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Assessment of Financial Risk Management Instruments Extension Report for Renewable Energy Projects

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MARSH

Marsh & McLennan Companies

Contents

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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 gives an extension to our previous study "Assessment of Financial Risk Management Instruments for Renewable Energy Projects – UNEP Working Group 1 Study Report" by investigating renewable energy projects in India and Egypt while revisiting the results given in our aforementioned study of the China wind farm study.

Risk assessment and stochastic modelling techniques have been used to identify, quantify and prioritise critical risks during key stages of developing either a wind farm or biomass generator. By use of cash flow models, risk modelling and financial techniques it was possible to determine the financial impact of selected FRM Instruments on a project's economics.

To carry out the risk assessment and modelling, a range of quantitative and qualitative data was gathered. This included data from wind farms in China, India and Egypt and a biomass generator in India, and a risk survey of experts involved in renewable energy project development and financing[1].

A brief discussion of the instruments available for renewable energy projects is given in the Executive Summary section of our previous report "Assessment of Financial Risk

[1] A brief discussion of the instruments available for renewable energy projects is given in the Executive Summary section of our previous report "Assessment of Financial Risk Management Instruments for Renewable Energy Projects – UNEP Working Group 1 Study Report".

Management Instruments for Renewable Energy Projects – UNEP Working Group 1 Study Report".

From this list of products available our analysis has found the following FRM instruments to be of crucial use when undertaking renewal energy projects such as those considered in this extension study.

Political Risk Insurance this instrument has shown very positive impact on default rate and debt rating. Of particular importance is this FRM leading to a greater ability for renewable energy projects to attract financing.

Standard Insurance Products this includes FRM instruments such as:

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

These products have shown to be valuable in mitigating the affects of the eventuation of risks for a renewable energy project.

Typically, for the projects considered, a combination of the two above FRMs has shown to improve a project's key results:

- Reduction in the **default rate** to a minimum;
- Producing an optimal **credit rating**; while
- Achieving a high **internal rate of return** for the investor.

The addition of FRMs such as wind derivatives and carbon futures in most cases did not enhance the project's key results due to their prohibitively high cost.

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Introduction

Marsh was commissioned to perform an analysis to understand the effect of selected Financial Risk Management (FRM) Instruments on the economics of selected renewable energy projects. This was initially performed for a hypothetical wind farm in China in our previous study "Assessment of Financial Risk Management Instruments for Renewable Energy Projects – UNEP Working Group 1 Study Report".

These FRMs were selected in light of the risks faced by renewable energy projects which were considered in our original study. These risks were derived from a survey of a panel of experts who gave their view on the various risks that may affect the project's economics. Using their knowledge an assessment of the cost impact and likelihood of each risk was made. A thorough discussion of the survey and how its results were used is given in our previous study "UNEP Working Group 1 Study Report" – Section 4 ("Survey Results").

A listing of the key risks considered to endanger a renewable energy project's economics is given in Section 2 ("Key Risks"). A more comprehensive discussion of these risks along with the FRMs used to mitigate these risks is given in our previous study "UNEP Working Group 1 Study Report" – Section 5 ("Addressing Critical Risks").

Given these risks and the FRMs available to mitigate against their financial affects an analysis of a renewable energy project's economics was performed under various scenarios that considered the use of one or more of the selected FRMs.

This report gives results and recommendations out of Marsh's analysis of four hypothetical renewable energy projects:

1. A wind farm in China;
2. A wind farm in India;
3. A wind farm in Egypt; and
4. A Biomass generator in India.

A simulation analysis was performed for each project to understand the likely effectiveness of selected FRM instruments such as insurance, futures and derivatives on the project's credit rating and simulated default rate along with their effects of the internal rate of return[2].

[2] A measure of the project's profitability.

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Key Risks

A list of key risks was identified by a number of professionals knowledgeable in renewable energy projects. A survey was made that was used to gain a consensus of the likelihood and impact of these risks.

