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Assessment of financial risk management instruments for renewable energy projects

UNEP Working Group 1 Study Report

GEF

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1

Executive Summary

Building on previous UNEP commissioned research efforts aimed at bringing about faster and more systematic deployment of Renewable Energy Technology (RET) this study assesses the value of Financial Risk Management (FRM) Instruments and considers the practical implications of deployment.

Risk assessment and stochastic modelling techniques are used to identify, quantify and prioritise critical risks during key stages of developing a wind farm. Using a cash flow model, risk modelling and financial techniques it was possible to determine the financial impact of selected FRM Instruments on project economics.

To carry out the risk assessment and modelling, a range of quantitative and qualitative data was gathered. This included data from wind farm in China and a risk survey of experts involved in renewable energy project development and financing

Risk ranking shows that contractual, performance and technology risks are perceived to be of most concern for the wind project case study. Several of the highest ranked risks such as contract bankability, offtaker default and warranty non performance relate to key contracts underpinning the revenue and technology aspects of the project.

Many of the critical risks identified by the study show potential for mitigation through a combination of existing and emerging FRM instruments. Of note several instruments are designed to mitigate project completion risk and revenue volatility which are particularly useful from a financing perspective. However, contractual risks prove to be the most difficult risks to mitigate using FRM instruments.

Existing and evolving FRM instruments selected for evaluation included:

- Traditional Project Insurance Policies (including Construction All Risks, Property Damage, Machinery Breakdown, Delay in Start Up, Business Interruption, Third Party Liabilities)
- Political Risks Insurance
- Certified Emissions Reduction Futures Contract (Put Option)
- Weather Derivative
- Credit Delivery Guarantee
- Turbine Warranty Insurance

Using typical parameters of financial robustness including, project default rate, debt service cash reserves (DSCR) and net present value of cash flows, it is possible to measure the value of each instrument. Instruments were assessed in isolation and together in different combinations to determine optimal value. For example using the full suite of traditional insurance products during construction and operating phases reduces the project default rate from 7.48% to 1.18%.

Consequential loss coverage provided by ***Delay in Start Up*** and ***Business Interruption*** is effective in providing revenue protection. Combined with other standard products such as Construction All Risks (CAR), Operating All Risks (OAR) and Machinery Breakdown (MB) such traditional products are able to improve confidence levels and allow the project to raise the required level of debt.

Introducing other non traditional FRM instruments also shows a range of important impacts on project economics.

Political Risk Insurance is effective in mitigating the risk of offtaker default and the model results show this instrument has very positive impact on default rate and debt rating.

Warranty Insurance offers significant scope for turbine manufacturers to “offload” future warranty liabilities and reduces balance sheet provisions. Although still evolving this type of product offers several credit enhancement opportunities for domestic and international turbine manufacturers looking to provide increasing volumes of equipment warranties and performance guarantees to their customers.

Notably, when used in combination with traditional insurance, political risk insurance and the CER futures contract result in the lowest default rate of 0.54% (compared with 7.48% without any insurance). As the market for CERs becomes more liquid and exchanged traded, this type of product may offer significant hedging opportunities in the face of long term price volatility and market uncertainty.

Conversely, the modelling also demonstrates that the cost of certain instruments can be prohibitively expensive; in the case of weather derivatives this can reduce the internal rate of return by more than 1%. The project can not support the risk premium required for a ***wind power derivative***. A more effective application could involve linkage to Business Interruption policies.

The ***Credit Delivery Guarantee***, although not specifically modelled, shows significant potential to mitigate a number of risks currently causing significant CER price discounting. Modelling has demonstrated that an average CER sale price increase from Euro15 to Euro20 could increase the IRR of the project to 16.5%. Delivery certainty provided by highly rated insurers could enable future carbon revenues to be more effectively monetized, increasing opportunities to leverage carbon finance.

The effectiveness of each FRM instrument will ultimately be dependent on the financial structure of the project and the risk appetite and tolerance of the project stakeholders. Similarly, the suitability of such FRM instruments for application under real world conditions at the local level must be given due consideration. Deployment can be constrained by a range of issues including a lack of product evolution, affordability, customer demand, information requirements and local insurance market restrictions.

In particular, deficiencies associated with the Chinese domestic insurance market are limiting the true value and benefits of several promising insurance products that are widely available outside of China. A lack of technical underwriting expertise and regulatory barriers are inhibiting wider forms of traditional coverage and the deployment of specialist consequential loss insurance such as Delay in Start Up and Business Interruption.

Furthermore the inability of the local insurance market to meet a number of other lender insurance requirements such as “A rated” security, faulty design and terrorism cover, could put Chinese projects at a disadvantage to other projects in developing countries looking to raise finance.

Intervention actions by the public sector should be focussed on removing barriers that prevent the deployment of FRM instruments. Useful public sector intervention options should focus on insurance vehicles that can leverage both the underwriting sophistication, breadth of coverage and highly rated security of the international reinsurance markets whilst utilising established distribution channels and customer base of the domestic insurance companies. Such a platform would need to be compliant with local insurance regulations and sensitive to the needs of the local domestic insurers.

2

Introduction

Marsh Ltd was selected to carry out the consultancy assignment for Working Group 1 as part of the research activities under UNEP/GEF Assessment of Financial Risk Management (FRM) Instruments for Renewable Energy Projects.

Previous research efforts have shown that several risks associated with RE projects can be mitigated through FRM instruments. However, little practical or empirical work has been undertaken to identify and prioritise perceived critical risks, quantify them in financial terms and measure the financial benefits of selected FRM instruments.

The overall aim of this study was as follows:

To determine which Financial Risk Management Instruments can be most usefully deployed to improve risk financing decisions and potentially reduce the cost of financing large scale Renewable Energy Projects.

To achieve the stated overall aim of the study several key objective were identified to inform the study approach.

The key study objectives include the following:

1. To identify risks which are perceived to be critical in financing decisions for large scale RE projects
2. To determine which instruments (emerging and new) that could address critical risks
3. To determine which of these instruments can have most beneficial impact on project economics
4. To explore which instruments are suitable for application in developing countries
5. To consider useful intervention options of the public sector

Point 5 although part of the overall consulting assignment does not form part of this report.

The UNEP/GEF Assessment of Financial Risk Management Instruments for Renewable Energy Projects effort is a two year USD1 million study aimed at facilitating innovation in the risk management area. It will provide the Global Environment Facility (GEF), public agencies and industry with a systematic and comprehensive analysis to determine more efficient public sector intervention options. The ultimate goal of the effort is to bring about the faster and more systematic deployment of RET by supporting and positively influencing the development of markets for RET project risk management instruments of all kinds.

3

Study Methodology

Summary

The study methodology uses a combination of proven qualitative and quantitative techniques to capture risk perceptions and translate these into meaningful financial terms for analysis and subsequent integration into a cash flow model.

In order to produce meaningful and accurate findings the study uses data gathered from experts in renewable energy financing and a real life wind project currently in operation in China.

Using stochastic modelling approaches it was possible to analyse the impact and mitigation effect of financial risk management instruments on the projects economics. Promising FRM Instruments could then be evaluated in terms of their suitability for application in China

In summary the study methodology involved several distinct but integrated phases including:

1. Project definition
2. Risk identification using a survey of renewable energy experts
3. Risk analysis to determine high priority risks
4. Design and calibration of cash flow model
5. Stochastic Risk Modelling
6. FRM instrument evaluation

A hypothetical wind farm in China was selected and project variables defined to reflect realistic financial and economic conditions. Wind as a technology was selected because it is the most economically viable renewable energy technology currently and China represents a significant growth market for large scale wind energy in Asia.

Using realistic economic, financial and technical parameters it was possible to design a financial model. Having identified risks and establishing a perceived level of materiality using a survey of experts it was then possible to integrate risks into the model to quantify the financial impact with and without selected financial risk management instruments. The last phase of work involved as evaluation of selected FRM instruments to identify constraints on availability and suitability for application in developing countries.

A wide range of experts were called upon to provide input to key stages of the study including leading financiers, (re) insurers and project developers active in renewable energy both at an international level and specifically focussed in Asia.

Project Definition

The purpose of the wind farm case study is to provide a basis from which to build a realistic financial model to measure the financial impact of risks on project economics. Importantly, summary details of project characteristics also enabled survey respondents to make more informed risk voting decisions during the survey.

The proposed case study project involves the installation of 67 turbines, each of which have a capacity of 1500KW, providing a total installed capacity of 100.5MW. The project is located at a good wind site in Jilin Province, Northeast China. The power generated will be sold to the state owned Power Grid, via a long term 25 year power purchase agreement (PPA). The electricity price of USD0.06 /kWh is consistent with the current price bids for Chinese wind farms.

The initial financial structure of the project assumes a debt and equity ratio of 66.6 / 33.3 and it is assumed that due to the location this will be largely locally financed but possibly with some international lenders / financiers involved. A turnkey, fixed price (or lump sum) equipment, procurement and construction (EPC) has been used to guarantee the construction of the project according to specifications, on budget and on time. It is assumed that the turbine manufacturer will act as the EPC contractor and also perform the operating and maintenance contract.

Further details of the Project Definition are provided in Appendix A

Risk Survey

Limited research has been carried out on the risk perceptions associated with renewable energy projects and how this impacts on financing decisions. As a key element of this study a risk survey was undertaken to establish expert opinion and views on pre-identified risks associated with the wind farm case study.

The purpose of the survey was twofold:

- To capture in a subjective but reliable way perceptions of risk associated with the development and financing of a wind project in China
- To provide baseline data which can be used as a starting point for risk analysis and input to the risk model phase

Appendix B provides details of respondent profile.

Risks Identification

Pre-defined risks for use in the survey were identified based on Marsh's in-house experience of carrying out risk assessments on other renewable energy projects. As our analysis is project specific many of the risks identified relate to operational and contractual aspects.

This method of providing pre-defined risks reduces the time requirements for completion of the survey which was considered to be major deterrent for participation. Survey respondents were also given an opportunity to identify further risks at the end of the survey if they considered that were additional risks of concern that had not been identified.

Risks were considered during key project phases including 1) development phase, 2) construction, testing and commissioning phase, 3) operating phase and 4) certified emission reduction phase. These distinct project phases present different risk profiles and concerns for lenders / financiers.

The survey questions and risks were also peer reviewed by a leading investment banking group Climate Change Capital who are active in clean and low carbon technologies.

Figure 2 provides a list of the risks identified as part of the survey. For each of the risks respondents were asked to assess the following, using a five-point scale detailed in Appendix C:

- Impact the risk will have on the project
- Likelihood of the risk occurring

Figure 2: Risk List

Risk Identifier	Risk Description	Details of Risk	Project Stage
A	Permitting / Planning delays	Risk of delay due to the inability to obtain building permit/ planning or other regulatory consents.	Project Development
B	Contract bankability	Risk of being unable to secure bankable offtaker / fuel supply contracts.	Project Development
C	CER bankability	Risk of Certified Emission Reductions (CER's) not being recognized as bankable revenue streams (i.e. able to support debt service obligations).	Certified Emission Reduction
D	Contractor non-performance	Risk of EPC and turn-key contractors being unable to deliver to specifications on time and at cost.	Contruction, Testing and Commissioning
E	Engineering risks	Risk of physical loss or damage to property caused by technical / engineering hazards (e.g. defective design, faulty parts and / or workmanship).	Contruction, Testing and Commissioning
F	Physical hazard (caused by man or nature)	Risk of physical loss or damage to property caused by man made and / or natural hazards / catastrophes (e.g. fire, lighting, explosion, earthquake, flood, windstorm).	Contruction, Testing and Commissioning
G	Offtaker contract failure	Risk that power offtakers withdraw from contract subsequent to financial closure.	Contruction, Testing and Commissioning
H	Catastrophic design failure	Risk of complete mechanical or control failure during testing and commissioning due to defective design.	Contruction, Testing and Commissioning
I	Process Interruption	Risk of complete plant shut down (total process interruption) at any time due to unscheduled maintenance.	Operating
J	Natural hazards	Risk of physical loss and / or damage to the plant and / or machinery breakdown caused by natural hazards / catastrophes (e.g. fire, lighting, explosion, windstorm, flooding)	Operating
K	Design / Engineering Risk	Risk of physical loss and / or damage to the plant and / or machinery breakdown caused by design / engineering perils (e.g. defective design, faulty parts and workmanship all occurring outside the scope of any warranty protection)	Operating
L	Physical hazard (caused by third party)	Risk of physical loss and / or damage to the plant caused by human hazards external to the project (e.g. strikes, riots, cival commotion, war)	Operating
M	Wind volatility	Risk that average wind speeds falls below required thresholds to generate economically efficient power outputs / electricity.	Operating
N	Offtaker default	Risk of the electricity offtaker defaulting on contractual obligations under PPA.	Operating
O	Warranty non-performance	Risk of the warranty provider failing to meet contractual obligations.	Operating
P	Legal liability	Risk of the legal liability caused by bodily injury or property damage to third parties.	Operating
Q	CER Regulatory Risk	Risk of Certified Emission Reduction (CER) delivery shortfall or failure due to Kyoto regulatory risk (e.g. changes to baseline methodology, monitoring procedures, additionality rules or other eligibility criteria).	Certified Emission Reduction
R	CER political risk	Risk of Certified Emission Reduction (CER) delivery shortfall or failure due to host country political action (e.g. expropriation, nationalization, confiscation and prohibitions in connection with the sale of CERs).	Certified Emission Reduction
S	CER performance risk	Risk of Certified Emission Reduction (CER) delivery shortfall or failure due to lower than expected plant performance.	Certified Emission Reduction
T	CER insolvency risk	Risk of Certified Emission Reduction (CER) delivery shortfall or failure due to insolvency of project proponents.	Certified Emission Reduction
U	Long term CER marketability	Risk of limited marketability of emission reductions post 2012.	Certified Emission Reduction

Risk Assessment

Using the simple point scores (1-5) for impact and likelihood it is possible to determine a combined point score for each risk. To provide a more meaningful parameter from which to measure risk perception the simple point score for each response was translated into financial terms more representative of wind farm economics.

For impact scores, the above tables were used to translate a point score into its corresponding financial loss. Each point was associated with a range of possible financial losses, hence, we used the midpoint loss in each category (e.g. impact score 3 corresponds to a financial loss between USD1m and USD10m – the midpoint of which is USD5.5m).

The same process was carried out for likelihood – with the midpoint of the range of probabilities corresponding to each point score being used for translation into financial metrics (e.g. likelihood score 4 had midpoint probability of 33%).

Both financial metrics were combined to calculate the expected loss each respondent voted for a given risk. The expected loss was calculated as:

$$\textit{Expected loss} = \textit{Financial loss} \times \textit{Probability}$$

The expected loss represents the likely average annual loss associated with each risk. It is worth noting that the financial metric equivalences of each of the simple point scores for impact and likelihood are not linear (e.g. impact scale 2 with a financial loss midpoint of USD525k, is more than twice that of impact scale 1 which has a financial loss midpoint of USD25k).

Appendix E describes some of the unintuitive results that occur using these metrics but explains the value of using two different but complementary methods of viewing the importance of each risk.

The results chapter provides analyses of each risk in terms of distribution and ranking.

Design of Project Model

A financial model was built as a quantitative tool to evaluate the benefit of Financial Risk Management (FRM) Instruments on the wind farm project. The role of such instruments is to cover unexpected and/or extreme cases (i.e. with low probability of occurrence). Therefore, valuing the project with different combinations of FRM Instruments solely relying on average measures is not appropriate.

A stochastic model assesses potential financial results in the whole range of possible scenarios (as a probability distribution). From this probability distribution, the average as well as the expected results at various confidence levels (75 %, 90 %, 95 %,…) can be determined.

The stochastic model is based on renowned modelling methodologies used by rating agencies and investment banks. It includes key risks factors (lack of wind, delays, business interruption, failure of manufacturer warranty etc) and forecasts the financial strain these risks might have on the project's viability according to their probability of occurrence and probable impact. The model is also able to assess the mitigation effect of using various combinations of FRM instruments.

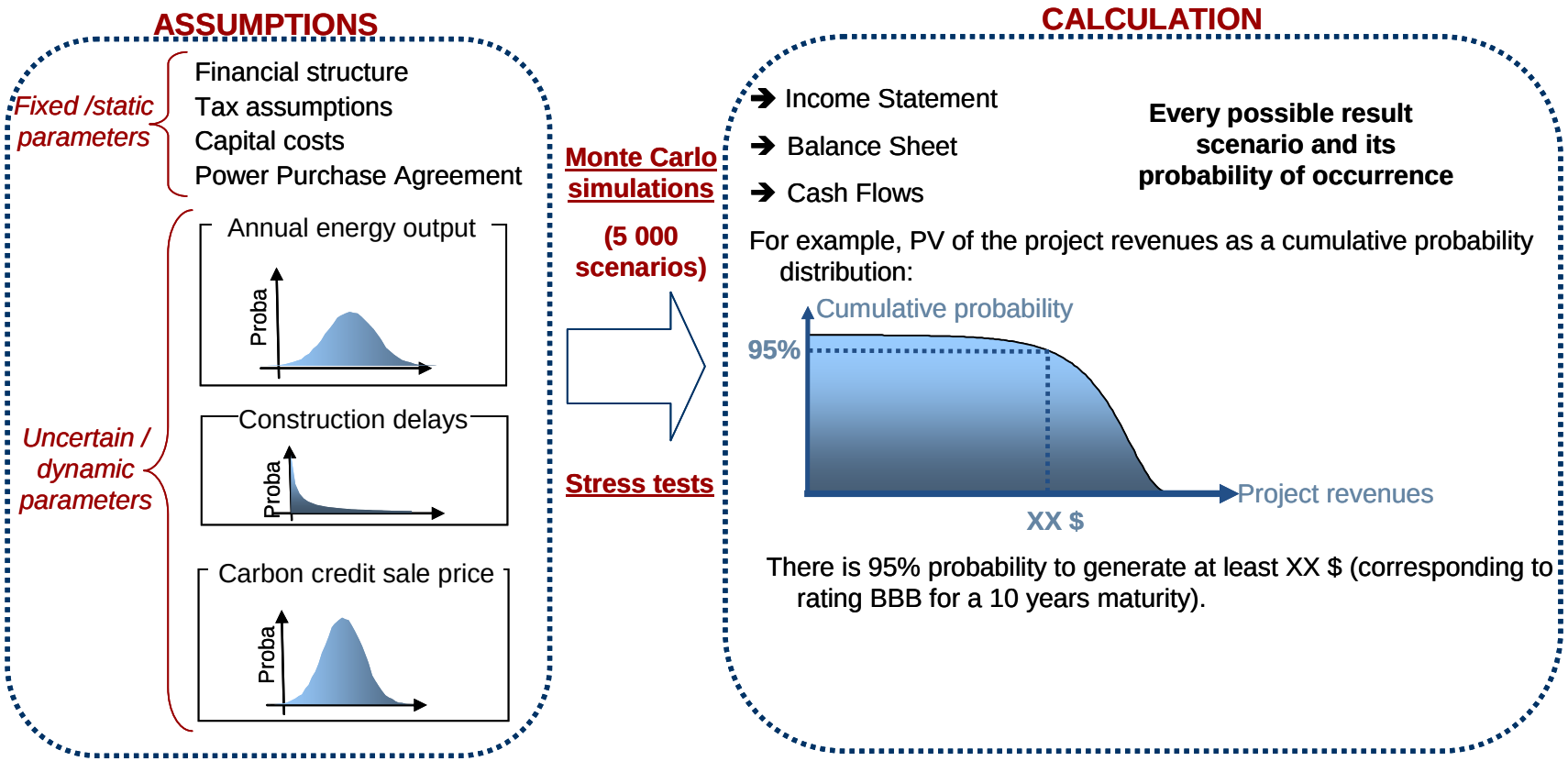
The model is a required preliminary analysis to help best optimise the financial structure, and particularly to improve the confidence and interest in the project for the financial community. It allows a better overview of the project profitability and the validation of financial covenants.

