitigate the risks can be adopted. In addition, the impact of risks and the resulting variability on project economics is of high importance. For projects in a competitive environment, such as auction schemes, the optimization of the project plays a crucial role, especially of those parameters with the highest impact on the economics.
This chapter illustrates the sensitivity of the project economics by varying project assumptions.

N.6.1. Basic project information and assumptions

A 100 MW CSP project in South Africa shall serve as example to illustrate the sensitivity. The project is purely hypothetical but contains many attributes of existing plants as well as current project concepts.
The CSP plant is located in Northern Cape, South Africa, in close proximity to De Aar. CSP tower technology with molten salt storage is applied. The power plant has a design gross capacity of 100 MW_e and 2 833 MWh_{th} storage capacity, which is equivalent to 12 full load hours. The full technical details of the CSP plant are described in Appendix B.
The CSP plant sells the electricity to a nearby mining company under a 25-year direct Power Purchase Agreement (PPA) denominated in USD. The power plant is not connected to the national grid and the national utility, Eskom, will not offtake any electricity from the CSP plant. The PPA is the foundation of the entire Project Financing Scheme. One of the most important elements is the creditworthiness of the offtaker. Offtake agreements with industrial corporations (e.g. mining companies) are a corporate risk and only few cases would comfort the banks with regard to their payment capability over a tenor exceeding 10 years. Most commercial banks would not lend directly to such corporates for tenors exceeding 10 years. In this example, the offtaker is a tier-1 mining company with global activities and an excellent credit rating.
The electricity is sold to the mining company at a competitive tariff of 90 USD/MWh in the base year. The tariff escalation rate is linked to the US inflation rate and assumed at 2% p.a. The tariff could be realized with relative low CAPEX and attractive long-term debt financing conditions.
The assumptions regarding CAPEX and OPEX are based on a recently published study [Breyer, 2016], and could be realized by a competitive tender process between several EPCs. A consortium of Development Finance Institutes (DFI) provides a concessional loan with a tenor of 18 years and an all-in interest rate of 5.3% p.a. The loans would be provided on a semi-annual roll over basis of LIBOR, an interest rate hedge over the loan lifetime in form of a LIBOR Swap (2.8% p.a. swap rate), as would be required by all project financing banks. The project risk margin, as most of the project risk is covered (85%) by the ECA facility, so the bank margin is 2.5% p.a.
The Project IRR of this project is 7.8% p.a. and indicates the interest the project generates on the overall capital. This figure disregards any financing scheme or the sources of such capital, and hence is a

measure for the economic strength of the overall project. The equity IRR (11.7%p.a.) indicates the return on the transaction for sponsors and considers the leverage effect of the lower debt interest rate.
The project details and assumptions are summarized in Table N-5.

Table N-5: Project assumptions overview

Item	**Data / value**
Location	South Africa, De Aar
CSP technology	CSP tower with molten salt storage
Total land area	9 050 265 m^2
Techn. details:	
Design gross/net power	100 / 90.5 MW_{el}
Tower height	198.1 m
HTF, storage	solar salt
Storage capacity	2 833 MWh_{th} (12 FLH)
Total salt mass	26 800 t
Cooling techn.	dry cooling tower
Schedule:	
Start of construction	2017
Start of commercial operation	2019
Operation:	
Output (net) Operating year 2+	632 340 MWh
Efficiency year 1	90%
Efficiency year 2+	98%
Tariff per MWh (base year)	90 USD / MWh
PPA term	25 years
OPEX (fix and variable)	7 523 530 USD per year
CAPEX	472 120 000 USD
Escalation:	
OPEX	2.0%
Tariff	2.0%
Depreciation	linear, 25 years
Tax rate	28%
Distribution of dividends	100%
Working Capital	30 days (consumables in stock, receivables, payables)
Days per year	360
Financing:	

