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The Concept of Risk Management in the Renewable Sector

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Abstract

This study explores the perception of risk and the level of risk management implementation in the renewable sector. Risk management is emerging as a key issue due to the loss of confidence amongst banks, causing the attainment of financing to be difficult over the next few years. To attract financing, there is a fundamental requirement to manage risk in a way that minimizes the probability of a negative financial impact on the project. Miller and Lessard (2001) argue that successful projects are not selected but shaped with risk resolution in mind. Rather than evaluating projects at the outset based on projections of the full set of benefits, costs and risks over their lifetime, successful developers start with project ideas that have the potential of becoming viable.

Therefore, this study bridges the gap that exists within the renewable sector in relation to risk management literature. This study succeeds through a detailed comparative case study analysis where two developers and two financiers were questioned through qualitative semi-structured interviews on the concept of risk management and its level implementation within the industry.

It is believed that the growth in financed renewable energy projects depends on the adequate design and implementation of risk management to mitigate inherent project risks. However, this study revealed that are certain types of developers in existence within the renewable sector, which underestimate the magnitude of risk and view the development of projects as a *'money racket'*. Therefore, it can be concluded that perception of risk will also differ, causing risk and uncertainty to vary from project to project, resulting in investment reluctance to be associated with certain projects. The study originality lies in how it demonstrates to developers the concept of risk management, outlining the simplicity and benefits of implementing it in project development. Finally, this study contributes to the knowledge by enhancing the awareness and understanding of the presence and nature of risk in a RE project environment.

"If we knew what it was we were doing, it would not be called research, would it?"

- Albert Einstein

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This paper has benefited from the generosity of many people who have contributed in so many ways during its development. I would like to express my sincere gratitude, in no particular order, to the following people:

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Glossary of Abbreviations, Definitions & Units

BMP	Best Management Practices
BSI	British Standard Institution
CDMs	Clean Development Mechanisms
CER	Certified Emission Reduction
GMIT	Galway-Mayo Institute of Technology
IMEC	International Program in the Management of Engineering and Construction
KW	Kilowatt
MCS	Monte Carlo Simulation
MW	Mega-Watt
NSAI	National Standards Association Ireland
NUIG	National University of Galway
O&M	Operation and Maintenance
R&D	Research & Development
RE	Renewable Energy
RMS	Risk Management System
SWOT	Strengths Weaknesses Opportunities Threats
UK	United Kingdom
UNEP	United Nations Energy Programme

CHAPTER 1 – INTRODUCTION

1.1 INTRODUCTION

1.1.1 Rationale:

In Ireland the wind industry has grown considerably in recent years. If the current rate of growth of installed capacity continues, Ireland will achieve its target of producing 40% of electricity from renewables by 2020.

Consequently, achieving these important goals depends on the willingness of banks to provide stability in the financing of these projects. However, due to the loss of confidence amongst banks, financing will be difficult over the next few years because of certain risk and uncertainty within the renewable sector. Nevertheless, risk and uncertainty are inherent characteristics of such projects, causing a saturation condition among banks, resulting in very stringent selection processes for project fund allocation (Montes and Martin, 2006).

Therefore, in optimising the profitability/risk factor of each investment, developers must carefully plan and analyse their projects. This is to avoid the development of inefficient renewable projects with high levels of risk (Alessandri et al., 2004). To attract financing, there is a fundamental requirement to manage risk in a way that minimizes the probability of a negative financial impact on the project.

Therefore, this research dissertation is not to provide an exhaustive list that is required to obtain project finance, but to highlight the risks which will need to be weighed and shaped if project finance is being considered.

1.1.2 Definition of Topic:

Every human endeavour involves risk (Dey and Ogunlana, 2004). Consequently, the success or failure of any venture depends crucially on how we deal with it (Dey, 2001). Risk can affect the productivity, performance, quality and cost of the project (Mills, 2001). Therefore, it is critical to recognise that developing a wind farm from an initial concept to operation is a prolonged and intricate process with associated risks of failure and non-recoupable costs in each stage of its development. However, operating wind farms in Ireland has proved to be a feasible and profitable investment for developers. Nonetheless, individuals willing to develop a wind farm project must be aware of the concept of business risk (Renewable Energy Partnership, 2004).

The type of financing available to renewable energy projects is largely dependent upon the risk management approaches adopted by the project's management and the instruments available to mitigate real and perceived risks (UNEP [United Nations Energy Programme], 2004). Implementing risk management systems and processes will convey a clear signal to investors that organisations undertake risks in a systematic approach and are committed to ensure risk management is at the focal point of their decision making framework (World Energy Council, 2004). Diligent developers refuse to sit idle, waiting for the probabilities to yield a *'win'* or a *'loss'*, but work hard to influence outcomes and turn the selected initial option into a success (Millar and Lessard, 2001).

Risk management is considered critically important, due to the large variety of parties involved in a project, all of whom create an element of risk. In order to develop a *'bankable'*, renewable project the associated risks have to be mitigated and managed, steps which are thoroughly checked by the financing consortiums. Consequently, it is common practice for financing institutions to employ independent experts to confirm compliance of the renewable project, in order to ensure only the minimum of risks. Therefore, investor confidence is critical for the financing of renewable energy projects. However, the process of checking and managing risk is perceived costly and adds to the overall project expenditure, influencing the revenues of project developers and also their willingness to adopt a risk management system (World Energy Council, 2004).

1.1.3 Research Question:

From analysing a selection of information from books and topical journals relating to risk management, and what has been already outlined previously, a pattern has been established that the concept of risk management should have an instrumental role in the development of any successful project. However, criticism was also expressed that successful projects are not selected but shaped with risk resolution in mind. Rather than evaluating projects at the outset based on projections of the full set of benefits, costs and risks over their lifetime, successful developers start with project ideas that have the potential of becoming viable (Miller and Lessard, 2001).

Therefore, the two-part question below is the central theme that will be examined in this research study and it is ultimately the torch of the research design:

What is the standard of risk assessment and management amongst wind energy developers and to what degree is the concept of risk management applied within the industry?

1.1.4 Aim:

While some of the literature emphasis is on how to *'price'* the associated risks with the project, the main purpose of this research dissertation is on the managerial process of recognizing, shaping and realizing these options (Miller and Lessard, 2001).

Therefore, this study outlines the various components of risk in relation to RE (Renewable Energy) projects, outlining the managers' need to address the critical nature of risk and uncertainty in the decision-making process, identification of the risks and uncertainties inherent in a proposed action, assessment of their impact on the possible outcomes and the design of contingency plans to manage and ensure sound business decisions (Alessandri et al., 2004).

1.1.5 Research Objectives:

The main objectives of this research dissertation include:

- To investigate what the perception of risk management is within the industry; and to examine what is inhibiting the implementation of a risk management process being more readily adopted.
- To examine the processes of risk management, to establish the way in which risk management activities are conducted in the renewable sector.
- To enhance awareness and understanding of the presence and nature of risk in a RE project environment. This encourages the need to consider project risks more carefully, and it will help develop confidence in dealing with the risks associated with projects in a systematic manner.

1.1.6 Contribution to Knowledge:

In a general context there is significant growth in risk management education and training at tertiary level, and an increase in professional career development courses on the same topic. Many of these resources are modified to the requirements of specific industries and professions. Consequently, few of these courses are presented in a project context, for example relating to RE projects (Edwards and Bowen, 2005). In the renewable sector there is still a considerable dearth of empirical research in the area of risk management. Although there have been some studies in other similar industries, there has yet to be a study that highlights the implementation of a systematic risk management system.

This study contributes significantly to the knowledge of risk management as it is the first qualitative one of its kind to explore how developers perceive and undertake risk management in the development of renewable energy projects. Its originality lies in how it demonstrates to developers the concept of risk management, outlining the simplicity and benefits of implementing it in project development. Ultimately, this study contributes to the knowledge by enhancing the awareness and understanding of the presence and nature of risk in a RE project environment.

1.1.7 Chapter Overview:

This dissertation is divided into the subsequent chapters and is structured as follows:

Chapter Two: Provides a detailed and critical literature review of the topic of risk definition and risk management with reference to RE projects.

Chapter Three: Outlines the chosen research methodology which includes the means by which the researcher will answer the research question and objectives.

Chapter Four: Contains the research findings and results. This chapter outlines the data gained from the various interviews that were conducted.

Chapter Five: Discusses the findings of Chapter Four in a broader sense with relevant comparison to the literature. It also outlines the principal conclusions drawn from the analysis.

Chapter Six: Outlines the course that future research might take before concluding on the strengths of the research.

CHAPTER 2 – THE CONCEPT OF RISK MANAEGMENT

2.1 LITERATURE REVIEW

2.1.1 Introduction:

The aim of this chapter is to provide an examination of the relevant literature with regard to risk management and its perception throughout relevant industries and sectors. It begins by discussing the ambiguity regarding its definition while also outlining the different perspectives existing in this area. It proceeds by highlighting the importance of risk management and how it has emerged to become such a topical issue. Further to this, it delves into more detail on some of these perspectives giving relevant examples suggesting how risk should be managed. Finally, it will conclude with how a company may develop a risk management system to ensure the development successful projects.

2.2 DEFINTIONS AND CONCEPTS OF RISK?

2.2.1 Risk:

The term '*risk*' in everyday life is generally used to refer to the potential for future harm. However, in a more formal and academic sense, risk basically refers to a future that is uncertain, independent of whether the future outcome will be beneficial or detrimental (Wiser et al., 2003). Chicken and Posner (1998) argue that risk is a universal concept, which is inherent in every aspect of life and that each activity has its own portfolio of characteristics, whether the risk activities be manufacturing, finance, major projects, transport or sport. Chapman (2006) define risk as: *"Exposure to the possibility of economic or financial loss or gains, physical damage or injury or delay as a consequence of the uncertainty associated with pursuing a course of action"* whereas the Royal Society (1991) defines risk as: *"Risk is the probability that an adverse event occurs during a stated period of time"*. This particular definition ensures that four aspects of risk (probability, event, impact, and duration) are each properly considered. Therefore, the most important feature to remember is that, in dealing with risk, all four aspects should be considered:

- The probability that an event will occur.
- The event and its nature.
- The consequence of that event.
- The period of exposure to the event.