The general specifications for the model are:

- Calculate the project results for a large number of scenarios in order to generate an extensive range of possible outcomes (Monte Carlo simulation).
- Calculate the project results in specific cases (stress tests) in order to evaluate the impact of particularly pessimistic but possible cases.
- Quantify the benefit of different financing options.

Figure 3 below describes the global methodology of the model. Using the project description (including static and dynamic parameters), the model will run Monte Carlo simulations and stress tests in order to quantify the project's value.

Figure 3: Outline of model methodology



Financial Risk Management (FRM) Instrument Evaluation

Having identified suitable FRM instruments and quantified their impacts on project economics the next phase of work focussed on suitability for application in developing countries.

As has been highlighted in the earlier UNEP scoping study a number of FRM instruments exist or are evolving which conceptually could meet the needs of the renewable energy sector. However, effectiveness of any FRM Instrument is conditioned by legal, political, social and economic factors which will vary from one country to another.

The objective of this phase of work was to give detailed consideration to some of the practical constraints and challenges posed by wind project development in China. Local brokers and insurance companies in China provided key insights on local customer demand, FRM instrument information requirements and local insurance market conditions.

4

Survey Results

Key Messages

Contractual, performance and technology risks are perceived to be of most concern in the context of financing renewable energy projects. Several of the highest ranked risks relate to key contracts underpinning the revenue and technology aspects of the project.

Contract Bankability is ranked as the most significant risk as it could effectively terminate the project. The other contractual related risks of note relate to the counterparty non-performance and / or default in respect of contractual obligations. Certain of these risks such as electricity offtaker default are symptomatic of doing business in emerging markets and others such as warranty non-performance are inherently linked to technology efficacy concerns.

Engineering risks linked to defects in design, parts and / or workmanship feature during the construction phase as the number one ranked technology risk. Again this is symptomatic of many renewable energy technologies such as wind which are still perceived to be prototypical.

CDM Project "delivery risks" appear less significant in terms of financial consequence compared with other risks. However delivery risks can influence the value attributed to future CER revenue streams and thus may be partly responsible for the greater significance attributed the risk of CER's not being recognised as bankable revenue streams.

The surveys were sent out electronically to participants during November 2006. 31 qualified experts active in the development and financing of wind projects in Asia completed the surveys voting on the 21 pre-identified risks.

All voting scores have been analysed to determine a level of consensus on risk impact and likelihood.

Before drilling down on individual risks it is useful to review the overall findings and to consider if it is possible to generalise different categories of risk. Although many of the risks are quite unique it is possible to align them in terms of the following 5 broad risk categories:

- Contractual
- Technology / Performance
- Physical Hazard
- Regulatory / Political
- Market / Financial

Each of these categories provides an insight on the nature of the risks contained with in as well as an indication of the possible FRM instruments that may be able to address the particular risks.

Risks falling under the Technology / Performance category dominate, making up 29% of the total risks. Design issues feature prominently in this category which suggest that although one of the most economically viable and mature technologies in the RE sector, there are clearly still concerns over the technology efficacy of the sector. Contractual, Market / Financial and Physical Hazard categories follow with 19% of the risks respectively. As will be discussed in more detail next, the risks contained in the Contractual category are also considered the most critical from a financial context. Generally speaking the risks contained with in each of these categories are also the most difficult to mitigate using FRM Instruments.

Regulatory / Political risk categories contain 14% of the total risks. Appendix D illustrates the distribution of risks according to different categories.

By quantifying risks in terms of “expected loss” (function of financial impact and probability survey scores) it is possible to prioritise risks according to financial criticalility. Figure 4 below provides the overall ranking of risks according to expected loss. The following analysis focuses on the top 13 ranked risks and discuses briefly some of the additional risks raised by respondents.

Figure 4: Wind Project Risk Ranking (Expected Loss)

Risk Ranking	Risk Letter	Head Line Risk	Details of Risk	Expected Loss (US$)
1	B	Contract bankability	Risk of being unable to secure bankable offtaker / fuel supply contracts.	10,465,953
2	O	Warranty non-performance	Risk of the warranty provider failing to meet contractual obligations.	9,235,476
3	N	Offtaker default	Risk of the electricity offtaker defaulting on contractual obligations under PPA.	8,739,566
4	E	Engineering risks	Risk of physical loss or damage to property caused by technical / engineering hazards (e.g. defective design, faulty parts and / or workmanship).	8,086,700
5	F	Physical hazard (caused by man or nature)	Risk of physical loss or damage to property caused by man made and / or natural hazards / catastrophes (e.g. fire, lighting, explosion, earthquake, flood, windstorm).	7,740,908
6	J	Natural hazards	Risk of physical loss and / or damage to the plant and / or machinery breakdown caused by natural hazards / catastrophes (e.g. fire, lighting, explosion, windstorm, flooding)	6,992,974
7	G	Offtaker contract failure	Risk that power offtakers withdraw from contract subsequent to financial closure.	6,779,618
8	H	Catastrophic design failure	Risk of complete mechanical or control failure during testing and commissioning due to defective design.	6,678,678
9	A	Permitting / Planning delays	Risk of delay due to the inability to obtain building permit/ planning or other regulatory consents.	6,647,000
10	C	CER bankability	Risk of Certified Emission Reductions (CER's) not being recognized as bankable revenue streams (i.e. able to support debt service obligations).	5,191,547
11	M	Wind volatility	Risk that average wind speeds falls below required thresholds to generate economically efficient power outputs / electricity.	4,873,565
12	I	Process Interruption	Risk of complete plant shut down (total process interruption) at any time due to unscheduled maintenance.	4,310,388
13	P	Legal liability	Risk of the legal liability caused by bodily injury or property damage to third parties.	4,279,955
14	L	Physical hazard (caused by third party)	Risk of physical loss and / or damage to the plant caused by human hazards external to the project (e.g. strikes, riots, civil commotion, war)	4,014,440
15	T	CER insolvency risk	Risk of Certified Emission Reduction (CER) delivery shortfall or failure due to insolvency of project proponents.	3,959,167
16	D	Contractor non-performance	Risk of EPC and turn-key contractors being unable to deliver to specifications on time and at cost.	3,777,648
17	U	Long term CER marketability	Risk of limited marketability of emission reductions post 2012.	2,741,763
18	Q	CER Regulatory Risk	Risk of Certified Emission Reduction (CER) delivery shortfall or failure due to Kyoto regulatory risk (e.g. changes to baseline methodology, monitoring procedures, additionality rules or other eligibility criteria).	2,631,244
19	K	Design / Engineering Risk	Risk of physical loss and / or damage to the plant and / or machinery breakdown caused by design / engineering perils (e.g. defective design, faulty parts and workmanship all occurring outside the scope of any warranty protection)	2,623,672
20	R	CER political risk	Risk of Certified Emission Reduction (CER) delivery shortfall or failure due to host country political action (e.g. expropriation, nationalization, confiscation and prohibitions in connection with the sale of CERs).	2,615,596
21	S	CER performance risk	Risk of Certified Emission Reduction (CER) delivery shortfall or failure due to lower than expected plant performance.	1,512,113

Note: The expected loss represents the likely average annual loss associated with each risk as described in the Risk Assessment Chapter (page 7)

Contractual Risks

The number 1 ranked risk "B - Contract Bankability" concerns the risk of the project being unable to secure bankable offtaker contracts. In reality without long term offtaker contracts in place it would be extremely difficult for a project to obtain financing. The expected cost of over US$10 million could be an indication of the project development costs incurred and additional costs associated with trying to get the project back on track such as renegotiating or securing new offtaker contracts.

Ranked as the number one operating risk (ranked 2 overall) at an expected cost of just over US$9.2 million *Risk O - Warranty non performance* concerns the risk of the turbine manufacturer failing to meet contractual obligations under the equipment warranty. This is major concern for most wind farm projects which typically rely on 5 year manufacturing warranties to cover all equipment servicing, repairs and in many cases turbine availability. As the number of warranties provided grow and increase in tenure, manufacturers exposure to future liabilities is clearly a concern. Insurance protection for warranty providers is considered as promising instrument in Chapter 9.

Offtaker default – Risk N is ranked 3 overall concerns the electricity offtaker defaulting on contractual obligations under the PPA once the project is operating. The PPA provides the long term revenue certainty for the project so offtaker performance is heavily scrutinised by lenders / financiers. The current bidding process for securing long term electricity tariffs for wind power projects in China is currently under review. This could be a factor which heightens the perceived risk associated with a 25 year PPA in China. Creditworthiness and reputation are also likely to be key factors considered as part of the perceived risk associated with PPA as is the state ownership in and control over much of the electricity sector in China.

Risk G – Offtaker withdrawal is similar to Risk N above but is concerned with the risk of the power offtaker withdrawing from contract subsequent to financial close but before the project is operating. Ranked 7th overall this risk is deemed to be of similar impact but due to the smaller timeframe concerned is perceived to be less likely to occur than Risk N.

This risk may not be specifically concerned with the withdrawal from the PPA so could also include the offtaker withdrawing from other contractual arrangements that may be in place such as grid connections.

Operational / Technology / Performance Risks

As discussed previously the majority of risks feature in this category. Technical / Engineering hazards during the construction phase (Risk E) are ranked highest (4th overall) in terms of expected cost out of all the technology related risks. The key concern relates to defects in design, material / parts or workmanship which can cause physical loss or damage to project plant and machinery.

In many instances the presence of defects in design, material / parts or workmanship will only become highlighted once testing and commissioning is underway as this is the first point

at which the entire plants performance is being tested under operating conditions. Any defects identified at this stage of construction make repair and replacement far more expensive that at earlier stages and can cause significant delay to the overall operation of the project.

The human error element during construction / installation combined with technology concerns could be a reason for the perception that this risk is more significant (in terms of expected cost) that the other technology / performance related risks. For example Risk H – Catastrophic design failure and Risk I – Process Interruption both concern the performance of technology but feature lower down the ranking in terms of expected costs (ranked 8th and 12th respectively). Risk – H, the risk of complete mechanical or control failure during testing and commission due to defective design has the highest impact but is considered to have a much lower probability of occurring compared with the other technology related risks.

Physical Hazard Risks

Risk F – Physical hazards during construction concerns natural hazards and man made accidents (of a non design / technology nature) resulting in physical loss or damage to property under the course of construction. Of most concern in China are the natural hazards such as earthquake, typhoon and flood which can cause the greatest extent of damage to plant and machinery but occur relatively infrequently (see low probability scores for Risk F and J).

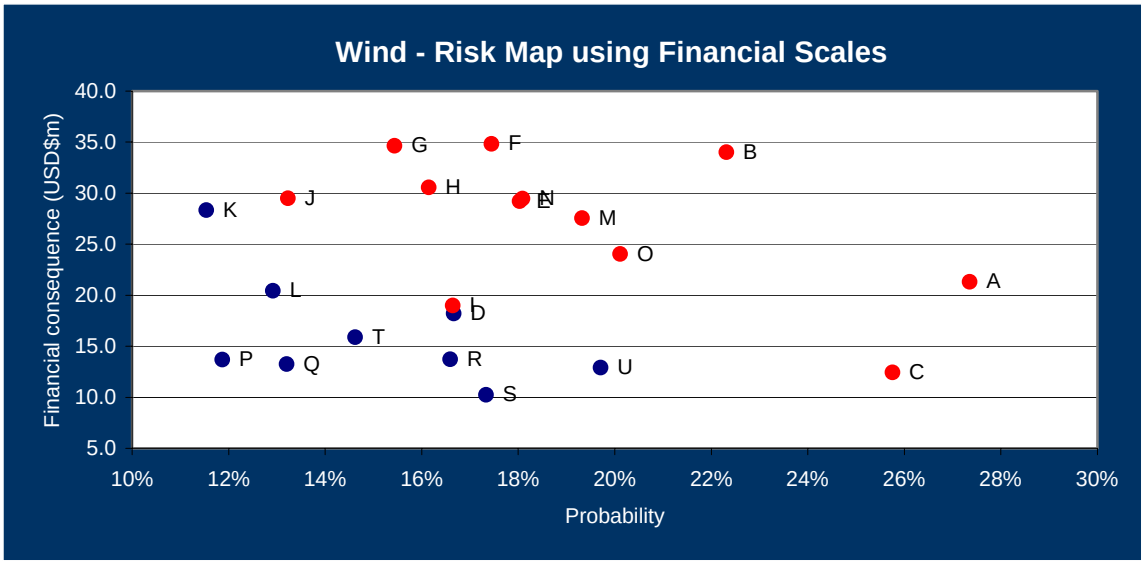
Although exposure to natural hazards / catastrophes is greater during the operating period when more assets are exposed for longer periods compared with during the construction phase, respondent perceptions indicate that there is greater financial impact and expected cost of this risk during the construction period. The risk map below (figure 5), shows that when considered in terms of financial impact only (Y axis) Risk F is the highest ranked risk overall, closely followed by Risk G and then B.

This could be explained by the fact that during the construction period the project may be more susceptible to damage from natural hazards / catastrophes with much of plant incomplete in term of strengthening and safety measures. Perhaps more importantly the project is perceived to be more financially vulnerable as cashflows and debt servicing will be delayed until the damaged parts are repaired / replaced and the plant fully commissioned.

The financial risk map below shows that Risk F – Physical Hazards has a higher impact but lower probability of occurrence that Risk E – Technical / Engineering hazards.

The other key physical hazard risk not yet discussed is Risk L – 3rd Party Hostility. This risk concerns the physical loss or damage caused by human action against the project such as strikes, riots, civil commotion and war. This risk is ranked 14th overall so is considered to have a lower expected cost that many of the other physical hazard and operational risks. As political stability is a key driver of this risk, respondents would seem to be reasonably comfortable with the political situation in China. This is also reflected by the very low ranking for Risk R - CER Political Risk and (ranked 20 out of 21).

Figure 5: Risk Map using Financial Scales



CDM Project Risks

Although certain CDM Project risks fall into the broader risk categories discussed earlier it is useful to consider the CDM Project risk under one common grouping. The highest ranked CDM Project risk, Risk C (CER Bankability) is defined as the risk of Certified Emission Reductions (CER's) not being recognized as bankable revenue streams (i.e. able to support debt service obligations). Interestingly based on the voting for likelihood this risk is ranked 2nd with a 26% average probability score or 1.2% probability of occurring in any one year. However, in terms of financial impact Risk C is considered to be less financially significant ranking as low as 20th overall.

This result implies that carbon finance is not yet fully utilized in the financing of renewable energy projects and in instances where it is used it may not provide a meaningful positive impact to the economics of the project. A key factor potentially reducing the potential benefits of carbon finance relates to the certainty around future delivery of CER's. As most project related contracts in the carbon market are done on a forward basis delivery shortfall or failure is a key concern for buyers. Analysis has shown that a wide range of risks can impact on the future delivery and marketability of CER which and this can lead to significant price discounting[1].

[1] Point Carbon

Several of the key delivery risks were identified in the survey but did not feature as prominently as the risks in terms of expected cost. Risks impacting on delivery were ranked as follows:

- CER insolvency risk (T) – ranked 15th
- CER regulatory risk (Q) – ranked 18th
- CER political Risk (R) – ranked 20th
- CER performance risk (S) – ranked 21st

The risk of CER delivery shortfall due to the insolvency of project proponents was ranked highest overall in terms of expected cost. Although quite similar in terms of ranking position to the other CER delivery risks the difference in terms of expected cost is over USD1.23 million. The concern over insolvency could be due to the characteristics of the CDM market, which sees many of the companies involved at project development being small start up operations which do not have the balance sheet strength European buyers and investors are used to dealing with.

Surprisingly CER delivery shortfall due to lower than expected plant performance is the lowest ranked risk in terms of expected cost overall. Again although close behind the other delivery risks in terms of ranking the expected cost for Risk S is nearly 40% lower than the next risk (Risk R – Political Risk) or 85% lower than the highest ranked Risk B – Contract Bankability. Respondents do not perceive that this is a critical risk which could suggest a level of confidence in the performance of the wind project in terms of CER generation.

The final CER related risk concerns the risk of limited marketability of emission reductions post 2012. This fundamental market risk will have the greatest financial impact on the project in terms of CER revenue post 2012. To address this risk we introduce CER price assumptions and model different pricing scenarios post 2012.

Chapter 9 discussed some of the FRM Instruments that could address “delivery” risks.

Other Identified Risks

Respondents were given an opportunity to identify and vote on additional risks which were of concern to them. A combination of contractual, financial and regulatory risks were identified some of which to some extend are covered by the existing pre-identified risks.