The risk profile changes during key phases of the project's life thus the risks considered during each phase also change. The three key phases considered in our analysis were:

- Construction – during the project's construction phase;
- Warrantee – during the product warrantee period of the parts used in construction of wind farm/biomass generator.
- Operation –during the operational phase of the project's life when revenues are being generated.

The following table lists those key risks considered and the Project's Phase during which they are considered as a peril. Our analysis took into account the various risks listed below and the action of these the risks on a project during its life cycle.

Table 2.1 – Key Risk List

Risk Description	Project Phase
Warranty provider failing to meet contractual obligations.	Warrantee
Electricity offtaker defaulting on contractual obligations under PPA.	Operation
Physical loss or damage to property caused by technical / engineering hazards (e.g. defective design, faulty parts and / or workmanship).	Construction
Physical loss or damage to property caused by man made and / or natural hazards / catastrophes (e.g. fire, lighting, explosion, earthquake, flood, windstorm).	Construction
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
Complete mechanical or control failure during testing and commissioning due to defective design.	Construction
Delay due to the inability to obtain building permit/ planning or other regulatory consents.	Construction
Average wind speeds falls below required thresholds to generate economically efficient power outputs / electricity.	Operation
Complete plant shut down (total process interruption) at any time due to unscheduled maintenance.	Operation
Legal liability caused by bodily injury or property damage to third parties.	Operation

Given the above risks and specifications of each project given in their respective Project Design Documents a simulation analysis was performed. This looked into the effect that various FRM instruments had in terms of mitigating the financial impact these risks may have had on the financial results of these renewable energy projects.

The set of risks faced by the biomass power generator project differ from that of a wind farm in particular biomass projects do not rely on wind speeds but have the risk of fuel costs increasing. A more detailed discussion of the biomass risks considered is given in Appendix B ("Biomass Risks").

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Financial Risk Management (FRM) Instruments

This section details the various FRMs considered in our extension study for renewable energy projects and the current status of availability of these products.

The following insurance products were considered:

Product	**Description**
Standard Insurance	This includes insurance instruments such as Construction All Risks, Delay in Start Up, Operating All Risks, Business Interruption, Machinery Breakdown and Third Party Liability.
Political Risk Insurance	Cover for Political Risks which in this case only includes the electricity off-taker failing to honour their obligations under the power purchasing agreements.
Carbon Futures	Used to protect the revenues from the trading of carbon credits created by the project by locking in a future price for the sale of these credits.
Wind Derivatives	Used to protect the project from years of low wind yields by guaranteeing target revenues set by the project financiers (i.e. lenders/banks).

The following table highlights the availability of FRM products for renewable energy projects in the local China insurance market.

Table 3.1 – Availability of FRM products in China

	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 Ecomomics	+	Not modelled	+	-	+++	Not modelled

The following table summarises the availability of FRM products for renewable energy projects in the Indian local markets.

Table 3.1 – Availability of FRM products in India

	DSU / BI	CDG	CER Futures Contract	Wind Derivatives	PPA PRI	Warranty Insurance
Product Status	Available	Evolving	Evolving	Available	Emerging	Emerging
Customer Demand	Medium	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 Ecomomics	+	Not modelled	+	-	+++	Not modelled

Note: shaded areas to be confirmed.

In Egypt the above products are not readily available locally due to the FRM instrument market being at an early stage of development. This means that these products are only available through international FRM product markets for Egyptian renewable energy projects. However, wind derivatives have the same availability in Egypt as in India and China.

The availability of FRM products in Egypt will improve over the next five years.

The pricing assumptions for the FRMs considered in our analysis are given in Appendix B – "FRM Pricing Assumptions".

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Debt and profitability results

The following section highlights the key findings from our simulation analysis. The results look at the case of no FRM instruments being used compared to that when a combination of FRMs are used.

A number of financial metrics were analysed that looked at the project's viability from the point of view of a lender (i.e. the ability for the project to pay off its debts) and the investor (i.e. the ability for the project to make a return on investment).

The project looked at various debt/equity structures such as:

- 60/40;
- 66/34;
- 65/35; and
- 70/30;

For each of these types of debt/equity mixes the performance of the project with debt reserves of 3 months and 6 months were analysed.