(Edwards and Bowen, 2005)

2.2.2 What are Project Risks?:

In a project environment risks can be described as likely future occurrences that will adversely affect the project's objectives or goals. Risks have three distinguishing features:

- A likely future occurrence. Risks are events or actions that may occur. Things that have happened are facts, not risks.
- The occurrence will adversely affect the project in terms of cost, schedule, quality, or the scope of the project.
- Not certain to occur: Risks are future uncertainties. An impact on the project which will definitely occur should be included in the project plan as a task and therefore is not a risk (UNEP, 2004).

A problem is something that has already occurred and action has to be taken to deal with the problem. Projects are regarded as very complex and unique, where risks raise from a number of different sources. These projects are characterised by the continuous decision making due to the numerous sources of risk and uncertainty, many of which are not under the direct control of the various project participants (Baloi and Price, 2002). Godfrey (1996) found that the greatest degree of uncertainty is encountered early in the life of a new project. Decisions taken during the earliest stages of a project can have a very large impact on its final cost, and durations. Change is an unavoidable feature of any major capital project, but it's the extent is frequently underestimated during these early phases (Godfrey, 1996 cited in Mills, 2001).

2.3 RENEWABLE ENERGY PERCEPTION OF RISK

2.3.1 Perception of Risk vs. Reality:

Leblanc (2008) coined the phrase *"new industry means new risk"* highlighting that renewable energy technologies are relatively new, and their market position is still fairly fragile (Leblanc, 2008). The situation is reinforced by the significant power of established market players and to a certain extent also by the poor understanding of the risks involved. The common misperceptions about renewable energy can be traced through all stages of a prospective project. Some of the perceived risks include:

- Risk of Energy Resource: Renewables are often perceived as unsuitable, unreliable and unstable.
- Renewable Technologies are perceived as ongoing R&D (Research & Development) projects, and therefore not field proven and containing application risks.
- Financial Risk Assessments are often based on the above perceptions. The technologies are perceived as expensive, deeming the project almost un-financeable, having only suitability for a *'rich'* environment.

However, the reality is different. The common perceptions are not completely wrong, but they are based on a biased interpretation of actual or historical experience with renewable energy (World Energy Council, 2004).

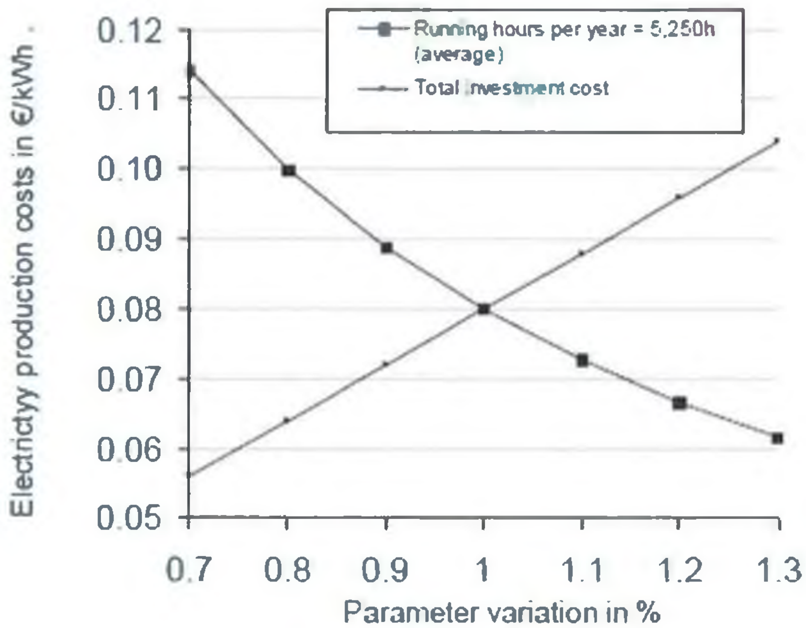
2.3.2 Specific Renewable Energy Projects:

In this element of the literature review, two types of renewable projects are briefly outlined based on their inherent risk characteristics. The two types of projects investigated are hydro (small-scale) and wind farm developments. The reasons being these are the two types of projects feasibly applicable in Ireland on a broad scale, but also there are similarities in their inherent risks, and finally they provided the most comprehensive information within the available literature.

Low Head, Small Scale Hydropower:

In 2005 the market growth of small scale hydropower in Europe was only 0.95% from 11,535 MW to 11, 644 MW installed power. The main difficulty of attaining finance in the low head, small hydro power market is however lack of investor confidence (ESHA, 2005 cited in Wiemann et al., 2010). The low head, small hydro market is perceived as low-profit and risky, therefore holding back its technology development and growth. Every decision is made with uncertainty, due to the risks that affect the most important consideration for owners and operators: the profitability. Risk consideration is very important in this market, because even moderate changes in running hours per year or total investment cost will immediately result in significant changes in power output (Figure 1).

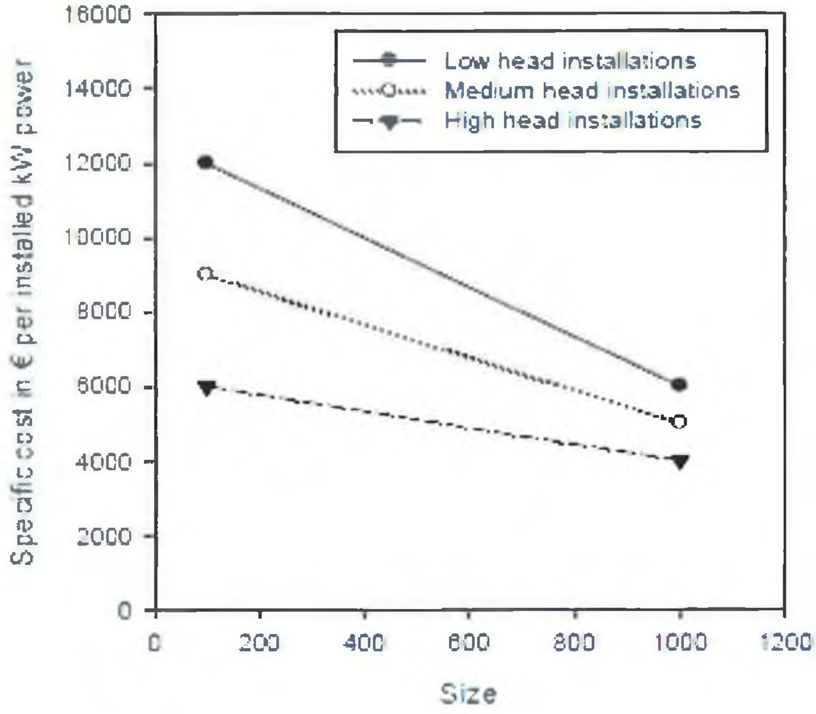
Figure 1: Sensitivity of a Low Head, Small Scale Hydropower



(Wiemann, 2010)

For example, even minute changes in the water level will directly result in significant changes in power output. An additional risk is that investment cost per installed kW of power for low head is significantly higher than for high head installations (Figure 2) (Goldsmith, 1993 cited in Wiemann et al 2010). Also, often a positive view of the manufacturer/inventor will over evaluate the revenues, as well as the specific investment costs as too low, leaving potential investors with a large margin of risk.

Figure 2: Specific Cost/Size Relationships

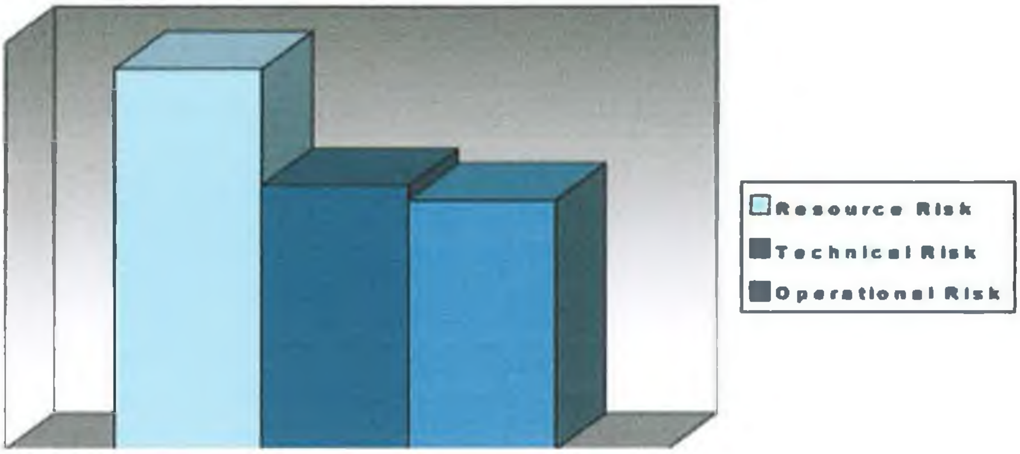


(Wiemann, 2010)

Wind Farm Developments:

It has been highlighted developing a wind farm from an initial concept to operation is prolonged and an intricate process with associated risks of failure. Resource risks present the highest potential impact, with technical and operational risks being lower. Thus, the analysis of wind frequencies for a single location is of critical importance for successful project implementation. Resource risks can be minimized if the wind measuring systems are installed early enough or historic data is available over a long-term analysis period. Results developed to date demonstrate that data gained during a one-year period is not sufficient to guarantee reliable wind frequency data to assess power generation over the medium to long term (Figure 3).

Figure 3: Risks with Strongest Impacts (Wind)



(UNEP, 2004)

It was also highlighted that the planning phase can be extensive for the implementation of a wind farm. As such, administrative costs for small or medium-sized project companies can cause significant economic barriers during the planning phase of the project (UNEP, 2004). There is high probability at this stage that the wind farm will not be commissioned .The refusal pattern by the Irish planning authorities of wind farm developments equates to 50-60%, which is predominantly evident in the western counties. This particular phase is at high risk of failure, and may be deemed the *'make-or-break'* phase. Currently in Ireland there is a less than even chance (45-55%) that at this stage the wind farm will be commissioned. The major disadvantage at this stage of the project is that if the project does fail that the costs are non-recoupable with also significantly large amounts time inputted into its development (Renewable Energy Partnership, 2004).