Although ranking is highly subjective and based only on individual voting it is useful to examine the risks and their relative significance. The first risk relates to the grid owner not accepting the electricity generated from the Wind project. This risk is similar to Risk N – Offtaker default but in this instance the risk occurs at a very early stage in project development. This would obviously be a major barrier to project development but it is unlikely to cause any major capital loss.

Two additional CER related risks were identified, one being CER fungibility risk and the other being CER Offtaker default. The Fungibility risk concerns the potential CER caps that could be introduced by EU member states wishing to prevent the overuse of CER for compliance purposes. Should caps be set to low this would have a detrimental affect on demand for CERs and CER prices. This type of regulatory risk is covered to some extent by Risk Q which has not been specifically modelled. However, we have modelled the risk of the CER price dropping to zero in Chapter 8.

CER counterparty risk is defined as the risk that the buying counterparty tries to renegotiate the CER price upon issuance of CERs. Fundamentally this is a contractual risk which could become more of an issue as a larger price differential emerges between the spot price of CERs and the forward price.

The next two risks are political in nature. The first involves action by host country government to withdraw incentives such as credits and capital subsidies designed to support project development. This is a common concern for the renewable energy industry which in many countries is underpinned by policy support measures. With the renewable energy law in China currently undergoing change we have stress tested possible changes to this regulatory support measure in our model (see Chapter 8). The second regulatory risk concerns a lack of local authority implementation of the renewable energy policy.

The final additional risk concerns an increase in CAPEX. This is a common risk associated with many projects and in the context of wind could be due to a wide range of factors including increases in wind energy component supplies. Towards the end of last year the wind industry has already experienced turbine supply constraints which led to price rises.

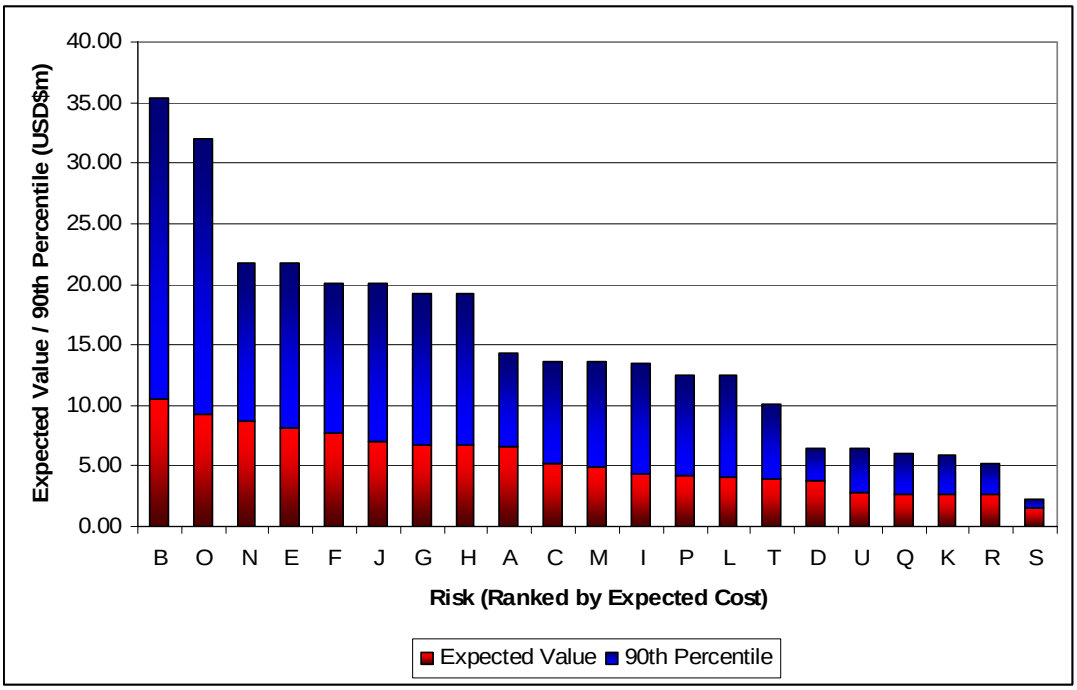
Crude ranking of risk criticalility based on individual votes was as follows:

1. Local Grid Permission
2. Fungibilty risks
3. CER offtaker default
4. Withdrawal of policy support measures
5. Lack of policy implementation
6. Capex Increases

90th Percentiles

Figure 6 shows the expected value (in red) for each risk and superimposes its 90th percentile cost (blue). The risks are shown ranked by their expected value.

Figure 6: 90th percentile results - Risks ranked by expected value



The 90th percentile reflects that response which was higher than 9 out of 10 responses. It represents an extreme case of the cost of the risk and can be viewed as a loss scenario that will occur once every ten years. Our analysis shows that the risk rankings according to the 90th percentile are ranked roughly in the same order as when expected values are used.

The 90th percentiles, while keeping risks in the same rough order, can change their relative significance. The average expected value across the top two risks B and O is 31% higher than that of the next six risks (N, E, F, J, G and H). However, if we use the 90th percentiles risks B and O are 65% higher than the six next risks. This highlights the importance of contractual risks in comparison to the others.

Using the 90th percentiles gives us confidence that there is no crucial risk that might have been overlooked if we based our findings solely on the average expected value across all respondents.

Survey Observations

It is possible to observe that the highest ranked risks relate to key contracts underpinning the revenue and technology aspects of the project.

As discussed the highest ranked risk concerns the inability to secure bankable offtaker contracts. This is a project development risk which affects many debt financed projects and can be difficult to transfer to other commercial risk takers.

The other contractual related risks relate to the non-performance and / default by the counterparty in respect of their contractual obligations. Some of these such as offtaker default are symptomatic of doing business in emerging and developing markets and others such as warranty non-performance are inherently linked to technology concerns.

Most of the risks ranked in the top 13 were operational in nature. Several related specifically to technology efficacy such as design failure and process interruption. Again this is a symptom of new technology which, when combined with inexperienced operators and contractors, creates a great deal of concern for commercial financiers and insurers. Wind volatility also featured in the top 13 which is illustrative of the resource dependent and vulnerable nature of wind and other renewable energy technologies such as biomass, biogas, geothermal and small scale hydro.

Physical hazard risks, particularly those occurring during the construction stage are perceived to be the most threatening to the project. Natural hazards typically are catastrophic impact low probability risks which fall outside the control of the project.

Based on the survey results and in the context of project financing it is possible to define critical risks as those which threaten project completion and revenue stability.

5

Addressing Critical Risks

Key Messages

Many of the critical risks identified by the study can be mitigated by a combination of existing and emerging FRM instruments both insurance and non insurance.

Traditionally contractual risks prove to be the most difficult risks to mitigate using FRM instruments. However, there are some cases where contractual risks with underlying technology or political characteristics can be addressed by new and emerging instruments.

Warranty Insurance could address the risk of the turbine manufacturers defaulting on warranty obligations and Political Risk Insurance can provide protection in the event of the electricity offtaker not honouring the PPA.

Notably, traditional Insurance could address over 50 % of the risks identified by the survey. Typically these insurance products respond to risks of physical loss or damage, machinery breakdowns and any resulting business interruption caused by a wide range of human and natural perils during the construction and operation of the project. However there are constraints on the availability and breadth of cover in China for certain products.

For price and wind resource risks quite sophisticated products such as futures options and weather derivatives are explored.

FRM instruments were selected on the basis of their ability to address critical risks (top 13 ranked risks from the survey) and on their availability in the market place.

On the basis that contract bankability risk occurs during the project development phase and is a fundamental requirements for the project to reach financial close it is considered that this risk most effectively managed by the project. There may be some government / donor sponsored risk mitigation tools available to address this risk but it is considered that very few commercial stakeholders would be willing and able to manage this type of risk.

As discussed in Chapter 3 contractual risks feature prominently in the top 13 ranked risk. Typically contractual risks by their very nature are difficult to mitigate using traditional financial risk management instruments and are normally managed contractual between the parties concerned.

For this reason few FRM instruments that can address contractual related risks have been selected. The exceptions to this are Risk O – Warranty Non-Performance and Risk N - Offtaker default. Although still at an evolutionary stage of development with limited market appetite, Warranty Insurance could address the warranty liabilities of turbine manufacturers. This is discussed in more detail in the Promising FRM Instruments Chapter 9.

Although not immediately apparent Risk N – Offtaker Default can be considered a political risk due to the fact that the electricity offtaker is state owned as is the case with much of the power and utility sector in China.

Political Risk Insurance typically provides cover in instances where actions of a foreign government or government entity that may deprive an investor/corporation of all or part of its assets or financial investments located in the foreign country. Commercial insurers are now willing to expand the scope PRI cover to include not only action by the host government to prevent or restricts the performance of a contract but also the non-honouring of government undertakings including those that may be contained in a PPA.

Although this coverage can protect a range of different interests including, book value of foreign equity, retained earnings and accounts payable, business interruption and extra expenses, for the purposes of this study cover is provided for loss of annual gross revenue.

Traditional project insurance products could address over 50% of the risks identified in the web survey occurring during the construction and operating phases of the project. As is illustrated by the survey voting, project completion can be severely hampered by major losses occurring during the construction period of a project. These may be as result of physical loss or damage to property during the construction phase of the project, which can typically be addressed by the Construction All Risks (CAR) policy. The CAR policy will cover all risks of physical loss or damage to project works including extensions for local transit and storage, debris removal, fire fighting expenses, professional fees / documents and plans and expediting expenses.

Engineering risks such as those associated with defective design, parts and workmanship can also be addressed to some degree by CAR Insurance. However, CAR insurance for wind projects typically only covers the resulting physical loss or damage caused by such engineering perils but will not cover any defective parts themselves.

The entire physical hazard related risks (Risks J, L and K) occurring during the operating phase of the project can be covered by a combination of an Operating All Risk and Machinery Breakdown policy. As is the case during construction insurers are not prepared to provide full design cover under Machinery Breakdown policies for wind projects. Typically the more restrictive form of design cover (resultant damage only) is provided as wrap around the manufacturer's warranty.

Typically for more comprehensive and competitive polices are placed together under one operating package. In this way Property Damage, Machinery Breakdown, Business Interruption, Transit and Third Party Liabilities can all be provided under one policy. Figure 7 below provides details of all of the traditional project insurance policies.

Figure 7: Traditional Project Insurance Products

RISK TRANSFER PRODUCT	BASIC TRIGGERING MECHANISMS	SCOPE OF INSURANCE / RISKS ADDRESSED
Construction All Risks / Erection All Risks (CAR / EAR)	Physical loss of and/or physical damage during the construction phase of a project	All risks of physical loss or damage and third party liabilities including all contractors work - this is the main product
Physical Damage / Operating All Risks	Sudden and unforeseen physical loss or damage to the plant / assets during the operational phase of a project	"All risks" package including Business Interruption
Machinery Breakdown (MB)	Sudden and accidental loss or damage necessitating repair or replacement	Defects in material, design construction erection or assembly Fortuitous working accidents
Business Interruption (BI) / Delay in Start Up (DSU)	Interruption / interference / delay resultant directly from, or in consequence of loss or damage causing loss of profits / reduction in gross revenue	Perils insured under the Property Damage policy (BI). Perils insured under the CAR policy (DSU)
Transit	Physical loss or damage to equipment in transit to site from anywhere in the world by land, sea or air.	All risks including those resulting from war and strikes.
General / Third Party Liability	Liability imposed by law, and/or Express Contractual Liability, for Bodily Injury or Property Damage	Legal liability in respect of Death or bodily injury, physical loss or damage to third party property, trespass nuisance and interference.

Figure 8 below also shows a number of specialist and more sophisticated products that are available to address certain risks.

The risk of wind volatility (ranked 11th overall) could be addressed by a wind power derivative. This type of instrument will indemnify the project up to a defined amount per kWh if production falls below a specific point due to low wind speeds.

Although not modelled Risk C - CER bankabilty (Ranked 10th overall) could be addressed by an emerging insurance product called the Credit Delivery Guarantee (CDG). This product could also address a number of the delivery risks associated with CDM projects and is discussed in more detail in Chapter 9.

A CER futures contract could address the risk of the Carbon market collapsing post 2012 – as defined by Risk U – Limited marketability of CER's. By entering into a put option the project has the right but not the obligation to enter into a specific transaction sale (Put) up to a certain date. The price (Strike Price), quantity and terms of delivery are locked in at the trade date. The expiration or exercise date (Strike Dates) is also locked in at that time, that is the date after which the option buyer's rights to enter into the transaction terminate. The option seller must live by the decision of the buyer, and is paid a premium for selling the optionality or flexibility to the buyer.

Further details of the assumptions and pricing of each of the products is discussed in Chapter 7.

Figure 8: Financial Risk Management Instruments

	Risk	Risk Ranking	Project Phase	Financial Risk Management Instruments
B	Contract bankability	1	Development	None
O	Warranty non-performance	2	Operation	Warranty Insurance
N	Offtaker default	3	Operation	Political Risks Insurance
E	Engineering risks	4	Construction	Insurance (CAR)
F	Physical hazard (caused by man or nature)	5	Construction	Insurance (CAR)
J	Natural hazards	6	Operation	Insurance (Property Damage)
G	Offtaker contract failure	7	Construction	None
H	Catastrophic design failure	8	Construction	None
A	Permitting / Planning delays	9	Development	None
C	CER bankability	10	Development	Insurance (Credit Delivery Guarantee)
M	Wind volatility	11	Operation	Wind Power Derivative
I	Process Interruption	12	Operation	None
P	Legal liability	13	Operation	Insurance (Third Party Liability)
L	Physical hazard (caused by third party)	14	Operation	Insurance (Property Damage)
T	CER insolvency risk	15	Operation	Insurance (Credit Delivery Guarantee)
D	Contractor non-performance	16	Construction	None
Q	CER Regulatory Risk	18	Operation	Insurance (Credit Delivery Guarantee)
K	Design / Engineering Risk	19	Operation	Insurance (Machinery Breakdown)
R	CER political risk	20	Operation	Insurance (Credit Delivery Guarantee)
S	CER performance risk	21	Operation	Insurance (Credit Delivery Guarantee)
U	Long term CER marketability	22	Operation	Futures Contract

It should be noted that for the purposes of this study certain instruments have been selected for analysis. Under normal project scenario a far wider range of instruments should be considered for risk mitigation.

6

Modelling Approach

Key Messages

The modelling approach employed defines a range of parameters and assumptions from which to produce financial results. A range of inputs including annual energy production, operating revenues and payment waterfalls were used to generate results.

Some of the model parameters are fixed ("static assumptions"). Conversely some parameters cannot be calibrated as single figures so are represented as probability distribution ("dynamic assumptions"). The probability distribution is calibrated to account for a range of possible values.

A stochastic approach combining Monte Carlo simulations and stress tests is used to assess the projects financial performance under a large number of possible scenarios as well as test the projects ability to deal with extreme cases. The financial projections calculated by the model follow a classical project finance structure.

In summary the modelling approach consists of a three stage process:

1. Defining parameters/assumptions of the model, and specification dynamic parameters
2. Calculation of the wind farm financial results (cash flow statements, balance sheet, financial ratios).
3. Generate results using the model under a large range of scenarios (stochastic approach).

Inputs

The following quantitative assumptions represent the key parameters required as input into the model in order to generate the wind farm's financial results.

- Operational parameters specific to the wind farm itself:
  - Construction period – start, duration and capital costs
  - Site description (e.g. wind potential) and turbines specifications (e.g. model, power curve, lifetime)
  - Power Purchase Agreement data
  - Additional revenues (e.g. Certified Emission Reductions)
  - Operating costs
  - Manufacturer warranty details
  - Major risks during construction and during operation, with their probability of occurrence and impact (i.e. regulatory delays, natural or man made damage, machinery breakdown, legal liability)

- The project's financial parameters include:

  - Financial structure
  - Reserve accounts in place
  - Country's tax policy
  - Market data: inflation and Carbon data

Some assumptions are fixed or are not expected to vary significantly ("static assumptions"). Other assumptions are modelled using a probability distribution which defines a range of possible values and their associated probability for each dynamic parameter.

The wind farm model includes the following dynamic parameters:

- Construction start delay – e.g. due to regulatory issues
- Increased duration of construction – e.g. due to defective design, failure during testing
- Annual energy output variation – e.g. .due to variation of mean wind speed
- CER sale price variation - e.g. due to market volatility
- Availability of turbines
- Operating cost annual increase – e.g. due to inflation

Key risks identified in the web survey have also been included in the model assuming a probability of occurrence with a fixed or varying severity.

Certain risks and assumptions included in the model have been derived from the web survey. The web survey results provide a risk perception from a range of industry experts based on a given theoretical project. The experience under an actual wind farm will differ to the results of the survey due to volatility and the subjective nature of the wind farm.

Financial Results

Calculation of annual energy production

Mean annual energy production is a result of:

- the power curves of turbines operated on the wind farm
- the wind potential of the site

This result is adjusted with an uncertainty factor taking into account the variability of wind speeds from predicted values.

Net production additionally takes into account the downtime due to maintenance, repair, machinery breakdown affecting one or a few turbines, natural or man made hazards affecting the whole wind farm.