Given the above financial structures available the most optimal structure (in terms of its attractiveness to both the lender and the investor) was selected for a given scenario. The end result looked into was the effect of the various FRM products on a renewable energy project's Credit Rating and Internal Rate of Return (IRR).

The following table highlights these results for the China wind farm project.

Table 4.1 – China – Wind Farm – Results of use of FRM products

FRM package	Debt / Equity Ratio	Debt Reserve (Months)	Debt Credit Rating (Debt point of view)	Internal Rate of Return (Investor point of view)
No FRM products	60/40	6	BBB	8.20%
All Standard Insurance (Std Ins)	66/34	6	A	9.10%
Std Ins+ Political Risk Insurance (PRI)	**70/30**	**6**	**A-**	**9.30%**
Std Ins + PRI + CER Futures Contract	70/30	6	A-	9.10%
Std Ins + PRI + Wind Derivatives Contract				

The highlighted figure shows the most optimal scenario for the China wind farm.

In this case the most optimal scenario was generated with the use of all Standard Types of Insurance and Political Risk Insurance. In this scenario the project achieved a credit rating of A- with an IRR of 9.30%. This is a definite improvement over the case where no FRM products were used where the credit rating was BBB- and the IRR was 8.20%.

Thus the use of FRM products gives noticeable improvements on the project's results that attract both lenders and investors to finance or invest in the project.

It should also be noted that without Political Risk Insurance the project's credit rating cannot surpass that of its country. This is highlighted by the results of the renewable energy projects in India.

The following table summarises the results for the India wind farm.

Table 4.2 – India – Wind Farm – Results of use of FRM products

FRM package	Debt / Equity Ratio	Debt Reserve (Months)	Debt Credit Rating (Debt point of view)	Internal Rate of Return (Investor point of view)
No FRM products	70/30	3	BB+	13.60%
All Standard Insurance (Std Ins)	70/30	3	BB+	14.80%
Std Ins+ Political Risk Insurance (PRI)	**70/30**	**3**	**BBB+**	**14.30%**
Std Ins + PRI + CER Futures Contract	70/30	3	BBB+	14.20%
Std Ins + PRI + Wind Derivatives Contract	70/30	3	BBB+	14.00%

Again the highlighted figure shows the most optimal scenario. Here it should be noted that while the case of purchasing All Standard Insurance gives the highest IRR at 14.80% the **India's sovereign credit rating is too low for the project to borrow debt without Political Risk Insurance**. With this insurance the credit rating of the wind farm that is achieved is BBB+ whilst also achieving an IRR of 14.30%.

The following table summarises the results for the biomass generator in India.

Table 4.3 – India – Biomass – Results of use of FRM products

FRM package	Debt / Equity Ratio	Debt Reserve (Months)	Debt Credit Rating (Debt point of view)	Internal Rate of Return (Investor point of view)
No FRM products	*Our simulation analysis showed the India Biomass project failing in all scenarios.*			
Std Ins+ Political Risk Insurance (PRI)	70/30	3	A-	14.00%
Std Ins + PRI + CER Futures Contract	**70/30**	**3**	**A-**	**14.20%**

In the case of no FRM products being used the Indian Biomass project met with insolvency in all cases. This is due to there being a very high aggregation of risks for the biomass project compared to the wind farm projects. An example is with a natural hazard: given the geographical spread of wind farm generators a single natural hazard may not damage all wind generators whereas the opposite is more likely with a biomass project.

A more detailed explanation of the biomass risk is given in Appendix A ("Biomass Risks").

The above results show that the use of all standard insurances, Political Risk Insurance and CER futures contract gives the most optimal outcome with a debt credit rating of A- (above India's credit rating of BB) and an IRR of 14.20%.

For the wind farm in Egypt it should be pointed out that our results showed the project to be commercially unviable without the use of public funding to assist in the project's finances under the Production Design Document's specifications. However, our research showed that power purchase prices higher than those given in PDD were likely thus under these assumptions more favourable results for the wind farm project were produced, making the wind farm project more commercially viable as shown below.