Leblanc (2008) highlighted other significant risks associated with the renewable industries, in particular wind. For example, the engineering processes are complex, particularly technical perils in handling, erecting and testing are an issue during the construction and maintenance period, requiring specialist contractors and dedicated equipment. Leblanc (2008) highlights that the commissioning phase should not be underestimated for wind farm developments, in terms of local disapproval for aesthetic and noise issues. However, in Ireland issues such as NIMBY's are becoming more of an irrelevant risk with regards the development of wind farms. According to a recently completed independent survey, wind energy has been embraced by the Irish public as a whole and even more strongly endorsed by residents where wind farms are planned and operational. Lansdowne Market Research carried out a study in 2003 - *'Attitudes towards wind farms in Ireland'* found that three quarters of the general Irish population would be willing to support government incentives to build wind farms with eight out of ten believing wind energy to be a good thing (Renewable Energy Partnership, 2004).

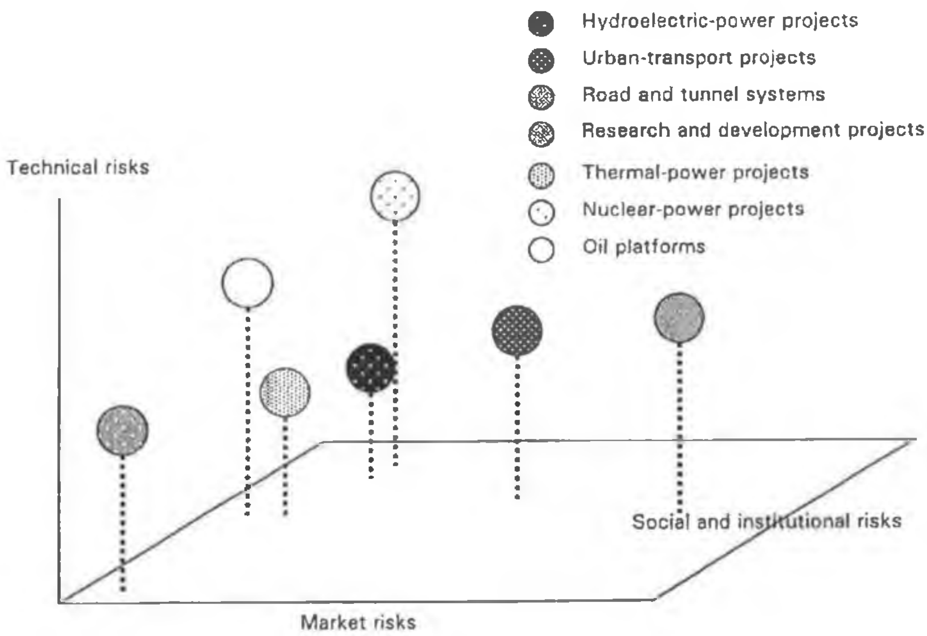
2.4 RISK CLASSFICATION

The question is then often posed why should we try to classify risk when time and effort may be saved by starting directly with the more *'hands on'* activities of risk management? However, classification enables risks to be considered within a more consistent framework, establishing a common basis for risk and risk management (Edwards and Bowen, 2005).

2.4.1 Risk Based Taxonomy:

Miller and Lessard (2001) provide some interesting literature on the taxonomy (classification) of risks in the development of large engineering projects. They highlight that risks vary in conjunction with the project type, according to the intensity of the risks they pose to sponsors (Figure 4). Hydroelectric-power projects, for example, tend to be moderately difficult in terms of large scale engineering, but can cause major difficulties in terms of social acceptability.

Figure 4: Risk Based Taxonomy of Large Engineering Projects



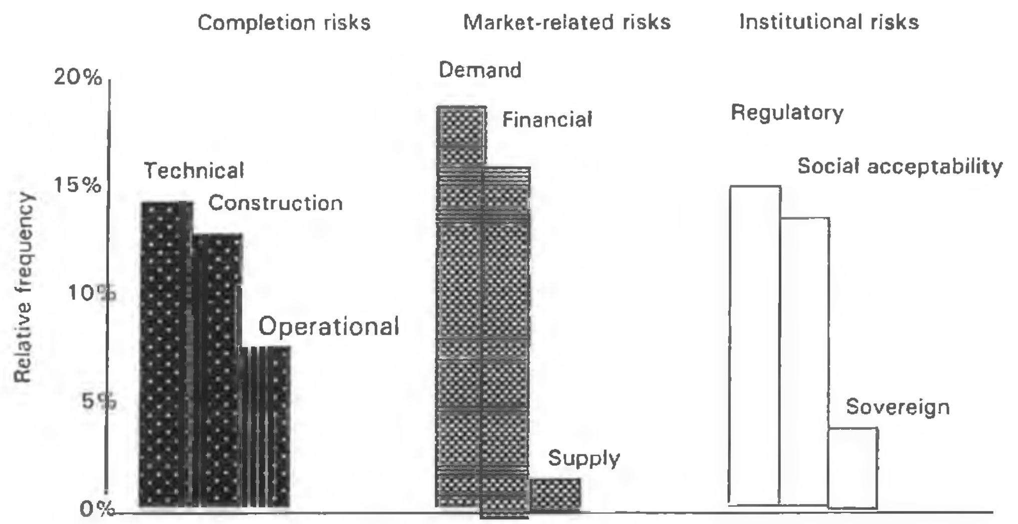
(Miller and Lessard, 2001)

Nuclear-power projects pose technical risks but still higher social and institutional risks. Oil platforms could be compared to offshore wind farm developments, in that they are technically difficult, whilst there are few institutional risks due to them being built away from public attention. Oil platforms are generally socially acceptable due to the high revenues they bring to surrounding areas. However, as stated earlier, every human endeavour involves risk. For example, in an unrelated field such as research-and-development, projects present scientific challenges but face less social acceptability and market difficulties as they can be broken into smaller testable investments (Miller and Lessard, 2001).

2.4.2 The Nature of Risks in Projects:

In terms of any project venture risks are multi-dimensional. Therefore, there is a requirement that risks are defined or categorised for a clear understanding of their causes, outcomes and drivers (Miller and Lessard, 2001). The International Programme in the Management of Engineering and Construction (IMEC) conducted a study in which 60 large engineering projects were investigated. The study requested managers to categorize and rank risks they faced in the early front-end timeframe of the project. The results of the study indicated that market related risks had the highest frequency (41.7%), followed by technical risks (37.8%), and institutional/sovereign risks (20.5%). Figure 5 indicates the frequency of risk that managers ranked first, second and third.

Figure 5: Major Risks in Large Engineering Projects



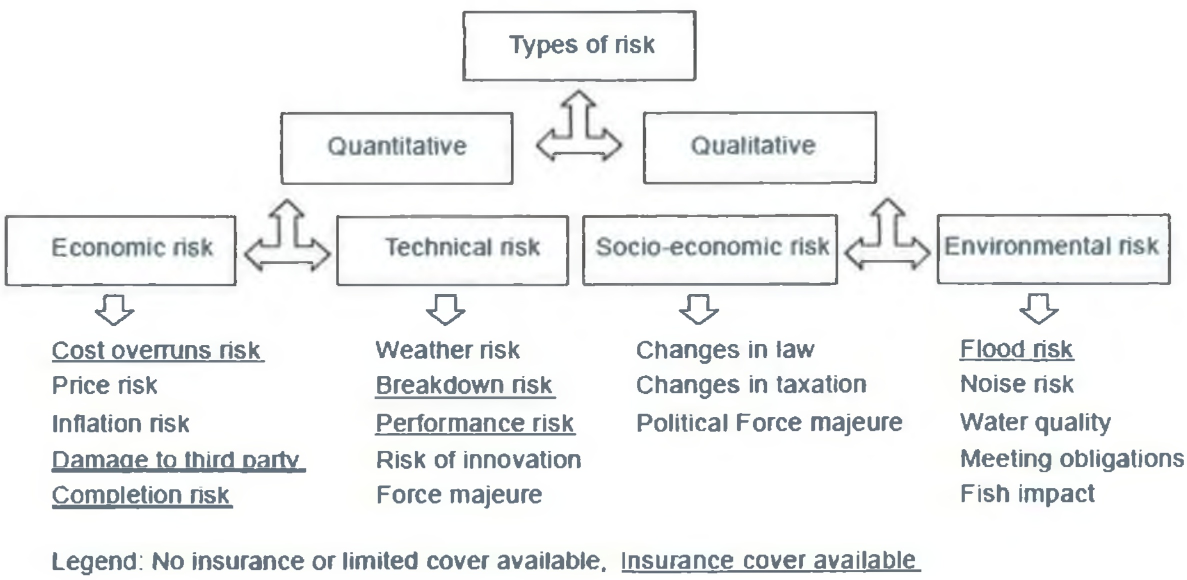
(Millar and Lessard, 2001)

2.4.3 RE Project Risk Classification:

Cooper et al., (1985) recommended that systematic risk evaluation could be performed by subdividing a project into its major elements, and analyzing the risk and uncertainty associated with each in detail (Cooper et al., 1985 cited in Dey, 2001). In terms of RE Projects, they are exposed to an uncertain environment because of such factors as planning and the complexity of the design, presence of various interest groups, resources, availability, climatic environment and political environment and statutory regulations (Montes and Martin, 2006).

Therefore, the categorisation of risk is critical to identify the risk source and its potential outcome. Low-head, small-scale hydropower projects face risk and uncertainty at the project selection stage with the reliability of the data incorporated into the feasibility studies, economic forecasts, and environmental impacts. This would include such issues as flood risk, noise risk, water quality issues or fish impact (Figure 6).

Figure 6: Risk Classification – Low-Head, Small Scale Hydropower



(Wiemann et al., 2010)

In the financing stage the risks are political and economic stability, government commitment to policy, reliability of cost estimates, revenue projections and financial measures, such as currency and interest rates. Following the approval and the necessary permission has been granted, risks are encountered in the construction phase, including completion risk, cost overrun risk, meeting environment obligations, political and other forces majeure, changes in taxation and in law (Figure 6).

In classifying risks they should be subdivided into tangible (quantitative) and intangible (qualitative) features. Tangible features include the cost and benefits because they can be expressed in monetary terms. Intangible features cannot be readily valued in monetary terms. Such risks include socio-economic and environmental risks (Goldsmith, 1993 cited in Wiemann et al., 2010). Even though Figure 6 is not a complete list of risks associated with a low head, small scale hydropower development, it does categorise the main sources of risk.

2.5 THE RISK MANAGEMENT CONCEPT

Risk Management is considered to be one of the most important and fundamental disciplines of the entire Project Management process. However, it is perceived that it receives a minimal degree of attention within project organisations (Edwards and Bowen, 2005).