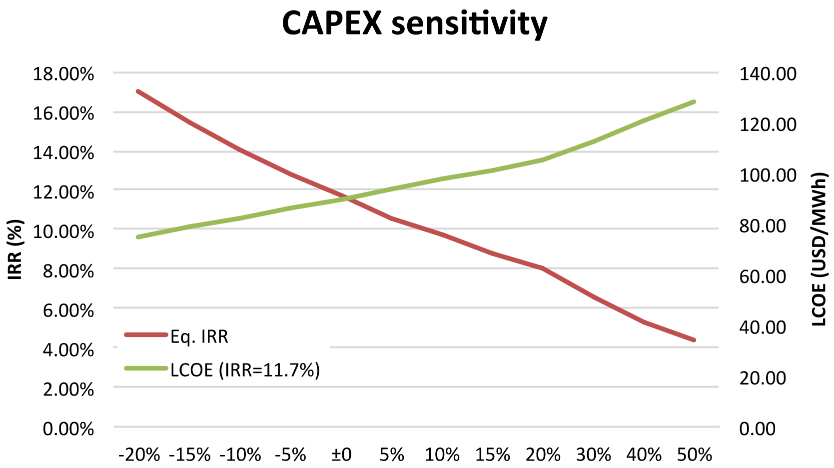
Leverage (debt/equity)	75% / 25%
Required Debt Service Cover Ratio	1.30
Tenor	18 years
Interest base rate	2.8% p.a.
Margin	2.5% p.a.
Up-front fee	1.5%
Commitment fee	0.75% p.a.
DSRA for	6 months
Interest on DSRA	0.5% p.a.
Project IRR	7.8% p.a.
Equity IRR	11.7% p.a.

N.6.2. Sensitivity analysis

The economic viability of a project can be implied for certain situations by analyzing risks and their respective sensitivities. Hence, potential obstacles regarding economic viability and subsequently regarding financing can be identified, and their impact on the resulting PPA tariff, Energy Yield, Investment Costs, Operation and Maintenance Costs, IRR, DSCR, etc. can be assessed. Therefore solutions to overcome obstacles and mitigate risks can be proposed.
This chapter will analyse construction risk, market and operational risk, financial and credit risk.

N.6.2.1. Construction risk

The completion risk can occur through a cost overrun in construction, by a time overrun, by not achieving completion at all, or by the completed plant not meeting pre-defined performance levels. To illustrate the completion risk, the CAPEX costs were altered in the base case. Several scenarios were developed and illustrated where costs overrun from 5% to 50%. In case the EPC price increases by 5%, the actual minimum DSCR for this scenario reduces to 1.27 and hence, it undershoots the required minimum DSCR by lenders in the first period. For the remaining time the DSCR increases slightly in every period compared to each previous period. Since the DSCR is still greater than 1 in this case, the project would nevertheless generate sufficient cash flow to service debt in this period. On the other hand, less remaining free cash flow can be distributed to sponsors and hence, the equity-IRR decreases from 11.7% to 10.6%. The higher the increase in CAPEX, the more important is the impact on the results of the project. Costs overruns in the construction period of 40% of CAPEX result in DSCR of 0.97 which means that the project is not able to service debt in the respective period.



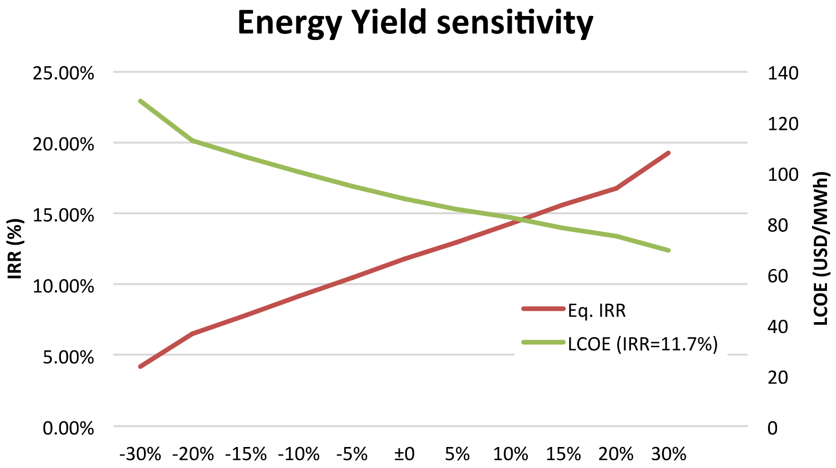
CAPEX (PROJECT)	-20%	-15%	-10%	-5%	±0	5%	10%	15%	20%	30%	40%	50%
Eq. IRR	17.00%	15.40%	14.10%	12.80%	11.70%	10.60%	9.70%	8.80%	8.00%	6.60%	5.30%	4.40%
LCOE (IRR=11.7%)	74.50	78.60	82.50	86.30	90.00	94.00	97.60	101.50	105.50	113.00	121.00	128.50
DSCR	1.55	1.48	1.41	1.36	1.31	1.27	1.23	1.18	1.13	1.04	0.97	-