Table 4.4 – Egypt – Wind Farm – Results of use of FRM products

FRM package	Debt / Equity Ratio	Debt Reserve (Months)	Debt Credit Rating (Debt point of view)	Internal Rate of Return (Investor point of view)
No FRM products	65/35	6	BB	12.00%
All Standard Insurance (Std Ins)	65/35	3	BB	12.70%
Std Ins+ Political Risk Insurance (PRI)	**70/30**	**3**	**A-**	**14.00%**
Std Ins + PRI + CER Futures Contract	70/30	3	A-	13.80%
Std Ins + PRI + Wind Derivatives Contract	65/35	3	A-	13.00%

As with the case in India, Egypt's credit rating is too low for the project to borrow debt without Political Risk Insurance. **The most optimal result is achieved with the use of All Standard Insurances and Political Risk insurance**. Here the IRR is maximised at 14.00% with the credit rating of A- (above Egypt's own credit rating of BB).

Further notes on results

The above results show the profitability of each project measured using the IRR. It should be noted the IRR is not comparable from project to project as these are of different sizes and thus have different start up and maintenance costs.

Whilst a project may be more profitable an investor may not look solely at this as there may be constraints on the amounts of capital required to invest in such a project and their own available capital. **It should be noted that the purpose of showing the IRR is to see within the same project the effect that a selected FRM may have on a project's profitability.**

Again we must also stress the importance of Political Risks Insurance. Without this FRM these renewable energy projects in these countries would not be able to attract funds from international lenders.

Appendix A – Biomass Risks

The following table shows the results of a survey of the risks considered applicable to the biomass project. Based on the survey responses for each risk we have ranked the risks based on their expected costs.

Table A.1 – Biomass Risks

Risk Ranking	Risk Letter	Head Line Risk	Risk Details	Expected Loss (USD)
1	B	Contract Bankability	Being unable to secure bankable offtaker / fuel supply contracts.	8,548,247
2	G	Waste Supply	Waste suppliers and power offtakers withdraw from contract subsequent to financial closure.	7,275,390
3	E	Engineering Risks	Physical loss or damage to property caused by technical / engineering hazards (e.g. defective design, faulty parts and / or workmanship).	6,539,699
4	N	Offtaker Default	Electricity offtaker defaulting on contractual obligations under PPA.	6,349,714
5	F	Physical Hazard (Caused by Man/Nature)	Physical loss or damage to property caused by man made and / or natural hazards / catastrophes (e.g. fire, lighting, explosion, earthquake, flood, windstorm).	6,065,533
6	T	CER Insolvency Risk	Certified Emission Reduction (CER) delivery shortfall or failure due to insolvency of project proponents.	5,427,319
7	O	Warrantee Non-performance	Warranty provider failing to meet contractual obligations.	4,925,098
8	J	Natural Hazards	Physical loss and / or damage to the plant and / or machinery breakdown caused by natural hazards / catastrophes (e.g. fire, lighting, explosion, windstorm, flooding)	4,244,080
9	H	Catastrophic Design Failure	Complete mechanical or control failure during testing and commissioning due to defective design.	3,978,299
10	D	Contractor Non-performance	EPC and turn-key contractors being unable to deliver to specifications on time and at cost.	3,611,125
11	K	Design / Engineering Risk	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)	3,545,862
12	U	Long Term CER Marketability	Limited marketability of emission reductions post 2012.	3,114,531

The key differences between the risks in a biomass project and that of a wind farm are:

- Wind speed is not a risk issue for biomass energy generators;
- Biomass generators require fuel and thus there is the risk that these fuel costs may increase during the project's lifetime;
- A biomass project consisting of several biomass generators within a fairly close proximity to each other has a greater aggregation of risk. A wind farm consisting of many turbines spread over a large area has a lesser aggregation of risk. This means a natural disaster may not affect (i.e. damage) the entire power production capacity of a wind farm whereas such a disaster may entirely remove the production of a biomass generator project.
- Likewise if a faulty part exists in a wind farm the level by which its power production is incapacitated will be less than that of a biomass generator. This is due to the fact that there are many generators for a wind farm and thus a defective

part may only affect one turbine which generates 0.04% - 1.49% (depending on the number of wind turbines) of the wind farm's energy. Whereas a faulty part that incapacitates a biomass generator will reduce the project's energy production by 20% (one out of five generators removed from production).