2.5.1 The aim of Risk Management:

The aim of risk management according to HM Treasury (2003) is to ensure that risks are identified at project inception, their potential impacts allowed for and where possible the risks or their impacts on a project minimised. This view is also shared by Flanagan and Norman (1993), who hold that the aim is to identify and quantify all risks to which the project is exposed. It has been outlined that the objective of risk management is to introduce a simple, practical method of identifying, assessing, monitoring and managing risk in a well informed and structured manner (Mills, 2001). Therefore, the aim of risk management is not to eliminate risk but to control it. Successful risk management reduces the uncertainty in achieving a successful outcome to acceptable and manageable levels (Dallas, 2006).

2.5.2 Perception of Risk Management:

Flanagan and Norman (1993) and Mills (2001) have the view that risk management is by no means a new concept. Mills (2001) established that traditionally risk management has been applied instinctively with risks remaining implicit and managed by judgement which is informed by experience. Systematic risk management makes risks known, formally describing them and making them easier to manage. Attention to risk is essential to ensure good performance. Although few would deny the importance of risk management, only few analyse the risks in practice other than by using intuition and experience. Risk management is a system which aims to identify and quantify all risks to which a project may be exposed, therefore leading to a conscious decision to be taken on how to manage the risk. Similarly, Baloi and Price (2002) observe that risk management relies heavily on experience, subjectivity and human judgement and thus is cognitive in nature.

2.5.3 Risk Management Cycle:

Risk management for a specific project consists of using the techniques of analysis and measurement to ensure that risks are properly identified, classified, monitored, managed and communicated to all relevant project stakeholders (World Energy Council, 2004). In order to understand the concept of risk management it is important to provide an introductory note to the risk management cycle, before it is explored in greater detail in Section 2.7. Wiemann et al (2010) and Jaffari and Anderson (1995) highlights that the risk management cycle should consist of three basic steps (Figure 7). They include:

Figure 7: Risk Management Cycle

(Wiemann et al, 2010)

1. **Risk Identification:** The risks are discussed following a structured approach of risk identification.
2. **Risk Analysis:** Probabilistic risk analysis provides a plausible scientific tool to identify and quantify the uncertainties of risk estimates. However, the process is more complex and costly in terms of analysis time and effort.
3. **Risk Resolution:** This process can be utilised using the previous two steps, to develop resolution strategies to strengthen or obtain investor confidence.

The extent to which the risk can be reduced or controlled is the responsibility of management, whose function is to plan, organise, control, monitor and review the measures needed to prevent exposure to risk (Wiemann et al, 2010). According to Godfrey (1996), systematic risk management helps to:

- Identify, assess, and rank risks, making the risks explicit.
- Focus on the major risks of the project.
- Make informed decision on the provision for adversity, e.g. mitigation measures.
- Minimize potential damage should the worst happen.
- Control certain aspects of projects.
- Clarify and formalise the company's role and the roles of others in the risk management process.
- Identify the opportunities to enhance project performance.

(Godfrey, 1996 cited in Mills, 2001)

2.5.4 Advantages of Risk Management:

There are many advantages to risk management; Dey (2001) highlights:

- **Control of Uncertainty:** There are often high levels of uncertainty at the outset of many projects. Risk management, however, aids the control of this uncertainty through identifying and questioning the assumptions on which the project are based and which could most affect the success of the project.
- **Greater Confidence:** Confidence can be increased knowing where uncertainties lie, how extensive these uncertainties are and their potential consequences.
- **Better Briefing:** One of the greatest causes of uncertainty at the start of a project is the problem of producing the brief. The application of risk management at the outset helps clarify the project objectives and can help recognise any constraints that are being set against these objectives.
- **Informed & Improved Decision Making:** Risk management techniques can help one appreciate the risks associated with a project. Decisions can be based on an objective, detailed and realistic assessment of the situation, whilst also taking alternative courses of action into account.

- **Concentration of Resources:** Risk management entails the early prioritisation of risks. Limited resources are concentrated on the major risks in order to achieve maximum effect.
- **Communication & Motivation:** Through a risk management team atmosphere, team members have an opportunity to air views and ideas and the opportunity to listen to others' past experiences. Team motivation and confidence are enhanced through the shared understanding of the project and the associated risks.
- **Risk at Minimum Cost:** By making risks explicit, risk management helps reduce the cost of risk. A systematic approach which focuses on risk at an early stage in the project is more likely to have high cost benefits.
- **Better Accountability:** Risk management offers a means of improving accountability in risk control by helping to identify and assign responsibility for risk management and ownership.

(Dey, 2001)

2.6 EVOLUTION OF RISK MANAGEMENT

2.6.1 Development of Risk Management:

During the second half of the twentieth century, in a similar industry, there was a rapid development of formal risk management processes in the construction industry. This was primarily due to the high occurrence of construction developments failing to deliver their project objectives. One of the major developments was in the 1970's in the construction of oil fields in the North Sea. Oil platforms were constructed on land and then towed out to be placed in several hundred feet of hostile North Sea waters during short weather windows. The requirement to predict accurately the completion dates of complex oil platforms against these tight timelines acted as a catalyst for the development of formal risk management in construction (Dallas, 2006).

In addition, at the end of the twentieth century the British Standards Institution (BSI) published the Project Management Standard BS 6079 of which the third part relates to the management of risks. This publication is not confined to any specific industry, but includes the management of risk in business-related projects (Dallas, 2006).

2.6.2 The Turnbull Report:

In 1999, the United Kingdom (UK) Government commissioned Professor Turnball to address the situation of business risk. The report made the following recommendation that all businesses should have in place a vigorous process for managing risk. The principles now set out in the Turnbull Report now set the standard for good corporate governance across all sectors, both public and private. The Report made the following recommendation:

"A company's objectives, its internal organisation and the environment which it operates in are continually evolving and as a result the risks it faces are constantly changing. A sound system of control therefore depends on a thorough and regular evaluation of the nature and extent of the risks to which the company is exposed. Since profits (or business results) are in part the reward for successful risk taking in business, the purpose of internal control is to control risk rather than eliminate it".

2.7 RISK MANAGEMENT PRACTICE

According to an HM Treasury Guide (2003) the *"Management of risk is an ongoing process throughout the life of the project, as risks will be constantly changing. Risk management plans should be in place to deal quickly and effectively with risks if they arise. It is important to work as an integrated project team from the earliest possible stages on an open book basis to identify risks throughout the team's supply chains"*. Therefore, in RE projects, managers need to address the critical nature of risk and uncertainty in the decision-making process, identify the risks and uncertainties inherent in a proposed action, assess their impact on the possible outcomes and design contingency plans to ensure sound business decisions. Failure to complete such activities will result in decisions made and undertaken that are likely to be sub-optimal, leading to unsuccessful project ventures (Alessandri et al., 2004)

2.7.1 Gateway Process

The Gateway Process helps to reduce overall project risk by examining the project at critical stages in its lifecycle to provide assurance that it can progress successfully to the next stage (Table 1).Whilst the Gateway Process outlined in Table 1 is related to construction projects the principles could be applied to RE developments.

Table 1: Gateway Process

Before Gate 0	Risk Analysis (High Level) of potential project options
Gate 0	**Strategic Assessment**
Before Gate 1	High Level Risk Assessment
Gate 1	**Business Justification**
Before Gate 2	Risk Management to identify risks for each procurement option, cost of managing them (Through avoidance, design/reduction, acceptance, share or transfer). Revise risk allowance
Gate 2	**Procurement Strategy**
Before Gate 3	Risk Management – Update risk register and revise base estimate and risk allowance

Gate 3	**Investment Decision**
Before Decision Point 1: Outline Design	Risk Management – Indentify residual risks and continue to manage risks and allowance. Implement collective risk management approach.
Decision Point 1	Outline Design
Before Decision Point 2: Detailed Design	Risk Management – Identify residual risks and continue to manage risks and risk allowance. Continue to implement joint risk management approach.
Decision Point 2	Detailed Design
Before Gate 4	Finalise design and start construction Risk Management ongoing during construction
Gate 4	**Readiness for service (Construction Complete)**
Before Gate 5	Risk Management ongoing
Gate 5	**Benefits Evaluation**

Early in the process, before Gate 1, decisions will be necessary about the balance of cost and risk in relation to the value that would be delivered to the client in terms of business benefit. In later stages the focus is on managing risk and opportunities for added value, having made decisions about the optimum way forward (HM Treasury, 2003).

2.7.2 Risk Management Activities:

The literature describes numerous process stages to define a systematic risk management cycle. There are disagreements on the terminology, and occasional combination and separation of some stages. However, in addition to the stages outlined in Section 2.5.3 an effective risk management system should comprise the following steps:

- Establish the appropriate context(s) of the project.
- Identify the project risks
- Analyse the indentified risks
- Develop a response/resolution to the risks
- Monitor and control the risks during the project
- Permit post-project capture of risk knowledge (feedback)

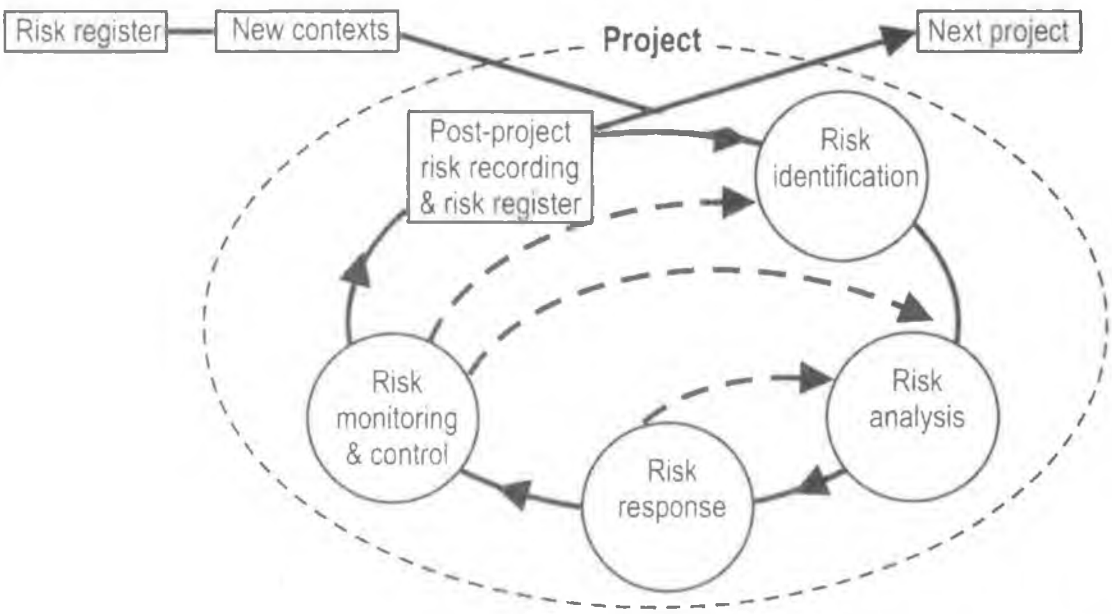
BSI (2002) gives a thorough description of risk management stating:

"*Risk management is the systematic application of management policies, procedures and practices to the tasks of establishing the context, identifying, analysing, evaluating, assessing, treating, monitoring and communicating risks in a way that will enable organizations to minimize loss and maximise opportunity in a cost-effective way*"

(BSI, 2002)

These processes can be represented as flow process diagrams (Figure 8). The system is deliberately shown here as cyclical loop, to indicate a learning process that should be ongoing from one project to another (Edwards and Bowen, 2005 and HM Treasury, 2003).