Calculation of operating revenues

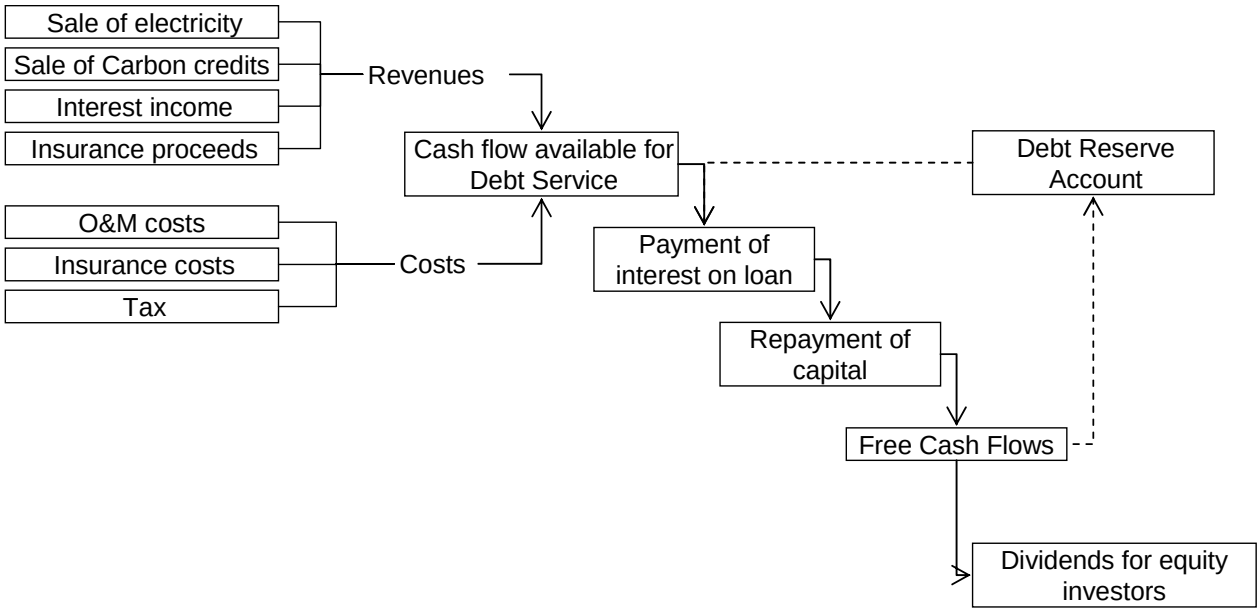
There are two sources of revenues:

- Sale of electricity: the amount of revenue depends on the energy produced during the period and the electricity prices fixed in the Power Purchase Agreement.
- Sale of carbon credits: the amount of CER to be sold depends on the project emission factor and the amount of electricity produced.

Payments Waterfall

Payments follow a classical project finance waterfall, as shown in Figure 9 below.

Figure 9: Payments Waterfall



The debt reserve account is used as a cash reserve when the operating cash flow is not sufficient to pay the debt service. It is funded up-front with an amount equivalent to six months of debt servicing. If the debt reserve is used, it will be refilled in the following years when positive free cash flows (remaining after debt servicing requirements) are available.

Calculation of the Financial Results

Financial statements typical for such a project as the wind farm are produced. Figure 10 which follows illustrates sample cash flow, income and balance sheet statements generated by the model.

Figure 10: Financial Outputs from the Model

Year

CASHFLOW **(in ' 000 $)**

Total revenues
- Electricity sale
- Carbon credit sale
- Interest income (on reserves)
- Insurance proceeds

- Total operating expenses
- Operation & Management
- Additional costs due to machinery damage or failure
- Legal Liability Costs
- Insurance & hedging

+ Capital increase from equity investors

- Taxes

Cash Flow available for debt service

- Interest on loan

- Repayment of loan principal

- Payment to / from reserve accounts
- Cash account
- Debt reserve account

Net Cash Flow from operations + financing

- Dividends distributed to equity investors

Free Cash

INCOME STATEMENT

Operating Revenues
- Electricity sale
- Carbon credit sale
- Insurance proceeds

Operating Costs
- Operation & Management
- Other costs
- Legal Liability costs
- Insurance & hedging

EBITDA

Depreciation

EBIT.

Net interest income
- Interest income (on reserves)
- Interests paid on loan

Net income before taxes

Taxes.

Net income from continuing operations

Non recurring events
- Sale of equipment or land

Net income.

Dividends paid to equity investors

Retained earnings

BALANCE SHEET (Period closing)

ASSETS

Current Assets
- Cash
- Debt reserve

Non-Current Assets

Property and equipment (net of depreciation)
- *Land.*
- *Turbines*
- *Other equipment*

Total assets

LIABILITIES AND SHAREHOLDERS' EQUITY

Liabilities.
- Senior loan

Shareholders' Equity.
- Share capital
- Cumulative retained earnings
- Retained earnings.

Total Liabilities and Shareholders' Equity

Stochastic Approach

Monte Carlo simulation

Monte Carlo simulation is a stochastic process that involves generating a series of random numbers to produce a possible outcome. This outcome is derived from the various fixed and dynamic parameters (where the parameter's value is determined based on a random number generated and its predefined distribution). This process is repeated many times (5,000 in this case) to derive a distribution of likely financial outcomes for the project.

The financial results from these simulations are compiled into a probability distribution. These distributions are then used to determine confidence intervals – e.g. we are 90% confident that the mean total asset value at the end of project's lifetime will be USDX.

Rating agencies and banks use this method to visualize the whole range of possible results of the project, the level of associated risk, and thus price the debt.

The simulation model processes are as follows:

1. Generate a series of random numbers and use this with each dynamic parameter's probability distribution to determine its value to use in a particular scenario.
2. Using the above and the other static parameters calculate the financial results for the simulation → scenario generated.
3. Steps 1 and 2 are repeated to generate 5,000 scenarios.
4. For a given financial measure use the model results to determine its likely distribution which will enable us to determine confidence intervals and percentile scores (e.g. the 90th percentiles as explained in Chapter 4).

Stress tests

Stress tests are used to investigate the likely effect of specific catastrophic scenarios on the project's financial performance. Stress tests are particularly used by banks to understand the resistance of financial covenants to major and unexpected risks impacts.

Typical stress tests for this type of wind project would include:

- A very bad wind year: wind speeds are decreased by 50% – to test if resulting revenues will be sufficient to cover operating costs and debt servicing for the year.
- Operating costs increase by twice the annual rate expected
- Carbon market collapse

The stress test process includes the following steps:

1. Modifying the model parameters as per the stress test analyses Figure 18
2. Running the model and observing the effect on the project's financial performance.

7

Definition and Calibration of Model Assumptions

A range of general, financing, capital cost, tax and economic assumptions are used for input into the model. The assumptions are based on several sources of information including but not limited to:

- Websurvey data
- The Jilin Tongyu Huaneng Project Design Document[2]
- Wind speed data from meteorogical stations in the Jilin region of China
- Market data on FRM instruments
- Sustainable Development Commission
- Marsh experience in the sector

Insurance Assumptions

In order to accurately reflect the cost of FRM instruments locally in China we have obtained pricing data from local insurers who are involved in underwriting insurance business for wind projects.

Insurance pricing, terms and conditions were obtained for all of the main policies expect Delay in Start Up (DSU) and Business Interruption (BI). These two policies are not typically provided by local markets as they fall outside the technical capabilities of the local underwriters. This is discussed in Chapter 10 and 11. In the absence of DSU and BI pricing locally, European insurers were approached to provide typical pricing for European based wind projects.

[2] http://cdm.unfccc.int/Projects/DB/TUEV-RHEIN1149172847.67/view.html

Wind Derivative

The Wind Derivative is a financial product to cover periods with low wind speeds and thus lower energy production. If the electricity production for one year is lower than the 168 GWh strike, then the wind derivative will indemnify 64 US$ per MWh below the strike. The strike 168 GWh corresponds to 66% of the average electricity production. Statistically, this level would be reached with a 1.5% probability.

The electricity production considered here does not take into account the energy lost when turbines are stopped (downtime due to machinery breakdown, natural catastrophe etc.).

Quotations for the wind derivative were obtained from several weather insurance markets and the most competitive selected for use in the study. These were based on real meteorological data obtained from nearby sites.

CER Futures Contract

The CER futures contract is a financial optional product to hedge low CER prices. If the CER sale price is lower than the 5 US$ strike, then the ERPA will indemnify the difference between the actual sale price and the strike, for a volume of 180 000 CER. The quotation for this product is a theoretical price based on historical market data.

Further details on the definition and calibration of model assumptions please contact Marsh.

8

Model Results

Key Highlights

The model output demonstrates that the project is expected to deliver on average 229 GWh of electricity output which generates US$64 000 of revenue per year.

Employing traditional insurance products would enable the project to borrow US$75m with a BBB rating over the US$116m of initial investment. The equity investors could expect an average 9.1% Internal Rate of Return.

However, the stress tests show the project is most vulnerable to a reduction PPA tariff (a 20% reduction was modelled) which would reduce the minimum DSCR from 1.98 to 1.00.

Removing traditional insurance products has a negative impact on project economics. As losses (which would otherwise be covered by insurance) have to be retained by the project, operating cash flows are less secure. In order to mitigate this financial strain

- the amount of debt is decreased to maintain a BBB rating level,
- the amount of equity is increased to compensate for a lower debt amount.

Evaluation of other FRM instruments demonstrates that Political Risk Insurance and the CER Futures contract are particularly beneficial to the economics of the project. Most notably these instruments allow the project to increase the amount of debt leveraged at a BBB rating. The results also indicate that the Wind Derivative appears to be too expensive to be supported by the project at this stage.

This chapter describes the results of the model based on the assumptions detailed in the previous chapter. The results are analysed mainly based on the Monte Carlo simulation output. These results are therefore presented as probability distributions in order to, for example, visualize the worst 10% of cases.

As a first step, we have considered solely a standard case, i.e. the project with the following traditional insurance policies in place:

- Construction All Risks (CAR)
- Delay in Start Up (DSU)
- Operating All Risks (OAR)
- Business Interruption (BI)
- Third Party Liability(TPL)

Noting the limited availability of certain standard products in developing countries such as China we then also compare the standard case with a diminished case, i.e. the project with less cover or no insurance cover at all, to evaluate the benefit of certain policies.

Finally, we have compared the standard case with an improved case, i.e. the project with standard insurance plus additional insurance and other financial instruments.

The additional products include:

- Political Risk Insurance
- Futures Contract
- Wind Derivative

Analysis of the standard case: project with standard insurance

We have first performed simulations for the project with standard insurance to value the project and confirm debt assumptions.

Three points of view have been considered:

- the global project performance in terms of energy production and cash generated
- the debt repayment
- the equity investors return

Project performance

Energy production

With its 67 turbines of 1500 kW each, the project is expected to produce on average 229 GWh per year. This is equivalent to:

- 2282 operating hours per year
- 26 % capacity factor

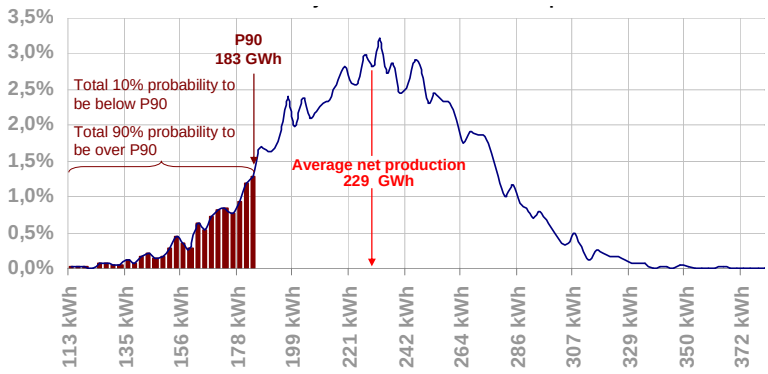


Figure 11: Probability Distribution of Energy Production

The exceedance probabilities (P50, P75, P90, P95) indicate confidence levels.

For instance, P90 is interpreted as the amount of electricity production reached with a 90% probability – 183 GWh. On the opposite, there is 10% probability that the project generates less than this amount of electricity. These confidence levels are necessary to evaluate the volatility of electricity production.

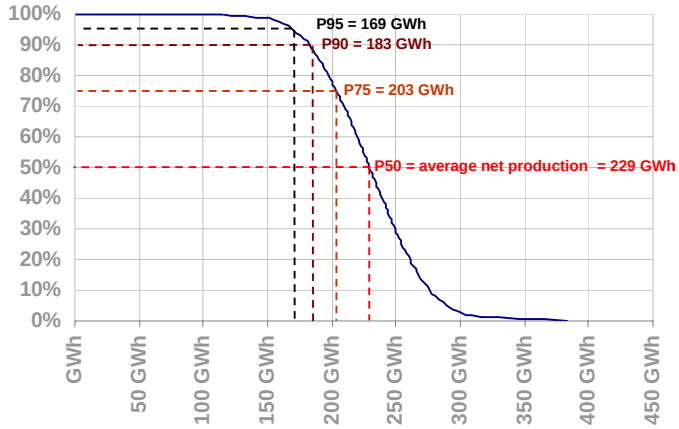


Figure 12: Reverse Cumulative Distribution of Energy Production

Operating revenues and costs

For 1 GWh of electricity produced:

- USD64 000 of revenue is paid by the off-taker for the electricity itself (with the increased tariff)
- 1005 CER units are acquired - if their price is USD15 the revenue is USD15 075

Therefore, CER revenues represent 19% of total operating revenues on average.

The project is expected to generate on average USD0.72 of operating revenues per kWh of electricity produced.
There is 10% probability for the revenues to be below USD0.61 / kWh.

Average expected annual revenues are therefore USD16.8 m.

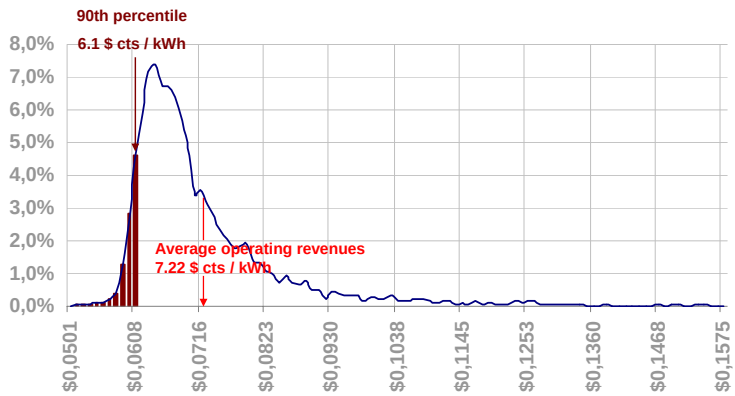


Figure 13: Probability Distribution of Operating Revenues

The project is expected to cost on average USD0.185 / kWh of electricity produced.
Average gross operating profits are therefore USD0.537 /kWh.

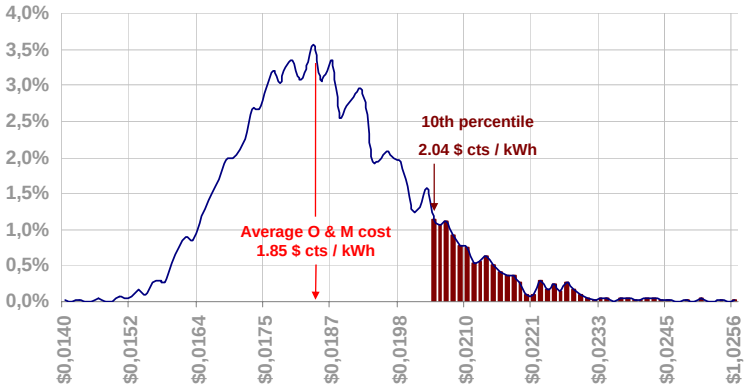


Figure 14: Probability Distribution of O&M Costs

Operating cash flows

The present value of operating cash flow on the whole project period (25 years) is USD116 m on average.

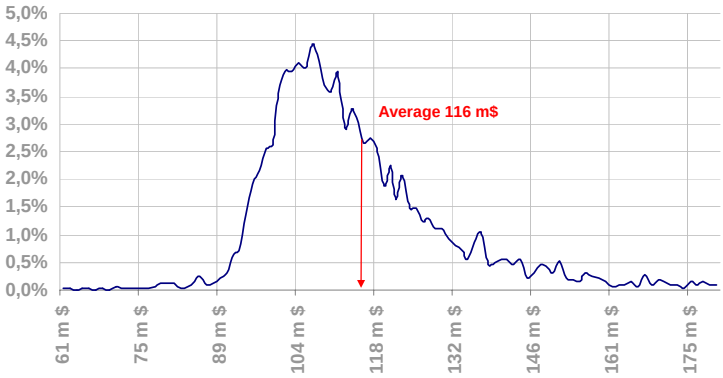


Figure 15: Probability Distribution of Operating Cash Flow

Debt service

In order to evaluate the risk associated with the debt repayment, three factors are measured:

- the simulated default rate indicating in how many cases would the project not be able to repay the debt
- the probability distribution of the Debt Service Coverage Ratio comparing the level of available cash flows to the debt service due for the fifteen years of the debt term
- the probability distribution of the present value of cash flows (available cash flows before debt servicing) representing the level of cash generated over the fifteen years

For this project, the simulated default rate is 1.6%. This rate is the simulated probability that the project defaults meaning either of the following:

- that at one point it has not been able to pay at least for interest service
- or that at the debt term, capital was not totally repaid

The Debt Service Coverage Ratio compares the cash flow available for debt service (including the debt reserve) to the debt service due for the period.

When the DSCR is below 100% the cash flows are not sufficient to pay for the debt service.

The probability that the MSCR (minimum DSCR) is below 1 is 3%. These results include cases of default and cases when the project is able to pay for interests only, and would repay capital in following periods.

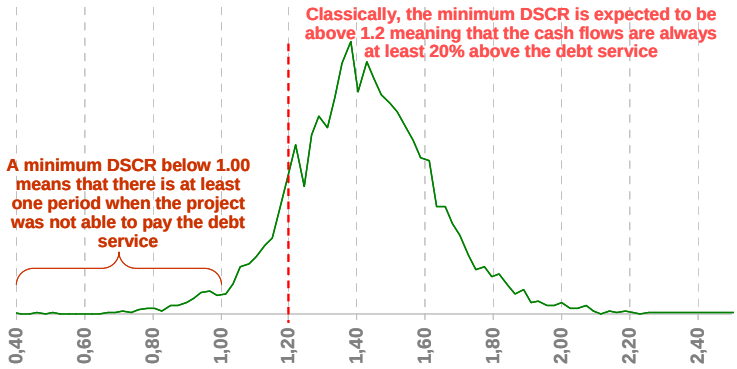


Figure 16: Probability Distribution of Minimum DSCR

Whereas the MDSCR represents the worst period, the ADSCR is the average DSCR over the fifteen years of debt term.

Here, the ADSCR is in most cases around 1.88.