Appendix B – FRM Pricing Assumptions

This section highlights the pricing assumptions of the various insurance products tested in our simulation models. Included are details on the sums insured, policy periods, deductibles and a brief description of the coverage is also given.

Our previous report "Working Group 1 Study Results" – Section 5 ("Addressing Critical Risks") provides a thorough discussion of the use of FRM instruments to address key risks faced by renewable energy projects.

The details of the FRM products considered are given for each project.

Table B.1 – Chinese Wind Farm

Product Type	Coverage	Policy Period	Sum Insured / Policy Limit	Deductible / Waiting Period	Rate	Annual Premium	Web Surveyor Risks Covered (Risk
Construction All Risk (CAR)	Physical loss or damage to property arising from natural hazards or accidents during construction works. Resultant damage	3	120,000,000	12,000	0.15%	60,000	D - Resultant damage only (Defective parts excluded by policy but
Delay in Start Up	Gross Profits	3	21,000,000	21 days	0.40%	28,000	D E
Operating All Risks	Physical loss or damage to property, removal of debris, expediting expenses arising from	1	120,000,000	12,000	0.05%	60,000	F S - Excluding defective
Business Interruption	Gross Profits	1	21,000,000	7 days	0.35%	73,500	F S - Excluding defective
Machinery Breakdown	Physical loss or damage to machinery arising from any sudden or unforeseen accidents caused by perils such as faulty design and workmanship. Resultant damage caused by	1	80,000,000	14,000	0.12%	96,000	S - Excluding defective parts which are covered by warranty / availability
Third Party Liability	All sums insured is legally liable to pay in respect of death / bodily injury and / or loss or damage to third party property	1	10,000,000	1250	0.10%	10,000	M
Political Risks	Loss of Profit following the failure by the Electricity Off taker to honor their obligations under the PAP	3	63,000,000	180 days	2%	420,000	C

Table B.2 – India Wind Farm

Product Type	Coverage	Policy Period	Sum Insured / Policy Limit	Deductible / Waiting Period	Rate	Annual Premium	Web Surveyor Risks Covered (Risk Number)
Construction All Risk (CAR)	Physical loss or damage to property arsing from natural hazards or accidents during construction works. Including losses resuling from defective parts, faulty workmanship etc. Includes third party liabilities.	3	51,250,000	5,000	0.10335%	17,656	E - Other than machinery breadown losses covered by warranty* F L
Delay in Start Up	Fixed operating costs including debt servicing.	3	9,500,000	60 days	0.15000%	4,750	E F
Operating All Risks	Physical loss or damage to property, removal of debris, expiditing expenses arsing from natural hazards or accidents during operation	1	51,250,000	5,000	0.03250%	16,656	J K L
Business Interruption	Fixed operating costs including debt servicing.	1	9,500,000	7 days	0.08%	7,719	J K
Machinery Breakdown	Physical loss or damage to machinery arising from any sudden or unforseen accidents caused by perils such as faulty design and workmanship.	1	50,000,000	5,000	0.02275%	11,375	J K
Third Party Liability	Legal and contractual liability for bodily indjury or	1	10,000,000	5000	0.04%	4,485	P
Political Risks	Loss of Profit following the failure by the Electricty Offtaker to honour their obligations under the PPA	3	62,000,000	180 days	2.0%	413,333	N