Figure 8: Systematic Cycle of Risk Management



(Edwards and Bowen, 2005)

2.7.3 Risk Identification:

Risk identification consists of determining which risks are likely to affect the project and then defining the characteristics relating to each risk. Identifying the project's risks is the first step in making it possible for a project to proactively reduce its overall risk and increase its chances of success (UNEP, 2004). The Institution of Civil Engineers et al. (1998) produced a guide for managing risk in projects. They highlight the importance of identifying risk because those which are not identified cannot be managed. In many cases, unfavourable outcomes resulted out of events which had not been identified as risk factors. In order to eliminate such failures the identification must be implemented in such a way as to minimize the number of unidentified risk factors (Dey and Ogunlana, 2004). In risk identification, the key question to ask is:

What are the discrete features of the project (risk sources) which might cause failure?
(Godfrey, 1996 cited in Mills, 2001)

Identification activities are critical, for any risks that are not discovered are risks accepted. The risk identification process provides the capability of uncovering the risk and sourcing the time of required action (Hall, 1997). Hall, 1997 identified some typical methods for risk identification. They include:

- **Physical Inspection** – Involving an actual visit to the location of the risk.
- **Flow Charts** – Used to describe any form of *'processes'* within a project.
- **Fault Trees** – Involves the representation of all proceedings diagrammatically which may result in loss. It also demonstrates the way in which the combination of proceedings may cause potentially dangerous problems.

Flanagan and Norman (1993) argue that an identified risk is no longer a risk but a management problem. Therefore, risk identification is a critical step when focusing on the sources of risk and possible effects.

2.7.4 Risk Analysis/Assessment:

When risks have been identified they must be individually assessed as to their potential probability and consequence (Borge, 2001 cited in Wiemann et al., 2010). The core of risk analysis according to Flanagan and Norman (1993) is that it attempts to capture all feasible options and to analyse the various outcomes of any decision. There is a view on risk assessment that it should be structured logically, and not based simply on intuition, giving the decision making process a defensible logic (Chicken and Posner, 1998). However, it is found that the most frequently used risk analysis techniques are intuition, judgement and experience i.e. subjective risk analysis (Lyons and Skitmore, 2004). The UNEP indicate that risk assessment for renewable energy projects should be completed and displayed by utilising the following matrix (Figure 9).

Figure 9: Risk Analysis Matrix

(UNEP, 2004)

Each risk is to be listed and a decision has to be made on the likelihood of the occurrence and the potential impact on the project if it occurs. The first quadrant, where the likelihood and the impact on the project are high, contains critical risks that will have a severe impact and are likely to occur. In the second quadrant significant risks are included that are not likely to occur but will have a material impact on the project if they do. The third quadrant manages significant risks that may be avoidable with careful planning and monitoring. However, those that do occur will have a low project impact, which is likely to be manageable. The fourth quadrant contains risks that should still be monitored to ensure that they do not change category. The amount of time devoted to these should be proportionate to their likelihood and impact (UNEP, 2004). If historical data is available, the projections made are more likely to reflect what could actually happen. However, it is important to handle this information with care, as many forecasts based solely on past data have been inaccurate or inadequate. If there is no historical information, estimates must be based on experience, knowledge or comparisons with similar cases, or effort must be expended to increase the certainty of the information (Vose, 1996 cited in Wiemann et al., 2010).

There are mathematical concepts of risk assessment. However, with regards most mathematical applications the calculation of probability relies on the theory of experimental repeatability. While this approach may be possible in industries such as manufacturing, where mechanised and computerised repetitive production-line processes are encountered, it is less frequently applicable to projects. Mathematical simulation (e.g. Monte Carlo Simulation (MCS) where iterative random number generation is used to represent probabilities in order to select unique variable values from predetermined range) can be used to replace experiments. However, if the inputted data is weak, the results of the MCS can be flawed. The nature of any project is diverse therefore limiting its specific exploitation in a project context (Edwards and Bowen, 2005).

The UNEP conducted a risk assessment case study of a hypothetical wind farm development project in China, which is a representative case of an emerging RE project in a developing country. The case study examines the risks associated with the potential development, concentrating on contractual, performance, technology and other engineering risks. The case study uses a survey method to produce a ranking of these risks in the context of the wind project, which presented twenty-one risks associated with developing a wind farm in China. Contractual, performance and technology risks are perceived to be of most concern in the context of financing RE projects. The most significant risk overall is contract bankability. It has the potential to effectively terminate the project. Warranty non-performance is linked to the technology efficacy still in question. Engineering concerns linked to defect in design, parts and workmanship during the construction phase is the number one ranked technology risk.

Further information on this case study is contained in Appendix 1.

2.7.5 Risk Response/Resolution:

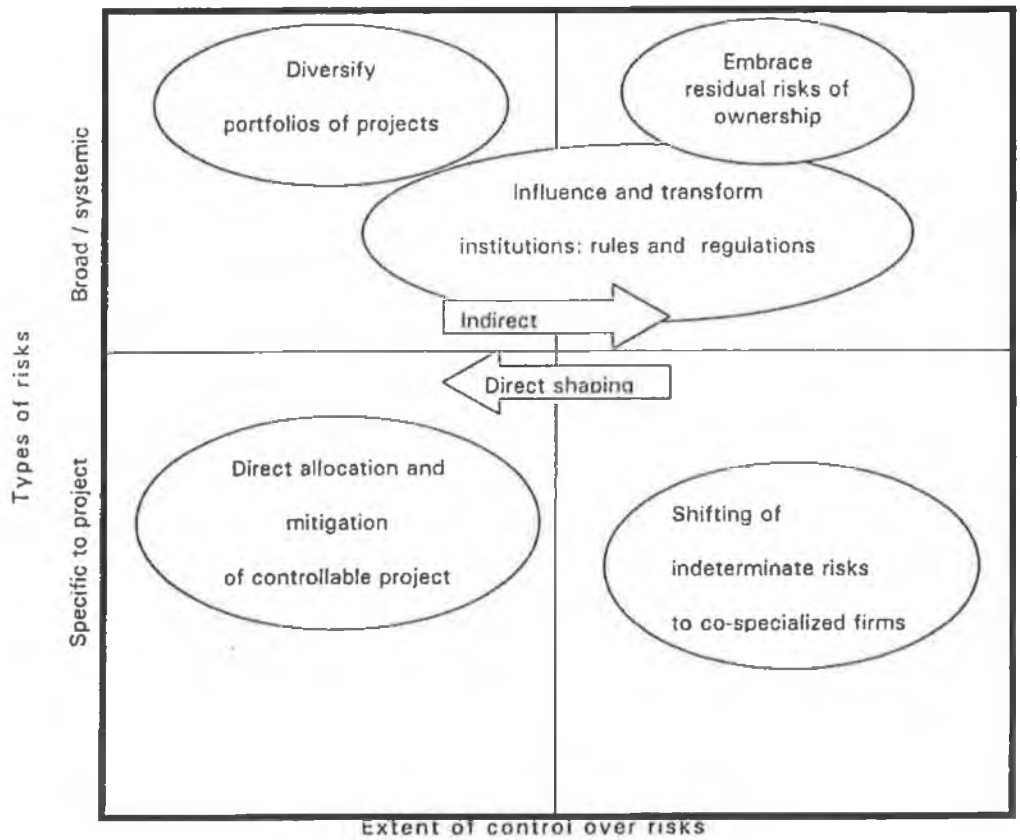
The greater the uncertainty associated with a project, the more calculated the response/resolution requirement must be. In this element of the risk management process the response required to resolve the risk should be accompanied with the benefits and costs of the course of action (Wiemann et al., 2010). Hall (1997) identified several risk response strategies including risk acceptance, avoidance, reduction, research and transfer. However, then UNEP indicate in reality there are only four possible responses that the parties involved in a RE project may adopt to deal with these risks. Risks may be:

- Avoided
- Mitigated
- Retained or
- Transferred

The first two examples of risk resolution are risk control techniques, a strategy conducted through mitigation, prevention, or anticipation. For example in the case of low-head, small-scale hydropower projects the risk of price uncertainty can be reduced through power purchase agreements. The feed-in tariff (EEG) in Germany for example, reduces risk and stimulates development. Risk transfer is the transfer of an identified risk to another party in the project team, which would be responsible for the consequences should the risk event occur. An example of this would be that construction risks can be eliminated by utilising a *'fixed timescale turnkey project'* with the contractor. Enzensberger et al. (2002) established that performance risk can be mitigated by analysing the present performance of previous projects of a chosen project developer. This risk strategy is called risk research which helps to obtain more information through investigation (Enzensberger et al., 2002 cited in Wiemann et al., 2010).

Millar and Lessard (2001) outline four risk management resolution techniques for large engineering projects: **(1)** shape and mitigate; **(2)** shift and allocate; **(3)** influence and transform institutions; and **(4)** diversify through portfolios. These techniques are illustrated in Figure 10 where it is based along two axes: the extent to which risks are controllable and the degree to which risks are specific to a project or systematically affect large numbers of actors. The recommendation for when risks are *"endogenous"* (specific and controllable) is to mitigate with traditional risk management approaches. In contrast, when risks are specific but outside the control of any of the potential parties shifting or allocating them using contracts or financial markets is the appropriate solution. When risks are poorly defined and under the control of affected parties, governments, or regulators, transforming them through influence is the way for sponsors to gain control. When risks are broad, systematic, but controllable, the approach is to diversify exposure through portfolios or projects. Residual, systematic, and uncontrollable risks have to be embraced by sponsors (Miller and Lessard, 2001).