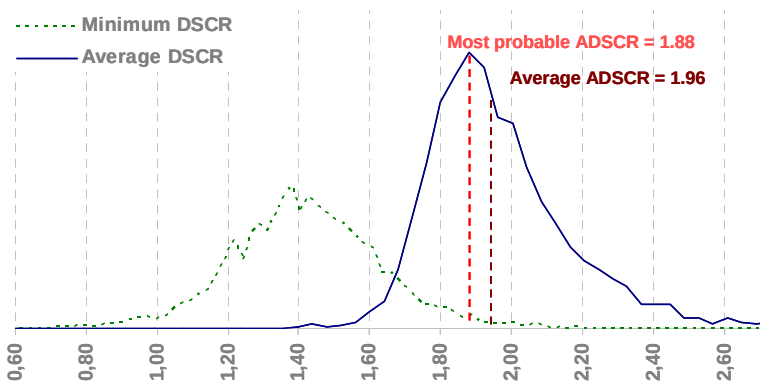


Figure 17: Probability Distribution of Average DSCR

The last factor analysed to determine the debt rating is the present value of operating cash flows over the debt period. It describes the total amount of cash generated over the debt term.

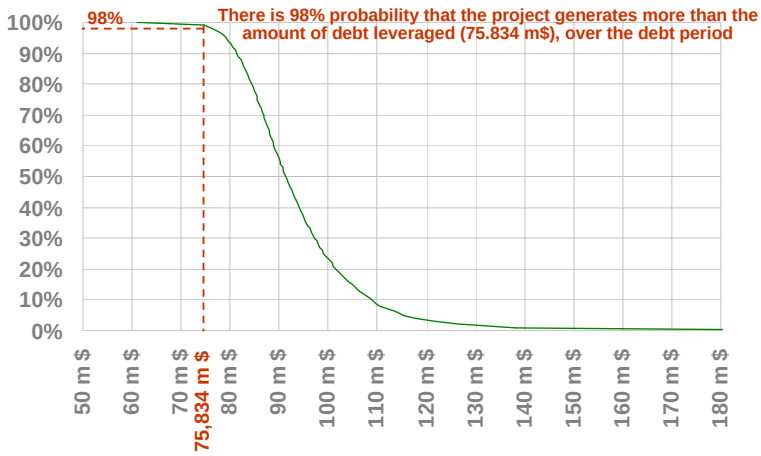
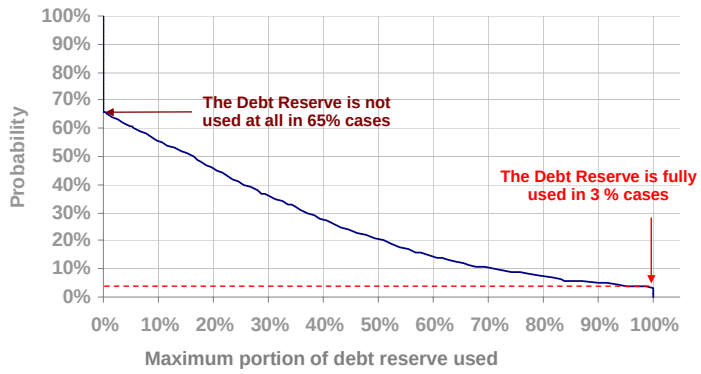


Figure 18: Reverse Cumulative Distribution of Present Value of Cash Flows

These three elements (default rate, DSCR and present value of cash flows) suggest that the amount of debt would have an equivalent rating BBB.

It is also interesting to look at the level of debt reserve to confirm that its calibration is optimised. The Debt Reserve account has to be calibrated considering:

- since it is funded up front, it should be as low as possible to decrease the initial investment
- with an higher amount of reserve, more default cases can be avoided



Here, the Debt Reserve account is fully used in about 3% of cases which correspond to the cases of default.

Figure 19: Probability Distribution of Debt Reverse Account Usage

In addition to the previous stochastic analysis, stress tests are performed to evaluate for instance the resistance of the project i.e. its capacity to repay the debt in particularly catastrophic but plausible scenarios.

The base case is used as a reference as it represents the most probable scenario or the average result for all key parameters. A P50 level is used as it represents the average energy production or the level of production reached with a 50% confidence level. The stress tests aim to determine how sensitive the project is certain scenarios. The prediction of wind speeds involves much uncertainty, whereas it is the primary source of revenues for the project. Therefore all the stress test are performed with a P90 level for energy production

(the level of production reached with a 90% confidence level). The second test only covers the wind factor.

The following stress tests each the impact of:

- a very high inflation rate (test N° 3),
- turbine underperformance (low rate for turbine availability in test N°4),
- a strong decrease in PPA electricity price from 2010 (test N°5),
- a carbon market collapse or other regulatory issues implying complete cancellation of CER revenues from 2010 (test N° 6)
- technology improvements or regulatory issues causing an unfavourable reassessment of the baseline emission factor and therefore strong decrease in CER issued (test N° 7).

		N°1 Base Case	N°2 Energy production	N°3 Inflation	N°4 Turbine availability	N°5 PPA tariffs	N°6 No CER revenues	N°7 Emission factor reassessed
Debt								
Min DSCR		1,98	1,66	1,66	1,44	1,00	1,20	1,52
Average DSCR		2,02	1,70	1,70	1,48	1,28	1,39	1,64
Operating Revenues								
Energy production (PXX)	0-100	P50	P90	P90	P90	P90	P90	P90
PPA tariff increase / decrease	%	-	-	-	-	-20%	-	-
from year	Year 2010 - 2031	-	-	-	-	2 015	-	-
CER sale price (if different from 15€)	€	15 €	15 €	15 €	15 €	15 €	- €	15 €
from year	Year 2010 - 2031	-	-	-	-	-	2 010	-
to year	Year 2010 - 2032	-	-	-	-	-	2 031	-
Baseline emission factor reassessment	%	-	-	-	-	-	-	-25%
from year	Year 2010 - 2031	-	-	-	-	-	-	2 014
Operating Costs								
OPEX annual increase (= inflation)	%	2%	2%	10%	2%	2%	2%	2%
Turbine availability	%	97%	97%	97%	92%	97%	97%	97%

Figure 20: Stress Test Analysis

All the stress tests show a minimum DSCR above 1.00 which means that in any of these cases the project would be able to repay the debt. The worst case is stress test n° 5 – a 20% decrease of PPA tariffs. The minimum DSCR is 1.00 which means that there is at least one period where the cash flow will be just enough to pay for the debt service. However, in that same test, the average DSCR is above 1.2.

Equity return

Equity investors participate in the initial investment (40%) and receive in return dividends based on remaining cash flows at the end of each period.

The Internal Rate of Return (IRR) is the discount rate that equals the present value of a future steam of cash flows to the initial equity investment. The IRR can be thought of as the annualized rate of return (in percent) of an investment using compound interest rate calculations.

When comparing several opportunities, investors would consider the project with the highest IRR as the most interesting to invest in.

Figure 21 opposite illustrates that the average IRR is 9.1%. However, it is likely that investors would probably not focus on the average IRR and instead would have a more optimistic view of potential returns. For example, the IRR could be dramatically improved if CER's could be sold at higher prices and if the wind resource is better than expected as illustrated by the analyses below.

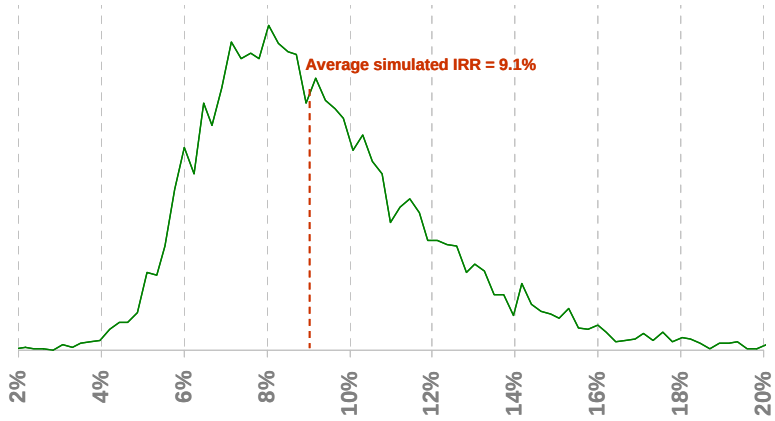


Figure 21: Probability Distribution of IRR

In order to evaluate the upside potential of the project, investors may test the benefit of optimistic assumptions (see Figure 22).

The following optimistic assumptions have been selected for analyses:

- Increased CER revenues as a result of improved CER sale prices at 30€ (test n° 2) and 20€ (test n°3),
- Increased electricity revenues as a result of improved PPA tariffs (test n°4)

Again the base case is used as a reference point as it represents the most probable scenario.

		N°1 Base Case	N°2	N°3	N°4
Equity					
Total Equity amount		39 066 000	39 066 000	39 066 000	39 066 000
IRR		10,7%	16,5%	13,5%	13,2%
Operating Revenues					
Energy production (PXX)	0-100	P50	P50	P50	P50
PPA tariff increase / decrease	%	-	-	-	+15%
from year	Year 2010 - 2031	-	-	-	2 010
CER sale price (if different from 15€)	€	15 €	30 €	20 €	15 €
from year	Year 2010 - 2031	-	2 010	2 010	-
to year	Year 2010 - 2032	-	2 031	2 031	-
Operating Costs					
OPEX annual increase (= inflation)	%	2%	2%	2%	2%
Turbine availability	%	97%	97%	97%	97%

Figure 22: Optimistic Assumption Tests

The results show:

- a 15% increase in PPA tariffs improve the IRR from 10.7% to 13.2%
- a favourable carbon market and potentially the ability of insurance products to enhance the CER sales price also significantly improves the IRR , from 10,7% if CER prices are 15€ to 13.5% if CER prices are 20€ and up to 16.5% with CER prices at 30€.

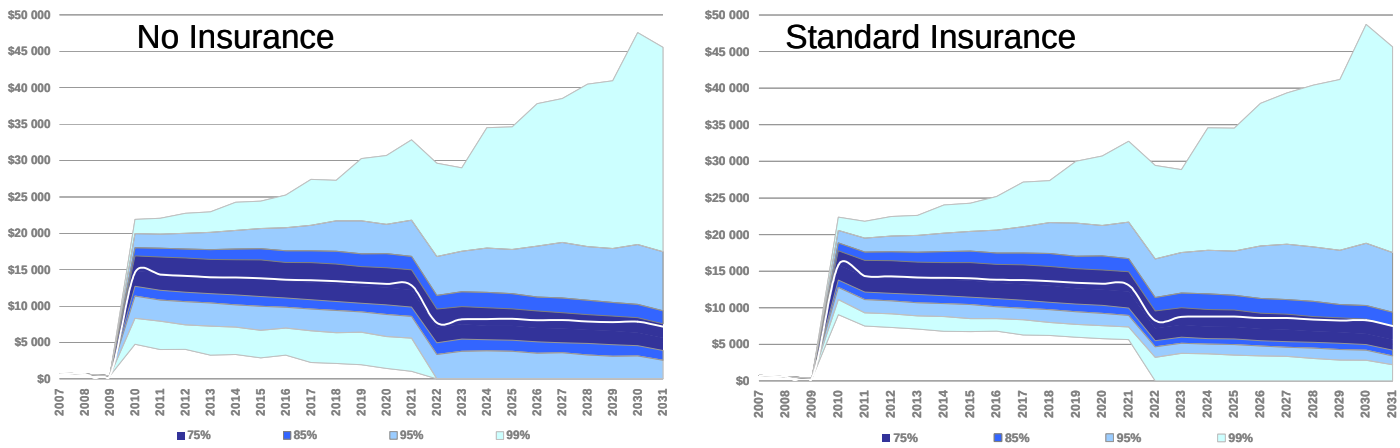
Benefit of Standard Insurance

To evaluate the benefit of standard insurance, we have compared three cases:

1. Our standard case analysed in paragraph 4.1 including standard insurance: Construction All Risk, Delay in Start Up, Operating All Risk, Machinery Breakdown, Business Interruption and Third Party Liabilities (referred to as “Cons + Op” on the graphs)
2. A case excluding Delay in Start Up and Business Interruption insurances which are of more limited availability in China (referred to as “Cons + Op – BI” on the graphs)
3. A case with no insurance at all (referred to as “No Insurance” on the graphs)

The immediate effect of removing insurances is that when an unexpected event occurs, the associated delays and costs are not compensated by insurance proceeds and therefore have to be supported by the projects own financial resources.

This is illustrated by the Figure 23 below:



LEGEND

Area between the 25th and 75th percentile. There is 50 % probability the model results are in this area.

Area between the 10th and 90th percentile. There is 80 % probability the model results are in this area or the darker one above.

Area between the 5th and 95th percentile. There is 90 % probability the model results are in this area or the two darker ones above.

Area between the 1st and 99th percentile. There is 98 % probability the model results are in this area or the three darker ones above.

Figure 23: Operating Cash Flows (with and without standard Insurance)

The two graphs show that the operating cash flows are more secured (close to the mean) with standard insurance in place: the uncertainty is reduced. During the years until 2021 there is virtually no chance of cash flows falling below USD5,000 in any year with "standard insurance" scenario.

For the years beyond 2021 while both scenarios have a likelihood of having USD0 cash flows in any year, the "No Insurance" scenario has a higher probability of occurrence (displayed by the second lightest blue area touching the lower chart axis as opposed to only the light blue area touching this line in the "standard insurance" case).

However, in the "No Insurance" scenario, insurance costs have been removed making the operating costs lower.

It should be noted that insurance:

- reduces the downside risk; and
- reduces the standard deviation of the results (the 3rd blue area is narrower in the standard insurance scenario)

To compare the three cases and analyse the impact of standard insurance, we have focused on the debt perspective (will the project be able to repay the debt as expected?) and the investors perspective (what rate of return can be expected?).

Debt service

As discussed previously, three elements are critical to the evaluation of the debt service:

- the default rate
- the Debt Service Reserve Account
- the present value of cash flows

Figure 23 below shows the default rates for the three cases. With standard insurance, 6.3% of default cases can be avoided. DSU and BI show only a marginal impact on the overall default rate (0.56% improvement) which suggests that their benefit is more meaningful in combination with other instruments. It should also be noted that pricing for DSU and BI is based on European market quotes, which may not accurately reflect what could be provided locally if the technical capabilities existed.

Figure 24: Default Rates for Selected Insurance Instruments

	Default rate
All standard insurance	1.16%
Standard insurance without BI and DSU	1.72%
No insurance	7.48%

The left part of the curve is much improved in the two cases with insurance, meaning that standard insurance has an impact on the cases with very low MDSCR and avoids a number of cases of default.

However, the impact of BI and DSU is less visible. The curve of the standard case is only slightly more on the right than the case without DSU and BI. This means that DSU and BI allow the MDSCR to increase a little.

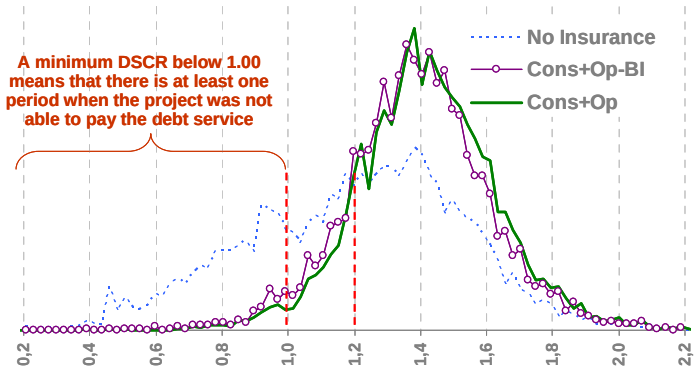


Figure 25: Probability Distribution of Minimum DSCR

The average DSCR curves confirm the conclusions from the MDSCR, however with less difference between the three cases.

Insurance has an impact particularly on worst cases, which are visible in the minimum DSCR. However, worst periods are diluted in the average DSCR and therefore they are not as visible in this curve.

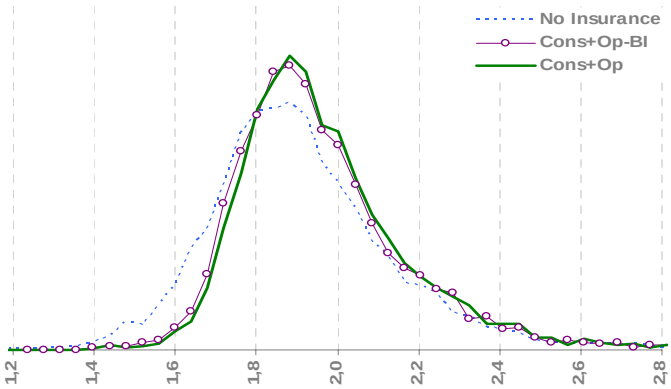


Figure 26: Probability Distribution of Average DSCR

Standard insurance also has a significant impact on the present value of cash flows: without this insurance, the confidence level associated with the amount of debt leveraged decreases from 98% to 94%.

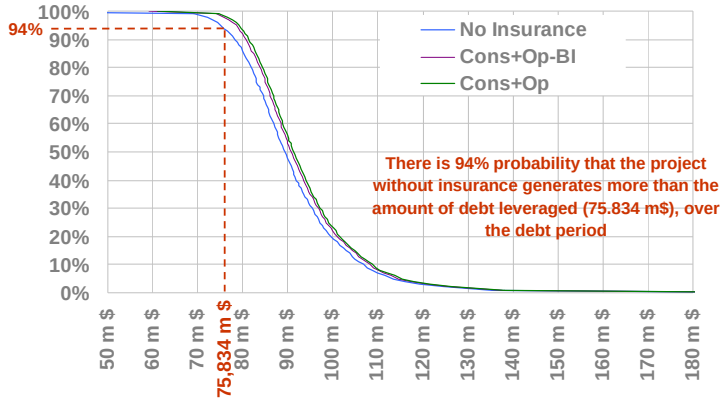


Figure 26: Probability Distribution of Minimum DSCR

Without insurance, the project involves far more risk as illustrated by the following negative impacts:

- there are 6.3% more cases of default on debt servicing
- the minimum DSCR are lower, and especially there are 30% cases with a MDSCR below 1,00 (compared to 5% with insurance)
- the probability that the project generates enough cash to fully repay the debt over the debt period is decreased by 5%

These impacts will threaten the projects ability to raise the required USD75, 834,000 of debt because the equivalent rating would fall to an estimated BB. Therefore, the debt / equity ratio has been adjusted to 60%/30% to lower the risk associated with the debt and to enable the project to reach a BBB rating.