Figure N-7: CAPEX sensitivity analysis (LCOE in USD/MWh)

N.6.2.2. Market and operational risk

The operational risk includes the risks that the output is less in quantity, or the defined quality of the product cannot be reached due to immature technologies or undeveloped production methods. This risk is significant as it can lead to lower revenues and hence, to lower cash flow. Consequently, the ability of the project to service its debt obligations may be jeopardized. In order to reflect the operational risk in the financial analysis, the energy yield has been altered and the impact on equity-IRR and DSCR analyzed. A reduction of 15% in energy yield seriously undershoots lenders' DSCR targets and leads to a drop in equity-IRR of 3.9%, to 7.8% p.a. LCOE levels are highly sensitive to energy yield variations. In order to realize the same economic results with 15% less energy yield compared to the base case, the tariff would need to increase from 90 to 106 USD/MWh.

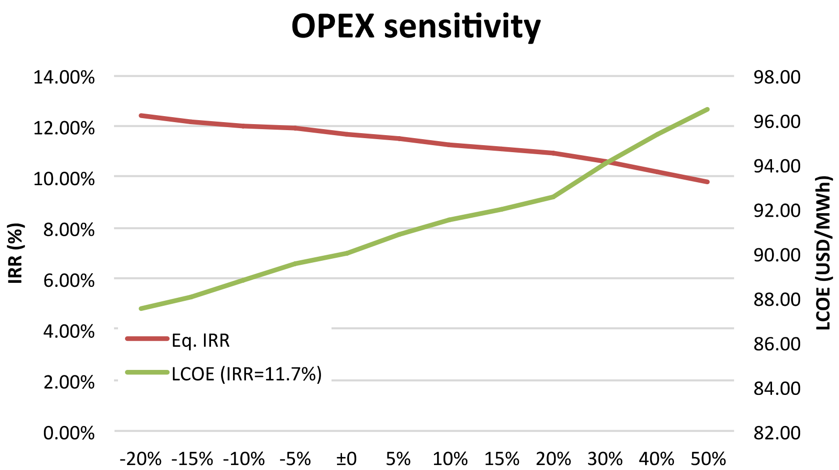
The energy yield indicator also includes resource risks (see below).



Energy Yield	-30%	-20%	-15%	-10%	-5%	±0	5%	10%	15%	20%	30%
Eq. IRR	4.20%	6.50%	7.80%	9.10%	10.40%	11.70%	12.90%	14.20%	15.50%	16.70%	19.20%
LCOE (IRR=11.7%)	128.5	112.50	106.00	100.00	94.80	90.00	85.70	82.00	78.30	75.00	69.30
DSCR	-	1.04	1.12	1.19	1.26	1.31	1.37	1.43	1.48	1.54	1.65

Figure N-8: Energy yield sensitivity analysis (LCOE in USD/MWh)