Figure 10: Risk Strategies



(Miller and Lessard, 2001)

2.7.6 Risk Monitoring, Updating & Control:

Risk Feedback

Risk feedback should be required from all those involved in the delivery of the project to complete the risk management cycle. The purpose being to establish how well risks were managed, and how this could be improved. This information can be used to improve risk management performance in future projects; it should normally form part of the post project review. This should:

- Define acceptable levels of risk in the areas of quality, cost and time.
- Detail the risk reduction measures to be taken to contain risks within those levels.
- Outline cost-effective fallback plans for implementing if and when specific risks materialise.
- Identify the resources to be deployed for managing risks
- Explain the roles and responsibilities of all parties involved in risk management
- Describe how risks are to be monitored (HM Treasury, 2003).

Risk Management Performance Review

In a systematic risk management system the area of performance review is considerably underestimated in a project context and under-researched in the risk management literature. Similar to other management techniques, the performance of the system should be reviewed. The review will have to rely upon the assessment of feedback evidence from staff involved in the use of the risk management system in project development, which will be primarily be subjective. If this process is conducted methodically and the results are validated, the process should suffice. Table 2 outlines suggested performance criteria which could be included in the performance review. It outlines a framework which could be customised to be applied to specific projects.

The frequency of the system review should be dependent on the implementation level of a systematic risk management system, which may refer to the organisation maturity level or commitment to managing risk. This particular element is explored in more detail in the following section. However, in order to complete a systematic risk management cycle it is important that the system is reviewed on its performance to ensure progressive improvement (Edwards and Bowen, 2005).

Table 2: Organisational Performance Review Focus

RMS Stage	Performance Focus	Suggested Performance Criteria
Risk Identification	Effectiveness of risk identification techniques and processes	• What difficulties did staff experience in using techniques? • What logistical problems were encountered in the identification process? • How many foreseeable risks were missed and subsequently discovered later in the project? • How many unforeseen problems were actually encountered later in the project? • How realistic were the subjective assessments?
Risk Analysis	Effectiveness of risk analysis techniques and processes	• How accurate and reliable were any quantitative assessments? • How effective was risk mitigation plans?
Risk Response	Appropriateness and effectiveness of risk response decisions	• How effective was risk transfer action? • What comparisons can be made between before/after treatment risk severity scores or cluster maps (for sequential series of projects)? • Has the contingency spend rate per project decreased?
Risk Monitoring and Control	Effectiveness of risk monitoring and control procedures	• Do any procedures overlap with other management actions (e.g value management, quality management, safety management)? • Entry rate for new material decreasing?
Risk Recording & Archiving	Adequacy and effectiveness of risk register	• Is the risk severity of new entry material increasing or decreasing? • Has the risk register yielded information of added value for case studies, disaster recovery plans and rehearsals, etc.?

(Edwards and Bowen, 2005)

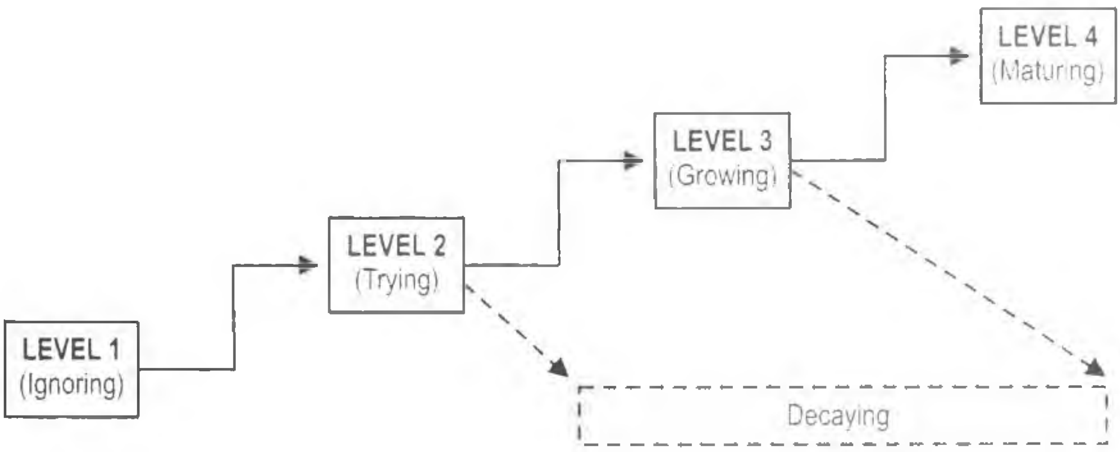
2.8 BUILDING A RISK MANAGMENT SYSTEM (RMS)

It has been noted throughout the literature review that risk is inevitable and an inherent characteristic of projects, with organisations implementing some level of risk management. The question that then arises is, How well do we manage risk? This particular element is the maturity of risk management within the organisation. Therefore, maturity can be measured in an organisation's commitment to managing risks systematically: how it has been implemented, how it operates, how it is maintained and improved (Edwards and Bowen, 2005). According to Hillson (2002), risk management maturity may be defined in four ascending grades (Figure 10).

2.8.1 Level 1: Ignoring:

In a Level 1 organisation risks are treated sporadically and usually on an ad hoc basis, resulting in the unsystematic management of risk. Therefore, in a Level 1 organisation risk management will be reactive rather than proactive. For example, the project activity proceeds on the assumption that everything will occur according to plan and that any deviation will be dealt with on its occurrence. Level 1 organisation planning is a basic process, resulting in *'luck'* attaching itself frequently to the organisation's descriptions of past project success, but failures are hardly mentioned (Figure 11).

Figure 11: Levels of Organisational Risk Management Maturity



(Hilson, 2002 cited in Edwards and Bowen, 2005)

2.8.2 Level 2: Trying:

Level 2 organisations seek to establish systematic risk management procedures. However, there is a continuing reliance on reactive rather than proactive responses to risk. Risk knowledge capture is likely to be patchy and inconsistent. This is primarily due to someone being assigned the responsibility for operating a project-based RMS often in addition to other organisational duties. In a Level 2 organisation, outside consultants will often have been engaged to provide advice and assistance with implementing the RMS.

2.8.3 Level 3: Growing:

In a Level 3 organisation risk management procedures will be standard, applicable to most projects. However, some unique or complex projects may test the capability of the RMS. Specialist staff may have been recruited, and selected staff given an opportunity to undertake advanced risk management education or training. Selected risk occurrences will be treated as learning experiences, as a means of internal training for staff and as a basis for procedural improvements. On some projects, the potential opportunity will have been recognised, and limited exploitation may have occurred.

2.8.4 Level 4: Maturing:

Risk management activity will be visible throughout a Level 4 organisation. Activity will be particularly evident in the operational, project-focused sections of the organisation. There will be a strong culture of risk management existing at all levels of decision making. Risk management procedures will also be mandatorily implemented, and no project will proceed unless acceptable procedures have been applied.

2.8.5 Decaying:

Just as an organisation can increase its maturity level in terms of risk management, its capability can also decay. Generally, the higher the level of maturity, the more gradual is the degradation of the RMS. Level 1 organisations are unlikely to experience any decay, due to them being unaware of their maturity level. However, a Level 2 organisation is likely to experience decay in its risk management activity for several reasons:

- Several projects have been completed without any clear identifiable benefit received from the application of a RMS.

- The senior management champion for the RMS loses enthusiasm or leaves the organization.
- The advice of outside consultants proves impractical.
- The post-project debriefings appear to yield little information of value.
- The RMS, or the risk knowledge database, proves too unwieldy or costly to operate and maintain.

In a Level 3 organization, decaying can often be due to the lack of continuing commitment to the objectives of the RMS. This may also explain the decay occurring in a Level 4 organisation (Hilson, 2002).

2.9 CONCLUDING REMARKS

In conclusion, risk is considered to be an unwanted factor which is liable to cause damage or loss to a particular project. Therefore, risks are effectively a threat to a project's success. There are many types of risk including socio-economic, technical, environmental, financial and legal. However, a critical and common factor with each risk is that it requires identification, categorisation, and control. It is acknowledged that trying to identify and eliminate all risks in projects is impossible, so there is a need for a risk management process in order to manage all types of risk. The emphasis should be on identifying and assessing the most critical risks and controlling them.

The most common activities practised are risk identification, risk analysis, risk response and risk monitoring and control. It can be concluded that the process of risk identification is the key to success in risk management. If a risk cannot be identified, how can it be managed? Therefore, the process of risk identification is essential to risk management. Once risks have been identified they must be individually assessed as to their potential probability and consequence. This will determine all feasible scenarios and analyse the various outcomes of any decision. From the various options of risk mitigation as discussed in this chapter, it may be concluded that risk reduction is the more widely practised and accepted form of response. It is a response whereby risks are actively reduced through the expertise and experience of project participants. It may also be concluded that continuous monitoring of existing, but also potentially risky situations, is essential to prevent unwanted and possibly detrimental risk events materialising.

Finally, it was noted that risk is inevitable and an inherent characteristic of projects, with organisations implementing some level of risk management. The question that then arose is how well we manage risk in determining an organisation's commitment or maturity. Consequently, this may prove an interesting comparison in the research findings of the study.

CHAPTER 3 – RESEARCH METHODOLOGY

3.1 RESEARCH METHODOLOGY

3.1.1 Introduction:

The aim of this chapter is to outline the chosen research design and the methods that were employed in order to carry out effective research for the purpose of this study. The chosen research design attempts to examine the perception of risk within the sector and the level of risk management implementation in project development. It outlines the chosen research process before discussing the research design and data collection methods undertaken. To conclude, it highlights the limitations of the research and how they have been adhered to.

3.1.2 Research Objectives:

Before the dissertation begins to explore the research design and the primary data contained in Chapter 4 it is important to once again highlight the research objectives, to understand fully what this study is striving to achieve. Therefore, the main objectives of this research dissertation include:

- To investigate what the perception of risk management is within the industry and to examine what is inhibiting the implementation of risk management being more readily adopted.
- To examine the processes of risk management, to establish the way in which risk management activities are conducted in the renewable sector.
- To enhance awareness and understanding of the presence and nature of risk in a RE project environment. This encourages the need to consider project risks more carefully, and it will help develop confidence in dealing with the risks associated with projects in a systematic manner.