Table B.3 – India Biomass

Product Type	Coverage	Policy Period	Sum Insured / Policy Limit	Deductible / Waiting Period	Rate	Annual Premium	Web Surveyor Risks Covered (Risk Number)
Construction All Risk (CAR)	Physical loss or damage to property arsing from natural hazards or accidents during construction works. Including losses resuling from defective parts, faulty workmanship etc. Includes third party liabilities.	1	75,000,000	5,000	0.09643%	72,321	E - Other than machinery breadown losses covered by warranty* F L P
Delay in Start Up	Fixed operating costs including debt servicing.	1	13,000,000	60 days	0.15000%	19,500	E F
Operating All Risks	Physical loss or damage to property, removal of debris, expiditing expenses arsing from natural hazards or accidents during operation	1	75,000,000	5,000	0.03250%	24,375	J K L
Business Interruption	Fixed operating costs including debt servicing.	1	13,000,000	7 days	0.08125%	10,563	J K
Machinery Breakdown	Physical loss or damage to machinery arising from any sudden or unforseen accidents caused by perils such as faulty design and workmanship.	1	55,000,000	5,000	0.02275%	12,513	J K
Third Party Liability		1	25,000,000	5000	0.04%	11,213	P
Political Risks	Loss of Profit following the failure by the Electricty Offtaker to honour their obligations under the PPA	3	80,000,000	180 days	1.5%	400,000	N

Table B.4 – Egypt Wind Farm

Product Type	Coverage	Policy Period	Sum Insured / Policy Limit	Deductible / Waiting Period	Rate	Annual Premium	Web Surveyor Risks Covered (Risk Number)
Construction All Risk (CAR)	Physical loss or damage to property arsing from natural hazards or accidents during construction works. Including losses resuling from defective parts, faulty workmanship etc. Includes third party liabilities.	3	105,000,000	5,000	0.20%	70,000	E - Other than machinery breadown losses covered by warranty* F L
Delay in Start Up	Fixed operating costs including debt servicing.	1	25,000,000	60 days	0.35%	87,500	E F
Operating All Risks	Physical loss or damage to property, removal of debris, expiditing expenses arsing from natural hazards or accidents during operation	1	105,000,000	5,000	0.25%	262,500	J K L
Business Interruption	Fixed operating costs including debt servicing.	1	25,000,000	7 days	0.25%	62,500	J K
Machinery Breakdown	Physical loss or damage to machinery arising from any sudden or unforseen accidents caused by perils such as faulty design and workmanship.	1	85,800,000	5,000		included in OAR	J K
Third Party Liability	Legal and contractual liability for bodily indjury or property damage to third parties	1	10,000,000	5000	0.25%	25,000	P
Political Risks	Loss of Profit following the failure by the Electricty Offtaker to honour their obligations under the PPA	3	25,000,000	180 days	1.50%	125,000	N

Appendix C – Project Specifications

The following table outlines the details of the four projects analysed.

Table C.1 – Summary of Project Specification

	Wind Farms			Biomass
	China	India	Egypt	India
Number of Turbines / Generators	67	250	120	5
Nominal Power Output (kW)	67,335	56,250	120,000	50,000
Construction Period (Years)	3	3	3	1
Construction Costs ($ US)	120,000,000	51,250,000	105,000,000	130,000,000

Appendix D – Guidance Note on Understanding Results

This report uses a number of financial terms to describe the economics of a renewable energy project. Such terms which are not commonly used in spheres outside the financial one used in this report are explained here. We also give a brief discussion the most optimal scenario (e.g. use of Political Risk Insurance and not using Carbon Futures) found in analysis.

Appendix D.1 – Risks and Perils

Section 2 ("Key Risks") of this report involves the concept of risks. Below is a brief description the concepts used in the aforementioned section.

Term	Description
Risk	In this study a risk can be considered to be the chance of event occurring that may cause financial impairment to a renewable energy project. This is considered a risk because it is not known at the outset whether it will occur or not. Among such risks is that of a natural catastrophe which may damage power generation facilities and will give consequence of the project being unable to generate revenues and hence finance its own financial obligations.
Peril	A peril is a specific event/cause that gives rise to financial impairment. An activity (in this case power generation) may lead to the risk of a peril arising. An example of this is in the case of wind farms there is a risk that annual wind speeds will be insufficient to yield sufficient power generation. However for biomass generator this risk does not exist hence the peril of low wind speeds is not an issue and thus not a risk. Insurance policies may name perils that are covered. In our studies the Political Risk Insurance only covers the peril of power purchase agreement price falling due to the off-taker not being able to meet its obligations. In our studies the term "risk" is used to refer to both risks and perils collectively.