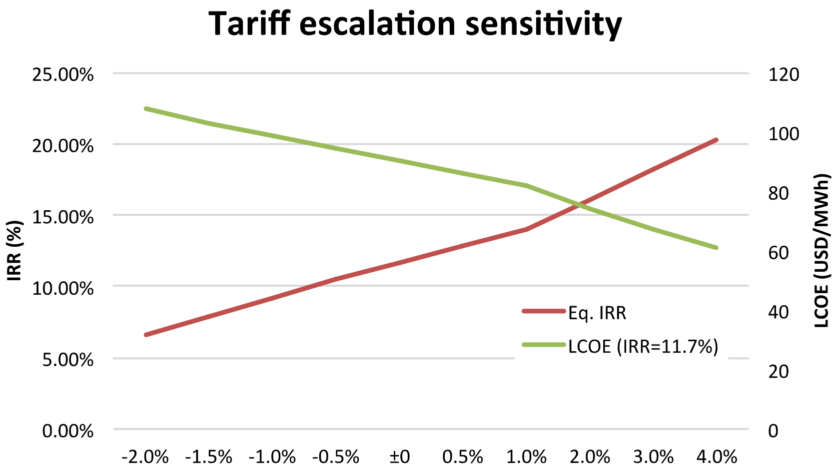
All threats during the operating phase that disrupt the production or lead to higher operational costs can be pooled as operational and management risks. The key consequence in the financial model is a lower cash flow. Similar to the analysis of the completion risk, the operating costs were increased ceteris paribus and their implication towards equity-IRR and DSCR are assessed. Both parameters are, as one would expect, less sensitive to changes in operational costs than in the previous case of completion risk. Even an increase of 10% for instance, keeps DCSR roughly around the required threshold of 1.3. In this case equity-IRR would drop to 11.3% p.a. LCOE levels are also only marginally affected by changes in operational costs.



OPEX	-20%	-15%	-10%	-5%	±0	5%	10%	15%	20%	30%	40%	50%
Eq. IRR	12.40%	12.20%	12.00%	11.90%	11.70%	11.50%	11.30%	11.10%	10.90%	10.60%	10.20%	9.80%
LCOE (IRR=11.7%)	87.50	88.00	88.80	89.50	90.00	90.80	91.50	92.00	92.50	94.00	95.30	96.50
DSCR	1.35	1.34	1.33	1.32	1.31	1.30	1.30	1.29	1.28	1.26	1.24	1.23

Figure N-9: OPEX sensitivity analysis (LCOE in USD/MWh)

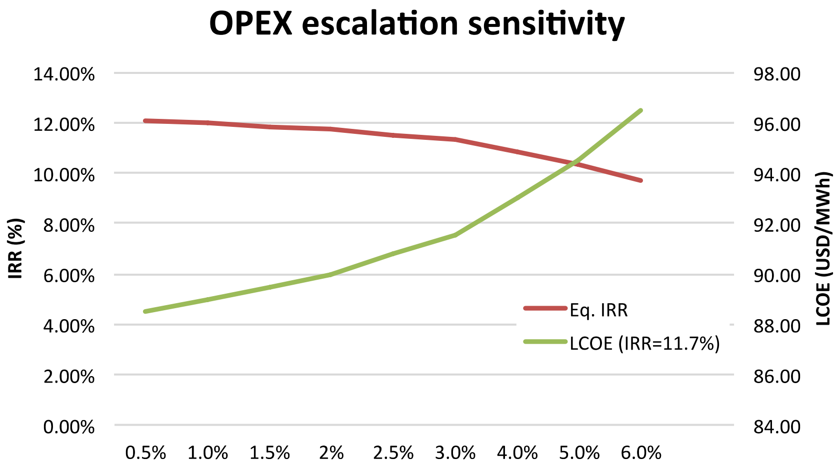
The losses caused by too optimistically calculated sales volumes, or wrong assessments of selling prices jeopardize positive cash flow, and subsequently the debt repayment capability of the project. Since tariffs are highly sensitive to market dynamics as well as policy changes, another risks analysis is carried out introducing deviations from the standard tariff escalation. Moderate changes ranging from -2% to +4% of the given escalation benchmark are calculated. Compared to the operational risk analyzed above, IRR and LCOE in this case are more sensitive to tariff changes than the DSCR.



Escal. Tariff	-2.0%	-1.5%	-1.0%	-0.5%	±0	0.5%	1.0%	2.0%	3.0%	4.0%
	0.00%	0.50%	1.00%	1.50%	2%	2.5%	3.0%	4.0%	5.0%	6.0%
Eq. IRR	6.60%	7.90%	9.20%	10.50%	11.70%	12.80%	14.00%	16.10%	18.20%	20.20%
LCOE (IRR=11.7%)	107.8	103	98.8	94.3	90.00	86.00	82.00	74.50	67.50	61.00
DSCR	1.05	1.15	1.27	1.3	1.31	1.32	1.33	1.36	1.38	1.4

Figure N-10: Sensitivity analysis of PPA tariff escalation (LCOE in USD/MWh)

Operational costs are also subject to changes caused by inflation adjustments or other market impacts. As one would expect given the sensitivity of IRR to changes in the overall operational costs above, the indicator is less sensitive to these changes than to an increase or drop in tariff escalation. LCOE levels are also only marginally affected by changes in the escalation of operational costs.