3.2. RESERACH PROCESS

3.2.1 Qualitative vs. Quantitative:

'Research by its very nature is complicated, so much so that it rarely falls into one definite category' (Saunders et al., 2000). The field of research is dominated by two processes; qualitative and quantitative. They are not mutually exclusive, but are fundamentally different in their collection of data. Tables 3 & 4 below provide a coherent breakdown of some of these key distinctions.

Table 3: Distinctions between Quantitative and Qualitative

Quantitative	Qualitative
• Numbers	• Words
• Point of view of the researcher	• Points of view of participants
• Researcher distant	• Researcher close
• Theory testing	• Theory emergent
• Static	• Process
• Structured	• Unstructured
• Generalization	• Contextual understanding
• Hard reliable data	• Rich, deep data
• Macro	• Micro
• Behaviour	• Meaning

Table 4: Qualitative & Quantitative Analysis

Comparsion	Qualitiave Research	Quantitiave Research
Types of Questions	• Probing	• Non-Probing
Sample size	• Small	• Large
Type of Analysis	• Subjective	• Statistical
Ability to replicate	• Low	• High
Type of research	• Exploratory	• Descriptive, casual

(Bryman and Bell, 2007)

3.2.2 Reliability and Validity of Research:

An essential component which all researchers need to take into consideration when conducting research is the reliability and validity of the methods employed to obtain the research findings. It is stated that *"reliability is the degree of accuracy or precision in the measurement made by a research instrument*" (Kumar, 1996). The validity of a study depends on the relationship of one's conclusions to the real world, and that there are no methods that can assure that one has adequately grasped those aspects of the real world that one is studying.

Therefore, it is the opinion of the researcher that qualitative research was the most suitable process used for this study, primarily as it allowed the researcher to speak to people who dealt with managing risk firsthand on a daily basis, documenting the opinions which they have derived from personal experience. Bryman and Bell (2007) indicated that 'Used properly, qualitative techniques can give you a richness and depth that you are not likely to get through other methods'.

Due to the nature of this study into risk management, not all of the findings can be discussed in more critical, analytical and comparative terms with that of other research findings in the field of risk management. However, the analysis will be largely centred on the main findings of similar research in the area of risk management and a comparison made with this research where applicable.

3.3. DATA COLLECTION:

3.3.1 Secondary Data:

A selection of methodologies for data collection was adopted in order to highlight the objectives of the study. Most of the information compiled was taken from a broad range of resources including electronic resources (GMIT and NUIG Library), research publications, and also in some instances inter-library loans from other institutions.

3.3.2 Primary Data:

The primary research tool used took the form of in-depth interviews which were semi-structured. They ensured the researcher did not deviate from the topic and when the interviewee did not understand a question the researcher was able to provide relevant information. It involved a list of themes and questions, drawn from the literature, ensuring each interviewee was given a chance to talk freely about beliefs and opinions regarding the management of risk. The main drawback from using interviews is the element of bias involved. Interviewee or interviewer bias was minimised through establishing an atmosphere of trust with respondents as the interviews progressed.

A total of four individuals (two developers and two financiers) were interviewed with background experience in the renewable sector. The purpose of the information attained from the interviews conducted with the developers was to investigate their perception of risk and the level of implementation of risk management in project development. In terms of the interviews conducted with the financiers it was more to provide to a contrasting opinion on the matter, but also to investigate their perception of risk within the industry and their willingness/confidence to invest.

The information attained from both sources proved very beneficial as it allowed the compilation of some substantial research findings to shed light and isolate the relevant issues discussed in the dissertation.

3.4 RESEARCH LIMITATIONS

Limitations were encountered during the research stage of the dissertation, primarily caused and influenced by resource constraints and information availability. The following limitations which were identified during the execution of the dissertation are categorised below:

3.4.1 Information (General):

During the research phase of the dissertation it was found that only a limited quantity of information was available regarding the topic relating to the RE Sector, and any information available seemed to be generated by a select few authors. Also, initially this dissertation was to concentrate on risk management with regard to wind energy developments. However, through further research in the area it was found that information was not only limited with regard wind energy developments, but throughout the RE Sector. It was the opinion of the researcher that these developments further highlighted the significance of the research question being posed.

This limited the research spectrum of the study and prevented the dissertation from acquiring information from a broad range of resources relating to the industry. However, it was found through research that the area of risk management within other industries is well advanced, such as in the construction industry and other large scale engineering projects. Therefore, on discussing this with the dissertation supervisor it was agreed that the principles of risk management within in these engineering projects could be applied to the renewable sector due to their vast similarities, in that a RE project is essentially an engineering project. Consequently, this further developed the spectrum of research providing other literature to review.

3.4.2. Personal Interviews:

The difficulty in securing personal interviews with suitable individuals created another obstacle during research. The pressures of modern business meant that many personnel targeted for their expertise in the RE Sector were considerably busy and student research was considered less of a priority.

3.5 CONCLUDING REMARKS

In the execution of the dissertation all options were investigated in thorough detail and the chosen methodology was the most adequate and rewarding for this study. "*Good research generates dependable data, derived through practices conducted professionally which can be used and relied upon*" (Blumberg et al., 2005). Considerable effort was made on behalf of the researcher to conduct the study with the highest of ethical standards and professionalism.

CHAPTER 4 – RESEARCH FINDINGS

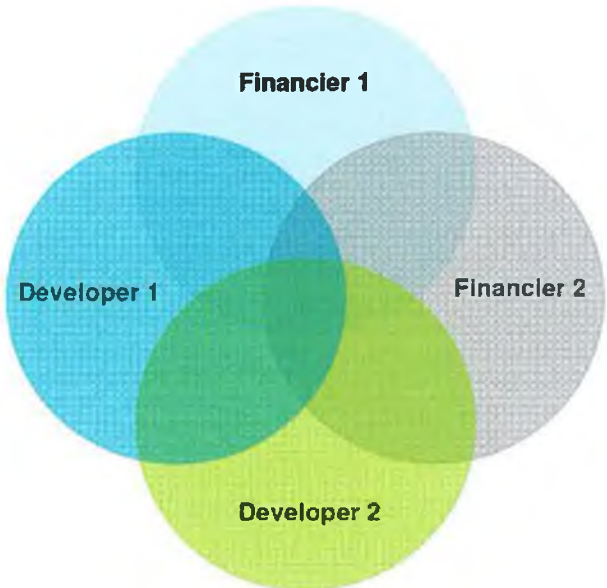
4.1 PRIMARY DATA

4.1.1 Introduction:

This chapter presents the research findings received from conducting interviews aimed at satisfying the research question. The most logical approach for a consistent breakdown is to divide the results into sections based on the research objectives identified. These are **(1)** To determine the perception of risk within the industry **(2)** To identify the development of risk management within the renewable sector **(3)** To investigate risk management strategies and practices. These elements are essential to answering the research question.

Due to the competitive nature of the industry, and the interviewee's eagerness not to reveal trade secrets, confidentiality was a major factor and as a result throughout this chapter the names of the interviewees will take the form of Developer 1 & 2: Financier 1 & 2 (Figure 12).

Figure 12: Interviewee Opinion



4.2 PERCEPTION OF PROJECT RISK

4.2.1 Attitude towards Risk:

When asked what the overall attitude towards risk in the industry was, a consistent response was provided. It is established however that the overall opinion is that there is a poor attitude towards risk in the industry. Developer 1 explained that there are many developers who have little or no experience in developing wind farms. They bring projects to a certain development stage in an attempt to make a '*quick buck*'. This was also the opinion of Financier 1 who indicated: *"Inevitably some developers are skewing the market. They have no interest in developing wind farms; they only see it as a 'money racket'. The worst thing about this scenario is that there are no consequences or repercussions if they get it wrong."* Financier 2 noted: *"Yes some developers put too little effort into managing risk early on in a project; maximising profit is the only consideration given any significant thought."*

In terms of their own organisations, it was evident from the discussion that both developers had an excellent understanding of risk, it being at the focal point of every decision of project development. Developer 2 stated: *"Within the industry there is a healthy appetite...in that developers are not afraid to take on risk. But, the success of the project is dependent on how well they manage them. There are people out there that who only see wind developments as 'money making games'. Our organisation's success did not just happen overnight. We have over 10 years' experience in the renewable sector...If we are going to do this, we have got to do it right"*.

Developer 2 proceeded to state that they take a proactive attitude towards risk, in every element of project development. In comparison Developer 1 made the point that risk management is critical: *"Right from the word go, from conception to operation. We accomplish successful projects by understanding the basics of project development....our board are insistent on assessing every angle"*.

2.2.2 Principal Risks:

Following from the previous section if there is a variance in attitude towards risk there will be variance in what is perceived to be a risk to potential developments. Developer 2 noted: *"In the renewable industry there are vast amounts of entrepreneurial developers out there....Depending were you're sitting within the industry, you have a different perception of risk.....It's not that these developers don't recognise some of these risks; it's the willingness of developers whether small, medium or large with the appetite to take on these developments".*

However, the principal risk which Developer 1 & 2 identified for the development of their renewable projects is the consistency of the wind regime (resource). Developer 1 indicated: *"Everything else can be managed to a certain extent".* Developer 1 highlighted that the perception of risk will vary from developer to developer. However, there perceptions should similarly correspond. Developer 2 indicated that the accuracy of their feasibility studies is critical, ensuring at minimum 2-3 years of wind data from the site location.

Developer 1 & 2 both stated that the second risk which they encounter is the proximity of the development to the grid. It was explained that a key element of both their risk strategies is in their site selection. Developer 1 stated: *"We have moved away from the West of Ireland. We look for flat sites....even small obstructions such forestations can significantly increase O&M [Operating & Maintenance] costs....it's the most simple cost effective approach....we are interested in developing projects which will pay back".* Developer 2 noted that their site selection criteria is essential in their risk mitigation strategy – *"We apply a hurdle rate for developments, if we exceed a certain hurdle rate....we re-evaluate the project viability"*

The final principal risk which both developers identified was planning: both referred back once again to their site selection criteria, stressing its essential bearing on project success. Developer 2 indicated *"that a good rule of thumb with regards planning in Ireland would be 50% project success rate".* In an interesting note both developers eliminated the idea of NIMBY's having an instrumental affect on the development of renewable projects. Both developers indicated that they have excellent consultation processes with local communities, stating that they revaluate development plans to meet their needs.