Term	Description
Expected Loss	The expected loss can be considered as an average loss. The actual loss itself is not likely to equal the average as the expected loss takes into account not only the size of the loss but also the frequency (or number of times) the loss will occur. In the Extension Report in Table A.1 ("Biomass Risks") a series of expected values are given which are used to rank the risks. The second row ("Waste Supply") has an expected value of US $7.3m – meaning the risk is going to cost, on average, US $7.3m. However, if the peril eventuates the cost will be higher than this expected loss. The expected loss also takes into account the likelihood (probability) of such a loss taking place. For a given loss size the lower the chance of the loss occurring the lower the expected loss.

Appendix D.2 – Modelling

This section gives details on some of the modelling concepts used in our report.

Term	Description
Models	A model, for the purposes of this study, is mathematical construction that uses key aspects of a real world situation to link various inputs (e.g. inflation, interest rates) and outputs (e.g. internal rates of return, default rates). For our study such models were used to link items such as the costs of construction of a renewable energy generator with the eventual energy production and resulting revenue in an environment of various risks being present (e.g. natural catastrophes, low wind speeds, the CER market collapsing etc.). A further discussion of our modelling approach is given in our original analysis "Assessment of Financial Risk Management Instruments for Renewable Energy Projects" – Section 6 ("Modelling Approach").
Simulation	In the past models considered only a single scenario and allowed for no variation (or volatility) in its results. A simulation considers variations in the final result and which results are more likely than others given the environment. Rather than looking at a single outcome that is determined by an average outlook a simulation considers a range of scenarios (e.g. one in which a risk occurs and one in which it does not) and derives a range of outcomes (e.g. default or no default). An analogy may be rolling a dice many times and seeing what numbers turn up and the distribution of those numbers (e.g. an equal amount of 1s, 2s etc. or rolling more 6s than other numbers).

Appendix D.3 – Financial Terminology

Financial terms used in our report to describe a project's economics are briefly explained in this section.

Term	Description
Financial Risk Management (FRM) Instruments	In our study such instruments include items such as insurance, derivatives and futures. These are called financial risk management instruments as they reduce the impact that a risk can have on a project's finances. The risk of the peril occurring is passed onto another party (e.g. an insurer) thus giving more stability to a project's outcome (e.g. internal rate of return). Such instruments involve a premium being paid to the risk taker. Thus a guaranteed loss (i.e. payment of a premium) is given to moderate against the financial impact of a possible larger loss (e.g. natural hazard destroying power generators and reducing revenues). Our simulations have tested the use of such instruments given the burden of their premiums (costs).
Credit Rating	A measure used by lenders (e.g. banks) to assess the attractiveness of lending funds to finance an investment. It is an evaluation of the likelihood of a borrower to default on a loan (i.e. not being able to pay back its financial obligations). A credit rating is given in the form of a grade from D (in default) to AAA (highest rating). The use of a + or – sign is used to give a relative standing of various the grades (e.g. BBB+ is better than BBB which is better than BBB-). An investment with a higher rating has a lower penalty charged ("spread") due to there being less risk of default. Hence the desire for a project to obtain a higher credit rating.
Debt/Equity (D/E) Ratio	All investments involve a Debt/Equity (D/E) ratio. This is the amount of an investment that is funded by banks and lenders versus that which is financed from the investors' own funds. A higher D/E means a greater proportion of the investment is funded by borrowings (from banks/lenders) and is associated with greater risk for a lender and hence will reduce the credit rating of a particular venture. Thus a higher penalty ("spread") will be charged for the additional risk. For an investor a higher D/E will mean fewer funds are required to