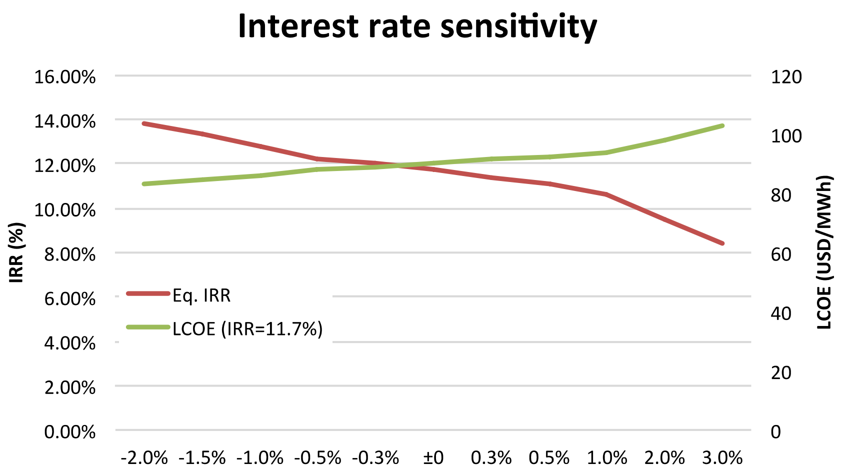


Escal. OPEX	0.5%	1.0%	1.5%	2%	2.5%	3.0%	4.0%	5.0%	6.0%
Eq. IRR	12.10%	12.00%	11.80%	11.70%	11.50%	11.30%	10.80%	10.30%	9.70%
LCOE (IRR=11.7%)	88.50	89.00	89.50	90.00	90.80	91.50	93.00	94.50	96.50

Figure N-11: Sensitivity analysis of OPEX escalation (LCOE in USD/MWh)

N.6.2.3. Financial and credit risk

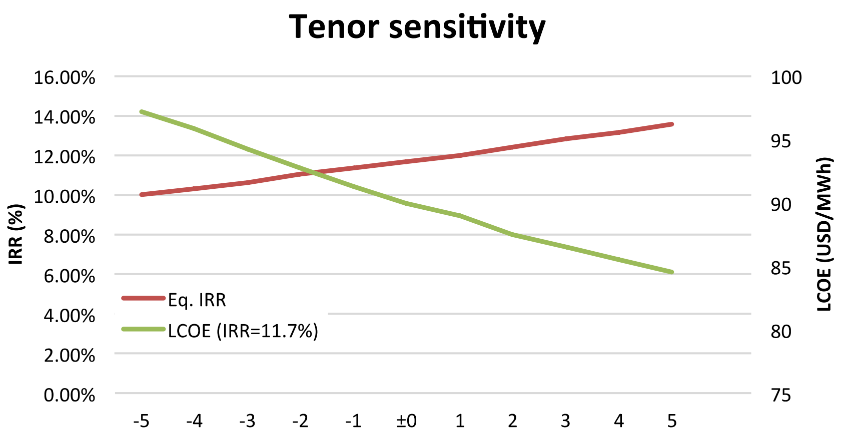
The financial risk includes the interest rate risk, the inflation risk and the exchange rate risk. With regard to changes in interest rates both DSCR and IRR are quite sensitive. An increase of 2% to 7.3% p.a. undershoots lenders' DSCR targets. The equity-IRR would drop from 11.7% to 9.5% while LCOE would rise to 98 USD/MWh.