Equity return

The best average Internal Rate of Return is reached when all standard insurance are in place.

Average IRR:
- No insurance: 8.2%
- Standard Insurance without BI : 9.0%
- Full suite of Standard Insurance: 9.1%

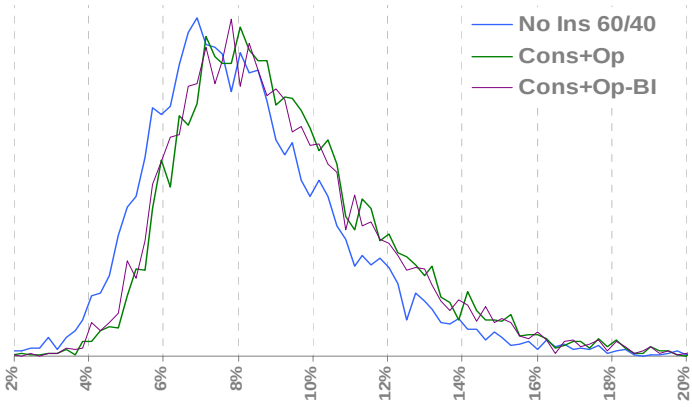


Figure 27: Probability Distribution of IRR

Benefit of Additional FRM Instruments

Three additional FRM Instruments have been selected based on the critical risks identified in the web survey, namely: political risk insurance, CER futures contract and a wind power derivative.

To evaluate the benefit of these additional instruments, six cases have been modelled:

1. Standard case as analysed in paragraph 4.1 including standard insurance: CAR, DSU, OAR, MB and BI.
2. A case including political risk insurance
3. A case including a CER futures contract
4. A case including a wind derivative
5. A case including the political risk insurance and the CER futures contract
6. A case including political risk insurance, a CER futures contract and a wind derivative

Debt service

The following table shows the default rate simulated for the six cases:

	Default rate
1. All standard insurance	1.16%
2. Standard insurance + Political Risk Insurance	0.70%
3. Standard insurance + CER futures contract	1.06%
4. Standard insurance + Wind Derivative	3.04%
5. Standard insurance + Political Risk Insurance + CER futures contract	0.54%
6. Standard insurance + Political Risk Insurance + CER futures contract + Wind Derivative	2.04%

The combination of Political Insurance and CER futures contract generates the lowest default rates (approx. 50% less than the default rate of the standard case). Conversely the two cases involving Wind Derivatives show the highest default rates.

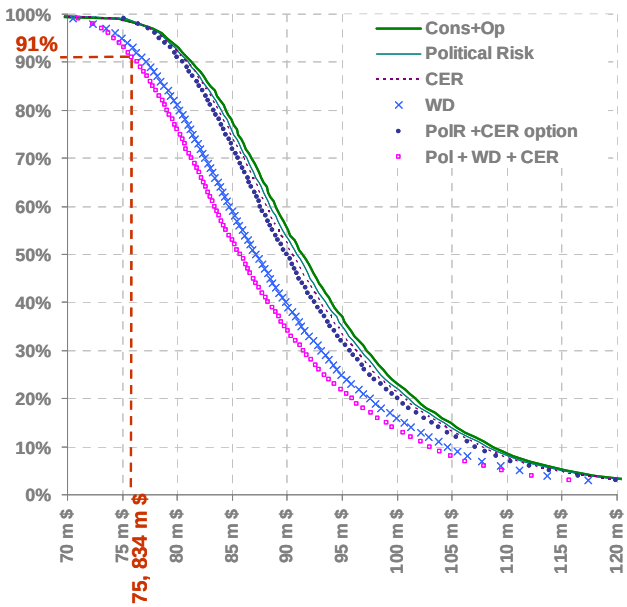


Figure 28: Reverse Cumulative Probability Distribution of Present Value of Cash Flows

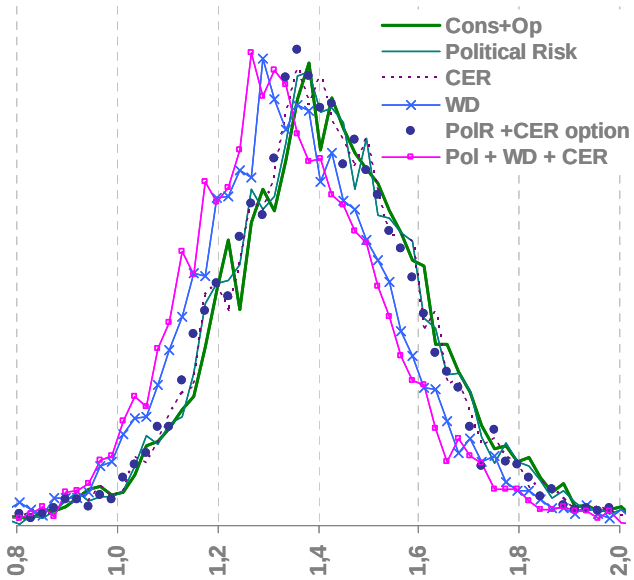


Figure 29 Probability Distribution of MDSCR

These curves in Figure 28 and 29 show a distinction between:

- the project with standard case (Cons + Op), with an additional Political risk insurance, CER futures contract, or both of them
- and the project with a Wind Derivative, combined or not with other insurances

The wind derivative reduces the DSCR and the cash flows generated, because it is prohibitively expensive costing USD300, 000 per year. The project is not able to support such an additional cost.

Evaluation of the political risk insurance and CER futures contract shows that default rates decrease by 50%. Therefore, in these two cases, the debt / equity ratio can be adjusted to 70% / 30%: a higher amount of debt can be borrowed USD80.4m attracting a BBB rating.

Equity return

The best average IRR is reached with the political risk insurance.
Conversely, the Wind Derivative reduces the equity return by more than 1%.

The average IRR is 9.1% but this changes with the introduction of each instrument as follows:

	IRR
Political Risks Insurance:	9.3%
CER option:	9.0%
Wind Derivative (WD):	8.0%
Pol + CER:	9.1%
Pol + CER + WD:	7.8%

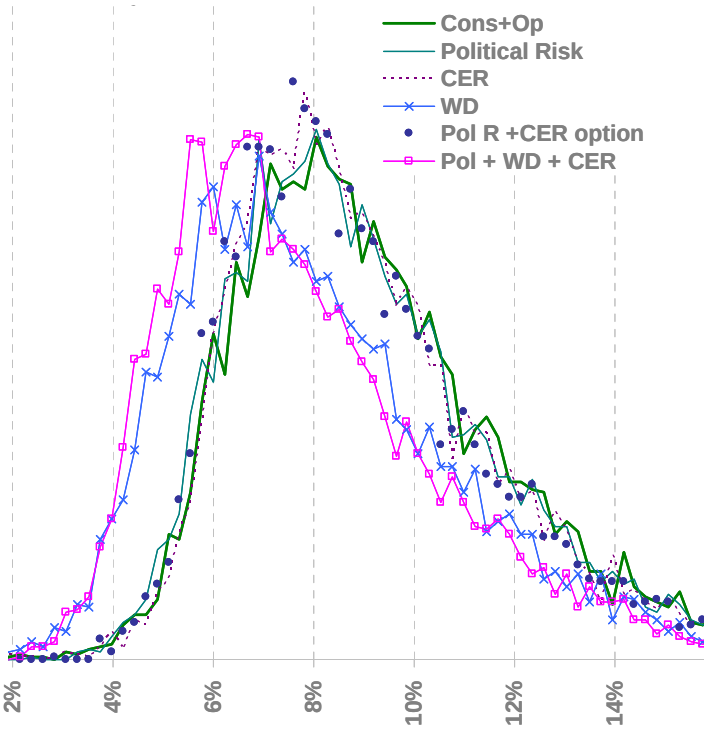


Figure 30: Probability Distribution of IRR

9

Promising New FRM Instruments

Key Messages

A range of traditional, non traditional, new and emerging FRM instruments were modelled to determine impact on project economics. Each FRM instrument addresses particular types of risk and in some cases such instruments provide an effective level of risk mitigation that can be economically supported by the project.

Consequential loss products (e.g. DSU / BI) can significantly reduce the default rate (from 3.38% to 1.72%) and improve the debt rating of the project. The value of the revenue protection afforded by these products is recognised and often imposed as a condition president by international lenders.

Political Risk Insurance is effective in mitigating the risk of offtaker default and the model shows the greatest positive impact on default rate and debt rating.

The Credit Delivery Guarantee, although not modelled, shows significant potential to mitigate a number of risks currently impairing CER forward transactions. Delivery certainty provided by "A rated" commercial insurers could enable future carbon flows to be more effectively monetized, increasing opportunities to leverage carbon finance.

Although still a conceptual product, the CER futures contract shows a positive impact on the default rate when used in combination with standard insurance. As the market for CERs becomes more liquid and exchanged traded, this type of product may offer effective hedging opportunities.

Warranty insurance offers significant scope for turbine manufacturers to offload future warranty liabilities. Although still underdevelopment this type of product offers several credit enhancement opportunities for domestic and international turbine manufacturers.

The project can not support the risk premium required for a wind power derivative. A more effective application could involve linkage to Business Interruption policies.

This Chapter focuses on a select few FRM instruments which show the greatest promise for addressing key risk exposures and offer potential for improving project economics. The basic mechanics of the product are considered along with the implications for deployment in the focus case study country China.

Delay in Start Up / Business Interruption Insurance

As discussed previously Delay in Start Up (DSU) and Business Interruption (BI) Insurance are designed to protect against the consequential financial losses arising from physical loss or damage insured under the construction all risks or operating all risks policies.

The study results show that project revenues can be severely impacted by any losses which cause a delay or interruption to the business. The modelling results show that BI can reduce the default rate of the project from 3.380% to 1.72% and improve the rating of the project from Baa 2 to A3 when compared to a scenario with out BI insurance.

Such revenue protection is recognised by international lenders / financiers who will often stipulate consequential loss coverage as a condition of financing. However in China it is apparent that most wind projects are currently financed locally without any requirement for consequential loss coverage's (DSU / BI). As the project has to fund these losses it must be assumed that this risk is currently factored into local financing terms.

There may be opportunities to achieve more favourable financing terms if it can be demonstrated that such revenue risks can be economically managed by transferring them to insurance markets. This is certainty recognised by most lenders involved in project finance in the developed world. The availability of such coverage's in China and other developing countries is however a problem which is explored in more detail in Chapter 11.

As an extension to traditional business interruption insurance, coverage can also be purchased for loss of earnings which occurs as a result of physical loss or damage at suppliers and customers premises. Perhaps more applicable to other renewable energy projects such as biomass, this cover will protect earnings in the event that a key supplier can not supply due to an insured peril. For wind farms, coverage could be provided to protect the projects earnings against the contingency of a loss which prevents the electricity offtaker from accepting the projects electricity.

As more international finance flows into the renewable energy sector in China it is conceivable that there will be a greater demand for consequential loss coverage. The clear lack of availability cover will become an increasing challenge for wind projects looking to raise international finance in the future.

Political Risks Insurance

This political risk insurance product is provided by commercial political risk insurers and has been adapted to be triggered by the non honouring of host government undertaking and the non honouring of an arbitration award.

It would be possible to obtain this coverage for this particular wind project because of the host government interest / ownership in the electricity offtaker company, which is quite common in China and other developing countries. The contractual arrangements under the power purchase agreement are in effect a host government undertaking which allows the investor to purchase protection against breach of contract or non honouring by the host government.

Robust international arbitration provisions need to be included in the PPA and these typically would need to reflect those contained in any World Bank project.

With very long waiting periods, potentially several years, this type of product is not designed to protect cashflow as such but rather the recovery of direct investments in the project.

Although expensive compared to traditional insurance products (with is reflected by a minimum DSCR of 1.29 compared with 1.5 in the base case) this product does have a positive impact on default rate and rating.

Credit Delivery Guarantee

Although not specifically selected as a FRM Instrument for modelling purposes it is useful to consider the positive implications this emerging product can have on project economics.

A Credit Delivery Guarantee (CDG) product is being offered by a select number of insurers to investors and buyers of emission reduction "credits" generated from Kyoto projects (so called Clean Development Mechanism and Joint Implementation projects). The product is designed to protect against "credit" delivery shortfall or failure arising under forward purchase agreements otherwise known as Emission Reduction Purchase Agreements (ERPA's).

During the negotiation of the ERPA, the allocation of such delivery risks between buyers and sellers is a key commercial issue and one which most obviously impacts on the price of contracts and the level of additional revenue the project can generate.

Where risk is not appropriately allocated or managed, price discounting occurs with forward contracts for perceived high risk, non guaranteed credits attracting the most severe price discounting.

The CDG product is a multi risk product covering several lines of business including:

- Credit risk
- Political risk
- Kyoto Regulatory risk
- Technology Performance risk
- Business Interruption

As more risk is removed from the project the level of price discounting should be reduced which can increase cash flows to the project. As more commercial banks and financiers get involved in providing debt and equity to projects, the transfer of key risks to insurance markets should also be reflected by more favourable financing terms and conditions.

Taking this a step further, it is conceivable that as confidence in the product builds buyers may be prepared to pay a premium on CER prices. Importantly, this could facilitate upfront payment for CERs bringing cashflow to the front end of the project. Optimistic assumptions have been modelled which show that increasing the CER sales price by Euro 5 to Euro 20 increases the IRR by 16.5% (a 26% rise from the base case).

The ability of the CDG to allow CER's to be incorporated into project financing decisions can bring significant benefits to project economics and ultimately could help to make more projects bankable.

CER Futures Contract

The CER Put Option enables the project to guarantee the sale of CERs at a specified price and in a specified time frame. Assuming there is a counterparty willing to enter into the transaction the project would be able to guarantee a minimum price of Euro 5 during a time (post 2012) when a great deal of political uncertainty exists over the future of the carbon market.

It is worth noting that Phase I EU allowances are currently trading at around Euro 3 due to over-allocation and by EU member states and the possibility that some installation achieved greater emission reduction than been expected.

The model demonstrates that this product would have the greatest impact on the default rate of the project, reducing from base case of 3.380% to 1.06%. However, there are limitations to this type of product which must be considered including the need for an exchange traded market for CER's. Whilst there are several exchanges for the trading of EU allowances currently no liquid exchanges exist for CER's. A trading exchange for CER's would allow for highly standardised contracts and delivery guarantees.

Turbine Warranty Insurance

The survey and modelling results show that the risk of the warranty provider failing to meet contractual obligations is significant.

As discussed as part of the Risk Assumptions this risk has been quantified by using the default rate of the manufacturer to determine the probability of default.

The justification for this is the increasing number, tenure and scope of warranties provided by wind manufacturers. Typically 5 year equipment warranties are provided by all the major turbine manufacturers as standard service included in the cost of the turbine. Increasingly full maintenance, servicing repairs and availability guarantees are also provided. Availability guarantees, guarantee a minimum technical availability from the

wind park and individual turbines under given wind conditions. In the event power output falls below the guarantee thresholds the project receives compensation.

These growing obligations pose significant future liabilities for some of the large US and European manufacturers. Typically these contingent liabilities are addressed through specific provisions on the balance sheet. For certain large manufacturers these financial provisions stretch well over USD100 million which can clearly have a detrimental impact on the financial strength of the balance sheet. For this reason manufacturers are very interested in FRM instruments which could help to transfer some of this contingent liability off their balance sheets.

In developing countries, manufacturers warranty liability may be less severe that that of European and US counterparts as market penetration maybe substantially smaller. However, this needs to be factored against weaker balance sheets which will work against smaller developers.

The insurance industry has been investigating turbine warranty insurance for several years. Typically the lack of available turbine operating data and a limited appetite for technology efficacy risk has prevented any meaningful response from the industry. Where manufacturers are prepared to share operating history with insurers there is significant potential for effective risk transfer to the insurance markets. There is one example of where this has occurred involving a turbine manufacturer who was able to insure a tranche of its warranty liabilities with a German insurance company.

By transferring warranty liabilities to insurers or other risk takers with superior balance sheets there are clear benefits to manufacturers who are able to free up credit facilities and reduce default rates.

Wind Power Derivative

Weather derivatives are essentially financial instruments used by companies to offset financial risk and uncertainty caused by weather volatility.

The weather insurance market, historically dedicated to energy companies, was used to trade mainly with temperature and precipitation indexes. The evolving needs of clients and the growing market appetite, has led major players of the weather derivative place to underwrite other underlying meteorological phenomena such as wind speed.

A fairly sophisticated market is now in place for temperature index hedging, but for other type of weather risk only a few Over the Counter (OTC) transactions occur. Customized wind power protection can suffer from the very different risk appreciation of the few market players that exist. For this reason, the wind derivative market is considered immature. However there are positive signals that this is changing as demand for lack of wind protection continues to grow and there is evidence of pricing stabilisation. For instance, the wind derivative quoted for this study was provided by two serious players but with significant divergence in loss calculations and pricing.

From a technical point of view, a customised wind power index is developed on the basis of historical wind speeds combined with the appropriate wind turbine power curve. This index forms the underlying risk and should be objective and reliable to fully reflect the parametric nature of this product.

Historical wind data is collected from nearby official meteorological stations, thus the underwriter will pay particular attention to the quality and sustainability of the meteorological network of the country. This can clearly be a problem for certain developing countries.

The Wind Power Derivative analysed in this study shows that the premium cost can be prohibitive in terms of project economics. Indeed, wind availability is the key performance driver of a successful wind energy project. The ability to transfer this entrepreneurial risk is equivalent to seeking equity risk takers. In a way this risk has to be mitigated during the early stages of the project, at the time the wind potential assessment is made.

Nevertheless a more economic and sustainable use of wind derivatives can be achieved when used in combination with other insurance products. For example, Business Interruption insurance could be linked to a wind derivative to better match the real loss of revenues during power outage periods by measuring the actual wind volume on the wind farm. This combined application could mutually enhance the effectiveness of the products and potentially reducing their overall cost.

Alternatively weather derivatives could help the financing of the project by introducing a wind interest swap, linking the interest portion of the debt service to the actual wind power production of the wind farm, thus fitting the commitment to the lenders with the revenues.

10

Product Suitability

Key Messages

Effective deployment of FRM instruments is conditioned by a range of legal, political, social and economic factors which will vary from one country to another.