Term	Description
	invest in a project enabling investment activity into a renewable energy venture. A balance is required in the D/E ratio: • To have an investment being sound enough for banks to consider lending (i.e. having a reasonable credit rating). • To enable investors to invest in a renewable energy project given their limited funds. Higher D/E ratios may be of benefit to an investor if the higher interest cost will be less than the earnings expected from the increased lending. This needs to keep in mind an investor's ability to repay its financial obligations.
Default Rate	A default can be considered occurring when a project is unable to repay its own financial obligations. In our studies this means that revenues and debt reserve have been more than exhausted by interest and capital (the original loan amount) repayments over the year. Thus the default rate can be considered as the number of simulated outcomes the project ends up in default divided by the total number of scenarios. The default rate thus estimates the probability (likelihood) of the project failing to meet its financial obligations. A lower simulated default rate equates to less risk of investing and lending to a project.
Debt Reserve	A debt reserve is used to cover debt repayments. A debt reserve of 3 months means enough money has been put into the reserve to cover debt repayments for three months in a period where there are no revenues available. Our studies have considered debt reserves of 3 and 6 months. A higher debt reserve involves a greater cost (as funds could be used elsewhere) thus maintaining a reserve as low as possible is desirable for an investor yet viewed favourably by lenders.
Internal Rate of Return (IRR)	The Internal Rate of Return (IRR) is the discount (or interest) rate at which net cash flows from a project are equal to its initial investment value. In our studies this means the discount rate at which a renewable energy project will have its net cash flows (i.e. revenue – maintenance costs) from its years in operation equal to its initial investment value (construction costs). An example is in Table 4.1 ("China – Wind Farm – Results of use of

Term	Description
	FRM products") where the most optimal scenario generated an IRR of 14.00%. This is equivalent to investing the same moneys into a bank account paying 14.00% interest a year over the life of the renewable energy project. The greater this discount rate the greater the return from an investment thus a higher IRR means the project is seen as a more profitable venture to investors.

Appendix D.4 – Other Points to Note

This section gives some other points to note out of our analysis.

Political Risk Insurance (PRI)

Political Risk Insurance (PRI) covers the risk of a political condition that will result in a financial loss. It is important to note that it would not be possible for the renewable energy projects considered in this study to borrow funds without enacting this type of insurance.

That is banks would require the type of projects considered in this study to have PRI cover.

Also without this insurance it is not possible for a renewable energy project to obtain a credit rating higher than that of its country of operation. Thus in order to be charged a lower spread (interest penalty) PRI is required.

Choice of Most Optimal Scenario

In this report in Section 4 ("Debt and Profitability Results") for each renewable energy project an optimal scenario has been selected.

In all these optimal scenarios PRI is used owing to the reasons given above (enable higher credit rating and attract loans from banks). Other than this the most optimal scenario has been selected based on:

- From the lender's point of view the project's credit rating – this takes into account the simulated default rate and is the banks view of the risk of lending funds to finance the project in question.
- From the investor's point of view the IRR – which takes into account the all costs and offsetting revenues from the project and is a measure of the project's potential profitability.

For a given IRR, a scenario with higher credit rating would be more desirable and conversely for a given credit rating a higher IRR is more desirable. However, this would also take into account the amount of start up capital required for undertaking a project. Thus a higher D/E and lower debt reserve is likely to be more desirable.

As an example the output for the China wind model from this report has been reproduced below (Table 4.1 – China – Wind Farm – Results of use of FRM products).

FRM package	Debt / Equity Ratio	Debt Reserve (Months)	Debt Credit Rating (Debt point of view)	Internal Rate of Return (Investor point of view)
No FRM products	60/40	6	BBB	8.20%
All Standard Insurance (Std Ins)	66/34	6	A	9.10%
Std Ins+ Political Risk Insurance (PRI)	**70/30**	**6**	**A-**	**9.30%**
Std Ins + PRI + CER Futures Contract	70/30	6	A-	9.10%
Std Ins + PRI + Wind Derivatives Contract				

For the simulations performed in the case above:

The most optimal scenario (purchasing all Standard Insurances and PRI) was selected because this gave the highest IRR, while giving an acceptable credit rating of A-. It was also selected because the use of PRI is required for banks to lend to a wind farm project in China (as is the case with the other renewable energy projects considered in this study).

MARSH

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