Variation	-2.0%	-1.5%	-1.0%	-0.5%	-0.3%	±0	0.3%	0.5%	1.0%	2.0%	3.0%
Interest Rate	3.3%	3.8%	4.3%	4.8%	5.1%	5.3%	5.6%	5.8%	6.3%	7.3%	8.3%
Eq. IRR	13.80%	13.30%	12.80%	12.20%	12.00%	11.70%	11.40%	11.10%	10.60%	9.50%	8.40%
LCOE (IRR=11.7%)	82.8	84.50	86.30	88.30	89.00	90.00	91.30	92.00	94.00	98.00	102.50
DSCR	1.48	1.43	1.39	1.35	1.33	1.31	1.29	1.28	1.24	1.15	1.07

Figure N-12: Sensitivity analysis of interest rate (LCOE in USD/MWh)

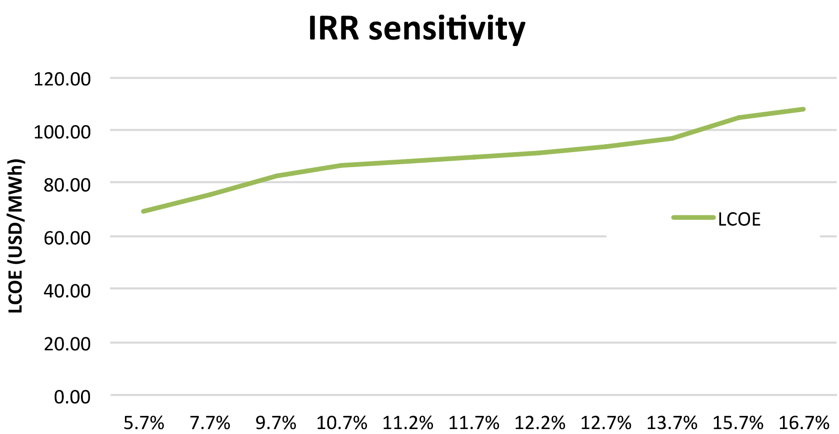
The longer the loan lifetime, the longer the possible repayment period. Longer tenors allow spreading the investment cost over a longer period and thus over more energy yield. Increasing the tenor by 1 year would result in higher equity return (12.0%p.a.) or lower tariff (89 USD/MWh). Looking at the other way around, a tenor of 13 years instead of 18 years decrease the equity IRR to 10% p.a. or would require a higher tariff of 97.2 USD/MWh.



TENOR (years)	-5	-4	-3	-2	-1	±0	1	2	3	4	5
Eq. IRR	10.00%	10.30%	10.60%	11.00%	11.30%	11.70%	12.00%	12.40%	12.80%	13.10%	13.50%
LCOE (IRR=11.7%)	97.2	95.80	94.20	92.80	91.20	90.00	89.00	87.50	86.50	85.50	84.50
DSCR	1.06	1.12	1.17	1.22	1.27	1.31	1.36	1.40	1.43	1.47	1.51

Figure N-13: Sensitivity analysis of tenor (LCOE in USD/MWh)

Finally, a closer look on the IRR itself reveals insights in to what tariff would correspond to which equity-IRR and vice versa, i.e. which expected IRR would allow which tariff level. Roughly stated, a 1% higher IRR would require the tariff to increase by about 3.9%.



Eq. IRR	5.7%	7.7%	9.7%	10.7%	11.2%	11.7%	12.2%	12.7%	13.7%	15.7%	16.7%
LCOE	69.30	76.00	83.00	86.50	88.30	90.00	91.70	93.50	97.20	104.50	108.00

Figure N-14: Sensitivity analysis of equity IRR (LCOE in USD/MWh)

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List of abbreviations

Acronym	Definition
CAPEX	Capital expenditures
CFADS	Cash flow available for debt service
COD	Commercial operating date
CSP	Concentrating solar power
DNI	Direct normal irradiation
DR	Debt ratio
DSCR	Debt service coverage ratio
DSRA	Debt service reserve account
EPC	Engineering, procurement and construction
FIT	Feed-in tariff
FSA	Fuel supply agreement
HTF	Heat transfer fluid
IPRA	International project risk assessment

IRR	Internal rate of return
JIBAR	Johannesburg interbank average rate
LCOE	Levelized cost of electricity
LLCR	Loan life coverage ratio
NPV	Net present value
OCF	Operating cash flow
O&M	Operations and maintenances
PPA	Power purchase agreement
PV	Photovoltaic
SPV	Special purpose vehicle
STG	Steam turbine generator
TKCC	Turnkey construction contract
WACC	Weighted average cost of capital

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