For each of the FRM instruments consideration needs to be given to:

- Product status (e.g. is the product existing, emerging or evolving)
- Customer demand (e.g. is there sufficient customer demand for commercial application)
- Information requirements (e.g. what information is needed to underwrite risk)
- Financial market sophistication
- Cost / risk premium (e.g. how affordable is the product)

For example, wind derivatives although technically possible to transact for this wind project, may not be suitable for other projects which can not provide the required wind resource data. Similarly the risk premium for such a product may also be prohibitive but should be considered in the context of each projects particular risk appetite.

Evolving products such as the CDG and the Warranty Insurance offer promising levels of customer demand but also have high and medium levels of information requirements. Another evolving product, the CER Futures Contract like Warranty Insurance is constrained by the high cost to structure such instruments and the associated risk premium.

No FRM instruments offer a perfect solution in terms of suitability for deployment. However, many of these challenges and barriers to implementation can be overcome as products become more standardised and affordable and local capacity for deployment improves.

Having identified several promising FRM instruments which can have positive impacts on project economics the next step is to consider practical constraints and challenges posed when attempting to implement these instruments under local conditions.

This analyses aims to more clearly identify where intervention options by governments and donor agencies can be most usefully employed to remove barriers and facilitate private sector involvement.

Effective deployment of FRM instruments is conditioned by a range of legal, political, social and economic factors which will vary from one country to another. For this particular study the focus country is China but analysis of other countries could be useful in helping to understand trends and solutions that could be replicated.

This chapter focuses on several parameters which will affect the suitability of products for application in China.

Qualitative and quantitative parameters are used to evaluate each of the FRM instruments relative to one another as follows:

- Product status
- Customer demand
- Information requirements
- Financial market sophistication
- Cost / risk premium
- Product affordability

The status and availability of several promising products can be categorized as "evolving" or "emerging". Evolving refers to products that are under development or refinement for commercial application. The CDG is an example of an evolving product which is still to be effectively transacted at a commercial level by major (re) insurers.

Similarly the CER Future Contract is conceptually possible, once CERs are able to be exchange traded and a more liquid futures markets emerges. EU allowances provide an example of a closely related but significantly more liquid market which can support futures contracts. For this reason the CER futures contract is categorized as having a high requirement for a sophisticated financial market.

Emerging products such as the DSU / BI typically are widely utilized in developed markets but are still emerging in developing markets such as China. The next Chapter discusses some of local insurance market deficiencies which are the cause of this low take up. The Political Risks Insurance product considered in this study is unique in its characteristics and conditions for application. For this reason and the fact that very few transactions have been completed, it is considered as an emerging product.

This study considers customer demand for DSU / BI as being low currently in China. This is due to a number of factors including:

- Low product awareness and penetration in China
- Limited availability from local markets
- Low demand from financiers

Many of these factors are also relevant when considering the low awareness of the other products such as the CER Futures Contract, Political Risk Insurance and Warranty Insurance.

The CDG is considered to have a high demand in China specifically from project developers who have an interest in maximizing the price at which CERs can be sold and securing upfront payment for CERs. Warranty Insurance is also viewed as having high demand from manufacturers and in some cases from project developers. The demand from developers is supported by the survey results which show that the risk of warranty non-performance is a key concern for the project in China.

The demand for wind derivatives will be directly linked to wind variability at the project site and the associated revenue volatility this may cause. More revenue uncertainty will equate to a greater cost of capital. Based on historical wind data the wind resource at the project site is deemed reasonably good so there may be less demand to hedge cash flows against poor wind speeds. As more projects are developed in more marginal wind resource sites in China the demand for wind derivatives could grow. Low demand for derivatives will also be impacted by the high cost and information requirements needed to execute this product.

In relation to Information Requirements as has been mentioned Wind Derivatives and Warranty Insurance both require significant underwriting information in order to accurately price the underlying exposure. Typically to structure a wind power derivative there is a requirement for a minimum of 10 years wind resource data from nearby meteorological stations. This can be problematic for developing countries which may not have accurate historical wind data.

The more technical approach of international (re) insurance companies toward DSU / BI requires more detailed underwriting information with particular focus on risk management, loss prevention and loss control. Typically wind project underwriters will want to understand the underlying technology risk, replacement parts and contingency plans, site accessibility. For larger projects underwriters will often also require underwriting surveys to be undertaken by a suitable risk engineering experts. Such information requirements may not be easily accommodated in developing countries such as China.

To transact the political risks product the PPA required robust arbitration provisions which can be a significant barrier to implementation. Although a “high” level of market sophistication is a pre-requisite for transacting a futures contract the level of information required is relatively low. Typically, although there may be large quantities of

information required for insurance underwriting typically this is not considered burdensome in terms of availability.

As the modelling results indicate there is a significant risk premium associated with many of the products, with the futures contract and the wind derivative by far the stand out products in terms of cost. These types of specialized products require significant analytical expertise and therefore have high embedded transaction costs which are reflected in the risk premium. Typically DSU / BI employ a standardized underwriting approach and hence transaction costs are lower in comparison to the other products. Insurance market conditions and competition for this class of insurance will also play a significant role in pricing.

Ultimately product cost has to be considered in the context of financial benefit and risk appetite of each particular projects circumstance. As the modelling results show uncertainty can be considerably reduced by using such products.

Figure 31 below summarises the considerations for product suitability and provides and indicative rating for each of the parameters used to evaluate suitability.

Figure 31: Rating of Product Suitability

	DSU / BI	CDG	CER futures contract	Wind Derivatives	PPA PRI	Warranty Insurance
Product Status	Emerging	Evolving	Evolving	Available	Emerging	Evolving
Customer Demand	Low	High	Low	High	Low	High
Information Requirements	Medium	Medium	Low	High	High	High
Financial Market Sophistication	Low	Low	High	Low	Low	Low
Cost / Premium	Low	Medium	Very High	Very High	High	High
Impact on project economics	+	Not modelled	+	-	+++	Not modelled

11

Chinese Insurance Market Deficiencies

Key messages

The true value and benefits of several promising insurance products are currently being undermined by a range of domestic market deficiencies in China.

A lack of technical underwriting expertise and regulatory barriers are inhibiting wider forms of traditional coverage and the deployment of specialist consequential loss insurance such as Delay in Start Up and Business Interruption.

The standardised and non technical approach to underwriting renewable energy projects such as wind farms means that coverage can be inappropriate for the risk profile and exposure of the project. A lack of revenue protection during construction and operating can leave the project and its lenders exposed to cash flow and debt servicing problems.

Furthermore the inability of the local insurance market to meet a number of other lender insurance requirements such as "A rated" security, faulty design and terrorism cover, could put Chinese projects at a disadvantage to other projects in developing countries looking to raise finance.

International reinsurers offer technical expertise, security and capacity to overcome many of the local market deficiencies. However, several regulatory barriers exist which prevent international reinsurers from being able to access the Chinese market.

Several different insurance products have been identified as potentially offering significant benefits to the renewable energy industry in the People Republic of China (PRC). However, several insurance market deficiencies have been highlighted as barriers inhibiting the deployment of certain insurance instruments, particularly in emerging markets and developing countries such as PRC. Barriers may differ quite dramatically in other developing countries but generally speaking immature insurance markets a more limited technical underwriting capability with high regulatory barriers to entry for foreign insurers.

The main areas of insurance market deficiency in PRC can be summarised as follows:

- Market immaturity – "Infant Industry"
- Lack of technical underwriting expertise
- Regulatory barriers to entry
- Inability to meet international financing insurance requirements

Market Immaturity

The PRC insurance market, as in many developing countries, is still at a stage of relative immaturity despite rapid economic growth in recent years.

The domestic insurance markets ability to provide suitable products for consumers and industry is inhibited by regulatory oversight and a rapidly changing financial market. The regulatory framework also clearly plays a vital role in the demand for insurance products which historically has been very low in the PRC with an insurance penetration rate of 2.7% of GDP. A low level of ***risk awareness***, within the PRC, has been identified as a key factor in the limited uptake of insurance and is, in part, due to a lack of innovative marketing and insurance mechanisms.

Insurance market capacity within the PRC is rapidly expanding, particularly for property insurance, leading to fierce competition on premium rates. Premium rates can be up to 50 percent below international levels, a discount that most observers believe is not sustainable for the long term. The Chinese Insurance Regulatory Commission (CIRC) has expressed its concern about the souring level of competition and its impact on the insurance markets' long-term sustainability, indicating recently that it may demand that insurers adopt more responsible underwriting and rating structures.

State controlled insurance companies dominate the market. Of the 35 property/casualty insurers operating in the PRC at the end of 2005, the 22 domestic insurers held a market share of more than 98 percent. Despite a growing influx of private sector and international companies, state owned insurers still dominate due to their size, ownership of established distribution networks, claims handling systems and large institutionally linked client base.

For this reason the introduction of any new products needs to be done in close cooperation with the domestic insurance market and in particular the ex-state owned insurance monopolies.

Lack of technical underwriting expertise

Skill shortages in the PRC exist in most areas of the insurance industry, notably in product development, actuarial and engineering fields.

Insurance for wind projects is a specialist area of underwriting that is not well understood in the PRC. Wind projects are typically dealt with in a similar way to power plants for insurance purposes and hence a highly skilled technical approach is required.

The approach in the PRC and in many developing insurance markets is to approach a wind project in a similar fashion to other physical assets. For this reason coverage is not tailored to the needs of the industry and can be wholly inappropriate for the unique risk profile of wind farms.

Delays in Start Up (DSU) and to some extent Business Interruption (BI) are examples of specialist cover that are not typically provided by domestic insurers because of a lack of underwriting expertise and available reinsurance protection.

Figure 32 below details other areas where domestic insurance markets impose exclusions or more restrictive forms of cover compared with coverage provided by international markets.

Figure 32: PRC Insurance Restrictions and Exclusions

	China Market	**International Market**
Delay in Start Up	Excluded	Available
Design Coverage	Limited	Wider cover available
Business Interruption	Limited	Wider cover available
Testing and Commissioning	Limited	Wider cover available
Consequential loss from wear and tear, corrosion etc	Excluded	Available
Strikes Riots and Civil Commotion	Excluded	Available
Legal liability during construction	Limited	Available
Terrorism	Excluded	Available

As a result, significant gaps in coverage terms and conditions exist, which put Chinese wind farms at a disadvantage compared to wind farms with access to international insurance markets. This can be major concern for lenders and financiers as will be discussed below.

International reinsurers typically follow a more technical approach to underwriting and are comfortable with providing broader cover in many of the areas which are typically restricted or excluded by domestic insurers.

Regulatory barriers to entry

Although the Chinese insurance market has undergone significant regulatory reform since 2001 a number of challenges remain.

A key challenge relates to the ability of local insurers to access reinsurance capacity and expertise provided by international reinsurers. Most risks, including renewable energy risks, must be written in the PRC by a licensed insurer or reinsurer. Although the market

has moved away from state controlled insurance companies, foreign owned companies still only account for 1% of the non-life market share.

In many cases domestic insurers rely on reinsurance to spread the risk of new lines of business until premium volume reaches a certain point of maturity. This is particularly important when insurers attempt to underwrite new technology risks in areas such as renewable energy.

As previously mentioned, the leadership and technical ability of reinsurance companies provides domestic insurers with a source of pricing and underwriting expertise allowing them to enter new lines of insurance business.

Key regulatory provisions require that domestic insurers should reinsure on a priority basis with other domestic insurers or reinsurers and must offer at least 50% of the risk to at least two domestic reinsurers. Furthermore no more that 80% of the sum insured or limit of liability should be ceded (reinsured) to the same reinsurer.

The balance of any risk remaining after local retentions and following 50% cessation to licensed reinsurers can then be offered to (re) insurers outside of PRC. As a result of the limited direct access to the PRC insurance market many foreign insurance companies have struggled to generate profitable business in the PRC. Exacerbating matters, any new products that insurers wish to introduce to the Chinese market need to be submitted to the Chinese insurance regulator for approval.

In the case of the renewable energy sector in PRC even less business flows into the international markets as much of the risk is retained or reinsured locally due to the smaller insured values of renewable energy projects. Typically most domestic property insurers in the PRC rely on reinsurance treaties which allow a fixed proportion of all risks underwritten to be ceded to treaty reinsurers.

Reinsurance treaties are designed to be very broad in terms of the types of property and risks that can be covered. This allows domestic insurers to reinsure much of their portfolio under one policy which can be highly cost effective for the local insurers' and profitable for reinsurers. However, a major drawback of the current reinsurance treaty system in the PRC is that certain aspects of cover are specifically excluded. Notably many treaties exclude coverage during testing and commissioning phase of construction, at a time when cover is crucial as losses are both more likely to occur and can financially significant. Similarly consequential loss coverage (DSU / BI) is also specifically excluded by most reinsurance treaties.

As the previous chapters have emphasized, project completion and revenue volatility are major areas of concern from a financing perspective. The difficulties in purchasing insurance for losses during testing and commissioning and for revenue protection are considered as major weaknesses in the current domestic insurance market.

Similar restrictions also apply to foreign brokers which until very recently have also had extremely limited access to Chinese business. Many insurers and markets such as Lloyds rely heavily on brokers to originate business. As well as their extensive distribution

channels brokers also encourage innovation, efficiency and better value to the policy holder (insured and reinsured).

Lender Insurance Requirements

The need for insurance should also be considered from an international financing perspective. Typically lenders will look for project security and to transfer as much risk to third parties as possible. International lenders, usually expect standard project and operational insurance policies to be in place in a non or limited recourse project financing.

Irrespective of the cost and remoteness of large loss exposures, lenders and financiers will generally impose minimum insurance requirements with regard to the size and application of deductibles and insurance policy limits. For high value projects this can cause capacity problems for domestic insurers.

As well as traditional property and liability products, lenders and financiers may often also require consequential loss (DSU / BI) covers including suppliers and customers extensions, DSU from a marine peril, full faulty design cover and terrorism cover (depending on location).

Consequential loss coverage such as DSU are particularly important for project principles who are generally under substantial pressure to ensure the economic viability of their construction project by generating revenue immediately following the scheduled completion date.

Apart from faulty design cover (which is available in a more limited form) domestic insurers in the PRC are not be able to underwrite these risks and most would be excluded under reinsurance treaties. Contingent business interruption, also excluded by reinsurance treaties, can be particularly important to renewable energy projects with high supplier and / or customer dependencies.

In addition lenders / financiers will often impose a number of insurance related conditions and clauses designed to protect their interests in the project. These may include but are not limited to:

- Insurances to be in full force and effect at Financial Close
- Minimum notice of cancellation or change of terms
- All policy / insurer changes to be agreed with lenders
- Insurance market minimum levels of security
- Major CAR claims + DSU claims to be paid at Lenders Control (Loss Payee) to designated accounts
- Waiver of rights of subrogation
- Assignment of Insurance Policy (and/or Reinsurance Policy) to Lenders

Of particular note is the requirement for minimum levels of insurer security. Typically in project financed deals or deals where international lenders, export credit agencies or multi lateral lenders are involved there is a minimum requirement for insurer security of

S&P A-. This is a major barrier for many developing country domestic insurers such as those in the PRC which have only recently begun to introduce international standards of solvency margins and claims reserving.

For example, currently, none of the domestic PRC insurers are rated by international rating agencies such as A.M. Best and Standard & Poor's, which raises concern about their ability to pay a claim. As a result lenders will only accept local insurers who act as fronting insurers, ceding the majority (or as close to 100%) of the risk to A- or better rated reinsurers. Fronting can in itself be particularly problematic in the PRC as it is not usually permitted and if allowed may require approval from CIRC and the cooperation of one of the major domestic insurers such as Peoples Insurance Company of China (PICC).

The fronting issue can be overcome by offering a small retention (typically less than 5% depending on the size of the risk) to local cedents and then reinsuring the majority of the risk through international reinsurers. Provided the local retention is very small and appropriate cut through clauses are in place this type of reinsurance solution can be acceptable to international lenders.

Insurer security can also be an issue for international insurance brokers who also have in place minimum guidelines for insurer security. Typically, brokers have stringent requirements for insurer security ratings (for example, S&P rating of BBB or higher) and will also review policyholder surpluses which typically need to be at a local currency equivalent of US$25 million. For unrated companies, the international brokers require a policyholders' surplus of US$50 million and a satisfactory analysis of the insurer's financial condition. Although brokers do not guarantee the financial performance of insurers, the quality implied by broker approved security does provide clients and lenders with a degree of confidence.

Closely linked to the financial strength of the local insurer is its performance in settling a claim in the event of a loss. When a valid claim is made, insurers must ensure the timely settlement of the claim to the insured. However, often lenders will wish to have security over the insurances and therefore will request that the Sponsors rights, title and interest are freely assignable. This measure along with cut through clauses is design to enable the reinsurers to bypass the local insurer in the event that they go insolvent so that the principle insured and in many cases the lender still receive claims payment. This can be common requirement for projects in the PRC involving international lenders.

It may be difficult for renewable energy projects in the PRC, looking to raise international finance, to comply with many of the requirements detailed above. As claims payment and financial credibility continue to be a major concern for international lenders involved in developing countries and emerging economics, these challenges will also apply to many other Asian developing countries.

The significant growth potential for the region could be undermined by a lack of secure and broad cover and an inability to provide bespoke protection typically expected and in some cases required by international project developers, contractors, investors and most importantly financiers.

If the current local market difficulties are left unresolved this may negatively impact the flow of future investment into renewable projects in Asia. Therefore a major focus for public sector intervention should be on measures to overcome the current domestic insurance market inefficiencies.

12

Study Conclusions

The report findings clearly indicate that certain FRM instruments can have significant positive impacts on project economics. Typically FRM instruments which can mitigate the impacts of project completion risk and revenue volatility are particularly useful.

The modelling approach introduces some useful parameters from which to quantify the financial impacts of FRM instruments on wind project economics. Historically insurance has been viewed in rather more mundane terms providing security and piece of mind in the event of catastrophic losses.

Our analysis demonstrates that utilising the full suite of traditional insurance products during the construction and operating phase of the project can have a notable improvement on key financial parameters used by financiers to measure risk and reward associated with the project. Traditional insurance products provided notable improvements to the project default rate, debt service cash reserves and present value of cash flows. This has a corresponding positive impact on confidence levels and allows the project to raise the required level of debt and reach BBB rating.

Introducing other FRM instruments and comparing them individually and in combination also shows a range of impacts on project economics. Notably, when used in combination with traditional insurance, political risk insurance and the CER futures contract result in the lowest default rate of 0.54% (compared with 7.48% without any insurance). Conversely, the modelling also demonstrates that the cost of certain instruments can be prohibitively expensive; in the case of weather derivatives this can reduce the internal rate of return by more than 1%.

Importantly the model also allows the flexibility to measure upside potential of the project which can be extremely valuable for a more optimistic equity provider. Significant improvements in IRR can be demonstrated by using more positive assumptions in relation to PPA tariffs and CER prices.

Consideration must be given to the practical aspects of deploying FRM instruments in developing countries. The study analysis has shown that many products although conceptually promising and beneficial to the project economics face difficulties at the implementation / execution stage. Barriers to deployment such as lack of suitable risk information and underdeveloped financial markets will pose challenges in many other developing countries other than the China.

In particular a lack of underwriting skills and regulatory restrictions on foreign insurers in the China dramatically reduces the availability of certain products and the breath of coverage. The difficulties in purchasing consequential loss cover (DSU and BI) is considered to be a major stumbling block that will be viewed negatively by many international lenders and financiers looking to access the market in China. The important role of FRM instruments in supporting the uptake of renewable in China is given greater magnitude in the context of future renewable energy targets put in place by the government over the next two decades. For example, the government of the China has targeted 8,000MW of installed capacity by 2010 and is extremely ambitious target of 30,000MW by 2030.

Possible Next Steps

Intervention actions by the public sector should be focussed on removing barriers that prevent the deployment FRM instruments. Useful public sector intervention options should focus on insurance vehicles that can leverage both the underwriting sophistication, breadth of coverage and highly rated security of the international reinsurance markets whilst utilising established distribution channels and customer base of the domestic insurance companies. Such a platform would need to be compliant with local insurance regulations and sensitive to the needs of the local domestic insurers.

The value of replicating the study methodology has already been highlighted as a useful next step. This could involve expanding the scope of the existing approach to include a focus on other Renewable Energy technologies in other regions.

Similar risk modelling approaches could be used to more fully evaluate some of the others instruments which show promise for future application in developing countries such as China. Further such studies could be particularly useful for the Credit Delivery Guarantee and Manufacturers Warranty Insurance.

13

Bibliography

Jilin Tongyu Huang CDM Project – Project Design Document Submission 15th March 2006

Power Engineer, December 2006

SDC (2005) Wind Power in the UK, Sustainable Development Commission, available at www.sd-commission.org.uk/wind

Marsh Risk Alert – Understanding China Business Risk Environment, January 2007

Benfield Report - China Insurance Market Review, September 2006

UNEP Scoping Study on Financial Risk Management Instruments for Renewable Energy Projects – 2003

UNEP Background Study, April 2006

Appendix A – Summary of Project Definition

Location	Jilin Province, Northeast China
Technology	GTW 1500 KW turbines and associated sub stations
Installed Capacity	100.5mw (67*1.5mw)
Electricity Conversion Efficiency	28.8%
Annual Emission Reductions	253,287t/CO2
Project Financing	
- Investment (USD)	120,000,000
- Debt to Equity Ratio	66.6/33.4
Revenue Streams (Annual USD)	
- Expected Electricity Sales	20,000,000
- Certified Emission Reductions	2,200,000
Expenditure (USD)	
- Capital Expenditure	1250 / kW
- Operating Expenditure	28.5 / kW
Key contracts	
- Construction	Engineering Procurement and Construction
- Power	15 years PPA
- Certified Emission Reductions	25 year fixed price forward (payment on delivery)

NB: Certain project information has been revised / adjusted for use in the financial model.

Appendix B – Respondent Profile

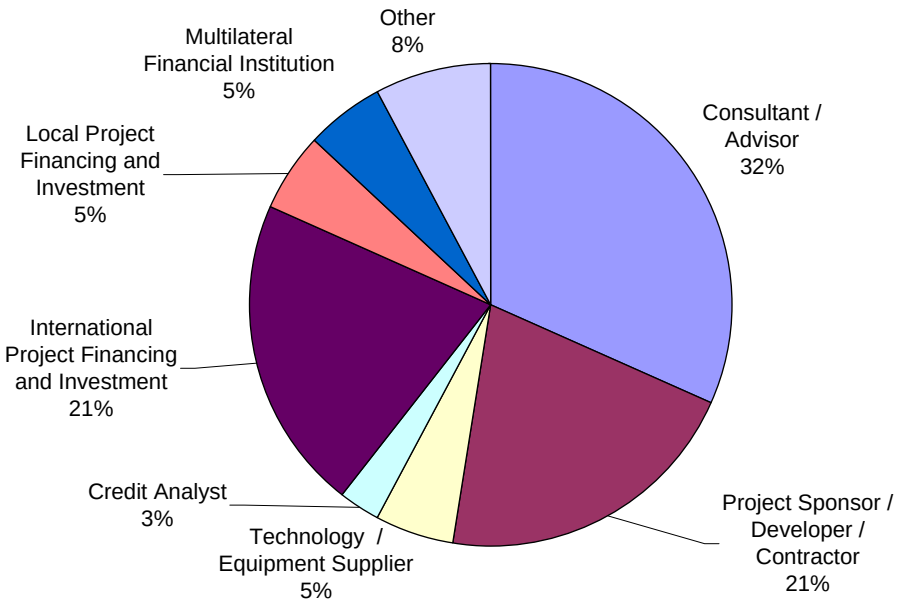
Respondents who participated in the survey were selected on the basis of their qualified expertise in the renewable energy sector with a particular focus on wind projects in Asia.

31 responses were received from a range of experts involved in different aspect of the renewable energy sector from project developers and financiers to credit analysts and equipment suppliers.

Such a range of experts were selected in order to reflect the unique nature of the pre-identified risks. These ranged from the more technical engineering related risks through to more generic contractual and market based risks. Each of the respondents provided a highly qualified and unique perspective on the risks which was vital for capturing perceptions on such a wide range of risk issues.

The main business activities include consultants / advisors (32%) financiers (26%) project sponsors (21%). The financiers group were made up largely of international financiers (21%) which included several firms generating over USD 1 Billion in revenue. Local financiers made up the remainder of this group with 5%. The "other" category (making up 8% of the total responses) included government advisors / policy makers, NGOs and academic / research organisations.

Respondent Profile – Business Activity



Appendix C - Risk Voting Scales

Respondents were asked to vote against risk impact and likelihood using the 5 point scale detailed below:

Risk Impact

The Risk Impact is a measure of the financial impact before any recoveries are made from insurance or other third parties, should the risk materialize in any given financial year. For the purposes of the survey, respondents were asked to assume that there were no controls in place. In some cases it is more appropriate to envisage the impact of a risk in more qualitative measures. Therefore additional scales are aligned with the financial impact.

Respondents were asked to assess Risk Impact using the point scale illustrated below:

	Qualitative Impact	**Financial Loss (US$)**	**Reduction in EBITDA**
1	Negligible	Less than 50,000	<1%
2	Minimal	50,000 -1million	1-10%
3	Significant	1-10 million	10-50%
4	Major	10-50 million	50-100%
5	Catastrophic	>50 million	>100%

Risk Likelihood

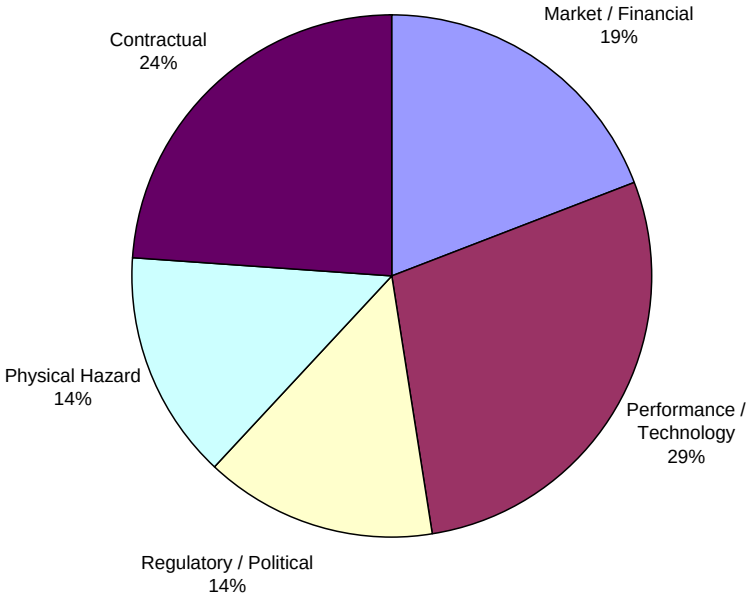
Risk Likelihood is the second factor to be evaluated for each individual risk and represents how likely it is for the risk to materialize in any given financial year.

Respondents were asked to assess Risk Likelihood using the point scale illustrated below:

1	Very unlikely	Not going to occur, less likely than a 1 in 25 year event
2	Unlikely	Unlikely to occur but not impossible e.g. between 1 in 10 and 1 in 25+ year event
3	Possible	Less likely than not to occur e.g. between 1 in 3 and 1 in 10 year event
4	Probably	Between 1 in 2 and 1 in 3 year event
5	Very likely	Very likely though not certain to occur e.g. every year occurrence to a 1 every 2 year event

Appendix D – Risk Categorisation

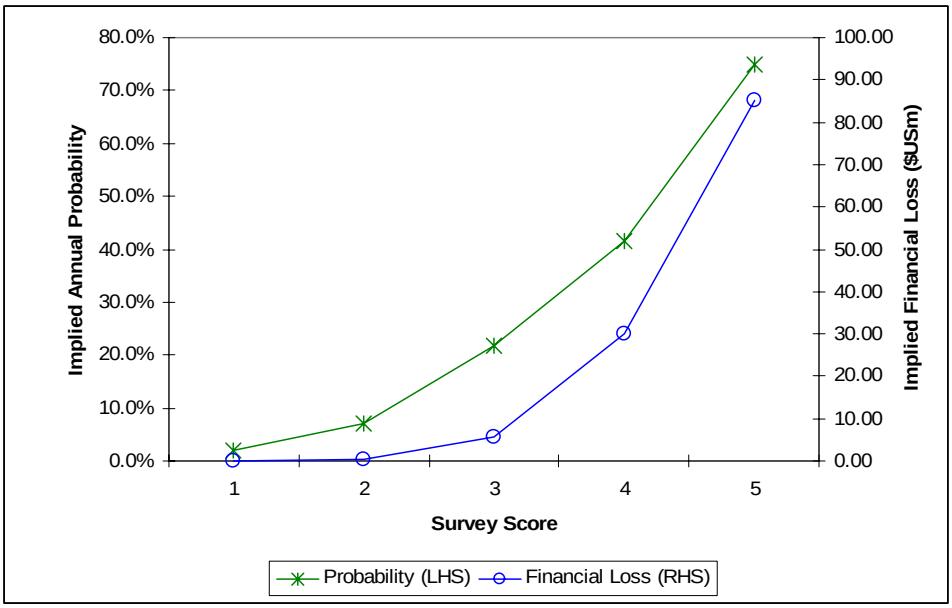
The risks identified through the websurvey can be categorised into the following categories:



Appendix E - Survey Score Analyses

The chart below shows the five survey point scores against their implied midpoint financial loss value or midpoint annual probability.

Survey Score versus Implied Annual Probability and Financial Loss



The chart above demonstrates the non-linearity of the translation of the survey scores into their financial metrics. A vote of 2 corresponds to a financial loss of USD0.5m while a 4 corresponds to a financial loss of USD30m. A 4-vote is, in terms of financial loss, worth almost 60 times the value corresponding to a 2-vote.

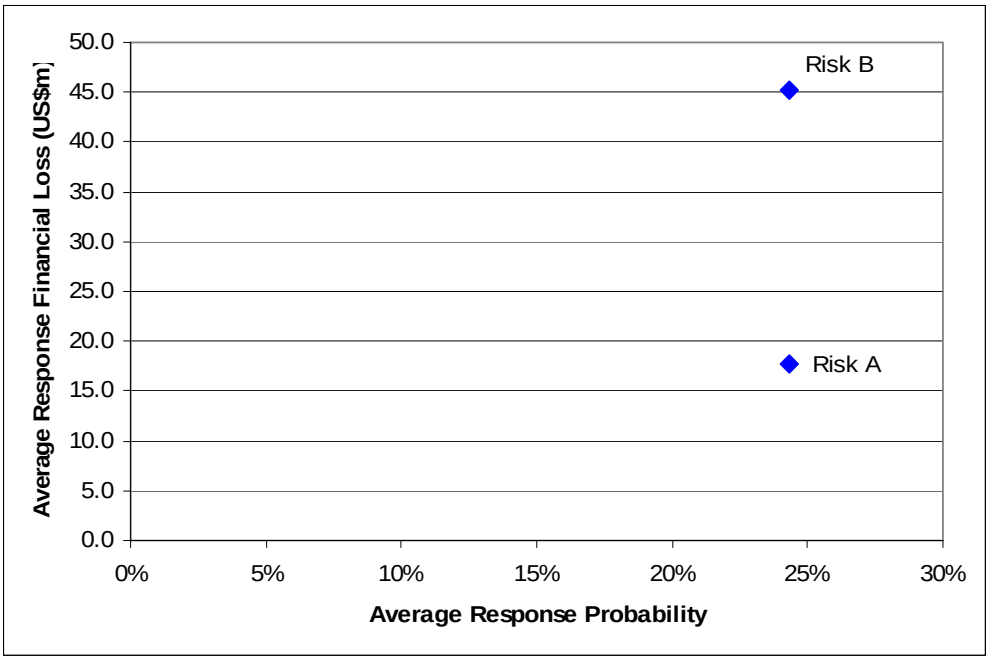
A similar phenomenon occurs with the translation of likelihood into probabilities.

This non-linearity causes some unintuitive results when the survey votes are averaged across all responses. The following tables and chart giving a hypothetical example illustrates.

Hypothetical Calculation of Expected Value

Risk A					
Respondent	**Impact**	**Financial loss**	**Likelihood**	**Probability**	**Expected value**
Person 1	3	5,500,000	2	7%	385,000
Person 2	4	30,000,000	4	42%	12,500,000
Average		**17,750,000**		**24%**	**6,442,500**

Risk B					
Respondent	**Impact**	**Financial loss**	**Likelihood**	**Probability**	**Expected value**
Person 1	3	5,500,000	4	42%	2,291,667
Person 2	5	85,000,000	2	7%	5,950,000
Average		**45,250,000**		**24%**	**4,120,833**



The risk map above shows the average respondent probability and financial loss for two hypothetical risks ("Risk A" and "Risk B"). Averaging the respondent probabilities and financial loss in isolation makes Risk 2 appear more crucial than Risk 1.

However, looking at the tables above when we calculate the expected values for each respondent then average those expected values across the two respondents we arrive at the conclusion that, based on expected values, Risk A is more crucial than Risk B.

While the results are quite different it is worth noting that the above methods are two different ways of viewing the importance of each risk. They compliment each other in terms of helping us to understand the relevance of each risk.

In this case, the analysis points to the fact that Risk A cannot be dismissed in our analysis given its expected cost. The analysis in this report rank the importance of risks according to their expected costs as this combines the information given on a risk's impact and likelihood, however, risk maps are still shown in order to round out the analysis.

Appendix F – Websurvey Results for Use in Modelling

UNEP - Renewable energy - Model assumptions - Wind

Risk rank	Question #	Question	Phase	Financial product available	Average response cost	Average response probability	Horizon	Annual response cost	Annual response probability	Expected value of risk	Average months downtime
1	2	Being unable to secure bankable offtaker / fuel supply contracts.	Construction	N	34,004,167	22%	3	11,334,722	7.4%	10,465,953	
2	15	Warranty provider failing to meet contractual obligations.	Warrantee	N	24,022,321	20%	5	4,804,464	4.0%	9,235,476	
3	14	Electricity offtaker defaulting on contractual obligations under PPA.	Operation	Y	29,468,966	18%	15	1,964,598	1.2%	8,739,566	
4	5	Physical loss or damage to property caused by technical / engineering hazards (e.g. defective design, faulty parts and / or workmanship).	Construction	Y	29,224,167	18%	3	9,741,389	6.0%	8,086,700	2.33
5	6	Physical loss or damage to property caused by man made and / or natural hazards / catastrophes (e.g. fire, lighting, explosion, earthquake, flood, windstorm).	Construction	Y	34,815,517	17%	3	11,605,172	5.8%	7,740,908	2.77
6	10	Physical loss and / or damage to the plant and / or machinery breakdown caused by natural hazards / catastrophes (e.g. fire, lighting, explosion, windstorm, flooding)	Operation	Y	29,504,310	13%	22	1,341,105	0.6%	6,992,974	25.46
7	7	Waste suppliers and power offtakers withdraw from contract subsequent to financial closure.	Construction	Y	34,626,724	15%	3	11,542,241	5.1%	6,779,618	
8	8	Complete mechanical or control failure during testing and commissioning due to defective design.	Construction	Y	30,571,667	16%	3	10,190,556	5.4%	6,678,678	2.43
9	1	Delay due to the inability to obtain building permit/ planning or other regulatory consents.	Construction	N	21,307,500	27%	3	7,102,500	9.1%	6,647,000	
10	3	Certified Emission Reductions (CER's) not being recognized as bankable revenue streams (i.e. able to support debt service obligations).	Operation	N	12,444,167	26%	22	565,644	1.2%	5,191,547	
11	13	Average wind speeds falls below required thresholds to generate economically efficient power outputs / electricity.	Operation	Y	27,540,179	19%	22	1,251,826	0.9%	4,873,565	
12	9	Complete plant shut down (total process interruption) at any time due to unscheduled maintenance.	Operation	Y	18,976,667	17%	22	862,576	0.8%	4,310,388	1.51
13	16	Legal liability caused by bodily injury or property damage to third parties.	Operation	Y	13,692,857	12%	22	622,403	0.5%	4,279,955	

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> the integration of environmental costs in development policies.

The Office of the Director, located in Paris, coordinates activities through:

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> Sustainable Consumption and Production (Paris), which promotes sustainable consumption and production patterns as a contribution to human development through global markets.
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