4.3 RISK MANAGMENT IMPLEMENTATION

4.3.1 Inhibiting Development Factors:

In determining the factors which are inhibiting the significant development of risk management in the RE sector, both Developers and Financier 1 believe that it is due to the lack of experience and poor attitude of developers. Developer 1 stated *"I must underline that it once again relates back to the type of developer in existence....I have no doubt there are renewable projects being undertaken which are not managed with the appropriate experience or knowledge."* Developer 2 was more consistent on the subject of developers *"not understanding the risk complexity and magnitude of renewable projects"*. In contrast, Financier 2 believed that the attitude of developers was the least inhibiting factor, ranking the availability & quality of risk management practices as his primary concern. In relation to this particular issue, Developer 2 stated that *"There is a complete lack of knowledge in the renewable sector from people that have entered the market. They don't appreciate the need for expertise in the development of renewable projects."*

Both Developers believe that the second factor which is inhibiting the development of risk management is cost. Developer 1 noted that *"Some developers are disillusioned by the costs of a wind development, which brings a sense of reluctance to the finance consortiums to their developments"*. Developer 2: *"It's not an additional cost, it's a necessity. If you don't even implement simplistic risk management principles, you won't develop a successful project"* Financier 1 believes that risk management does add a considerable cost to management expense: *"at the front end....but the advantages definitely outweigh the costs in the long term repayment of risk."*

All interviewees agreed that there is significant improvement needed within the industry in terms of knowledge and experience. Developer 2 stated *"That there is always room for improvement in terms of education and training, further developing the wealth of experience, which is critical for any project development"* Both Financiers indicated that the concept of risk management is broad and often expressed in general terms. Financier 1 stated *"it would be beneficial to introduce education and training project specific to the renewable sector...there is a complete lack of available people with industry knowledge."* Both Financiers agreed that it is a serious issue that Developers will not carry out critical risk management procedure on renewable projects. Financier 1 commented: *"Yes, it is a critical aspect....but it relates back again to profit maximisation on the developer's behalf."*

It can be noted from all interviewees that there was a strong opinion that intuition and experience are considered key factors when managing risk on a project. Developer 2 commented *"Education of risk management is key...understanding the business"*.

4.4 RISK MANAGEMENT PRACTICES

4.4.1 Techniques & Practices:

Within Developer 1's organisation risk management is an internal process, as they believe it achieves more satisfactory results both in terms of cost and quality. Developer 1 explained that their organisation has very significant risk management tools at their disposal – *"The board are insistent that such tools as business models, simulations, and stress test models are utilised in the evaluation of each project....there are developers out there that have entered the market because the barrier level was so low....they do not utilise such practices....there is essentially no forethought going into the development of projects"*. This opinion concurred with Financier 2 who stated that *"There are a many developers present in the industry....while risk is considered and factored into decision making it is usually done in an unstructured manner"*

Developer 1 explained that *"within our risk management toolbox, we have over 20 years' experience in developing wind farms"*. Even though there were no recognised risk management techniques/systems in operation within the organisation, it was evident from the discussion that risk was a critical aspect and at the centre of each project development. However, they did implement such systems for health & safety and quality, which could be identified as an element of risk mitigation. Developer 1 stated that they utilise simple risk management tools and principals such as brainstorming, decision trees, SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis and scenario planning, concepts which have been outlined in the research dissertation. Developer 1 outlined *"using such risk management tools and principles and the combinations of our development teams intuitive nature and understanding of risk, allow us to present water-tight projects to investors."*

In comparison, in Developer 2's organisation risk management was also an internal process. Whilst Developer 2 indicated that they did not have a risk management department per se, it was a critical aspect of their project management structure. Developer 2 stated "*Our Risk management tool is simple...We ask the questions – What's the problem? What's the likelihood? What's the severity and how can it be mitigated? It's based on a framework of essential categories of wind regime, grid, planning and land."* (Order of importance) Developer 2 indicated: *"The risk process is only as good as the information inputted...it's like a computer. A computer can only do what you tell it to do!! If you can't identify the risks, there is no point having a risk management structure.... experience is essential"*.

Developer 2 proceeded to discuss procedures and BMP (Best Management Practices) of developers, indicating how risk management procedures can be basic in an organisation, by setting out management principles clearly in doing x, y and z systematically. Developer 2: *"You don't need a risk manager per se; you need to develop an ethos of risk management within your organisation....it's general project management"*. Developer 2 commented on some developers risk management practices indicating - "*It is done in everyday dealings but it is not a formal written structure*". Within their organisation every element is tabulated. This provides a more systematic approach, but also allows their organisation to build up a portfolio of projects. In an interesting note Developer 2 indicated that they utilised a gateway process in the development of their projects. Developer 2 stated that *"This gives us an indication at each stage of our development what the severity of risk is, and what level of risk management implementation is required."*

4.4.2 Managing Risk:

When asked what their opinion on managing risk in project development was, Developer 1 said that the most cost effective way of dealing with risk is for them to take responsibility, stating that *"due to the large extent of partners involved in the development of a wind farm, in the end no one wants to be left 'handling the baby'"*. For example Developer 1 utilised the construction phase as an example, highlighting that if they put all the onus on the construction contractor, this would lead to increased construction tender prices, with the construction companies embedding additional costs. Developer 2 noted: *"Discussing risk in a general context...there are risks that cannot be controlled, then there are risks which can be controlled but are still at a very high rate....experience plays an integral role."*

In terms of managing risk Developer 1 stated *"It is essential to have in place clearly devised contracts, which are a significant mitigation tool"* Developer 1 highlighted that some developers see legal costs as an inappropriate expense, stating that *"Slightly increasing expenditure in the devising of contracts, may pay dividends in the risk mitigation of the project."*

In contrast, Financier 2 emphasized that the most effective way of controlling risk was *"ensuring you have and maintain control over the relevant risk throughout the development process. If developers do not have the sufficient skill set, using a professional provider should be the ideal option"*. Developer 2 believes without question that it is *"internal organizational processes, procedures, policies, BMP that are critical to the successful management of any project. Developers impose risk on themselves by not adopting such risk management essentials."*

4.5 CONCLUDING REMARKS

This chapter presented issues uncovered from the semi-structured interviews conducted with two Developers and two Financiers. The researcher compiled the interview responses under the categories and issues that the research objectives were composed of. The next chapter discusses these findings in relation to the literature and draws some conclusions from this.

CHAPTER 5 – DISCUSSIONS & CONCLUSIONS

5.1 INTRODUCTION

This chapter will further analyse the findings contained within the previous chapter examining further each area. The findings in some instances will be viewed in light of what has been discussed in the literature. Conclusions are also contained in this chapter.

5.1.1 Aims and Objectives:

This study intended to examine what is the standard of risk assessment and management amongst wind energy developers and to what degree is the concept of risk management applied within the industry? On the basis of the research question being posed, the dissertation literature review principally aimed to investigate and examine the various components of risk in relation to RE projects, outlining the managers' need to address the critical nature of risk and uncertainty in the decision-making process, identification of the risks and uncertainties inherent in a proposed action, assessment of their impact on the possible outcomes and the design of contingency plans to manage and ensure sound business decisions

Therefore, through the research findings of this study intended to determine what the perception of risk management is within the industry; and to examine what is inhibiting the implementation of a risk management process being more readily adopted, but also to enhance awareness and understanding of the presence and nature of risk in a RE project environment.

On the basis of the information that was discussed in the study and from what was outlined above the following maybe discussed and concluded from the dissertation.

5.2 RENEWABLE ENERGY SECTOR

5.2.1 RE Project Risk:

Chicken and Posner (1998) argued that risk is a universal concept, which is inherent in every aspect of life and that each activity has its own portfolio of characteristics, whether the risk activities be manufacturing, finance, major projects, transport or sport. In a project context risks can be described as likely future occurrences that will adversely affect the project's objectives or goals.

These projects are characterised by the continuous decision making due to the numerous sources of risk and uncertainty, many of which are not under the direct control of the various project participants. In terms of RE projects, they are exposed to an uncertain environment because of such factors as planning and the complexity of the design, presence of various interest groups, resources, availability, climatic environment and political environment and statutory regulations. Therefore, in a renewable context it can be concluded that risk is predominantly considered to be an unwanted factor, which will cause damage or loss, effectively risks are threats to the project success. Therefore, the attitude towards managing risk is critical to ensure successful project development.

5.2.2 Attitudes towards Risk

Millar and Lessard (2001) argued the idea that diligent developers refuse to sit idle, waiting for the probabilities to yield a *'win'* or a *'loss'*, but work hard to influence outcomes and turn the selected initial option into a success. It is also argued within successful firms they cut their losses quickly when they recognise that a project has little possibility of becoming viable. It can be concluded from the interviews conducted with the developers that they both have a proactive attitude towards the management of risks, both developers noted throughout the interview that they are **ONLY** interested in developing successful projects. Developer 2 indicated "*...If we are going to do this, we have got to do it right*" whereas Developer 1 stated "*We accomplish successful projects by understanding the basics of project development....our board are insistent on assessing every angle*".

However, it was it was the opinion of all the interviewees there is a variance in developer in existence within the renewable market. Therefore, it can be concluded that perception of risk will also differ, causing risk and uncertainty to vary from project to project. In the opinion of Financier 1 - *"Inevitably some developers are skewing the market. They have no interest in developing wind farms; they only see it as a 'money racket'"*. It was concluded from the interviews conducted, the variance in developer is due to barrier level for entry into the market being too low. Developer 2 stated *"Within the industry there is a healthy appetite for risk, in that developers are not afraid to take on risk. But, the success of the project is dependent on how well they managed them. There are people out there that only see wind developments as 'money making games'"*. Developer 2 also stated that there are developers *"not understanding the risk complexity and magnitude of renewable projects"*. Similar to this Mills (2001) argued there are *'risk takers'* who take on risk without understanding the full impact.

Therefore, in a leading argument it can be concluded the principal factor which is influencing the significant development of risk management in the Irish RE Sector, is the genuine knowledge and attitude of developers. However, it can be determined that this is based on the type of developer in existence undertaking renewable energy projects. Developer 1 stated *"...I have no doubt there are renewable projects being undertaken which are not managed with the appropriate experience or knowledge."*

It can be concluded that the second inhibiting factor is cost. In the literature it was discussed that the process of checking and managing risk is perceived costly and adds to the overall project expenditure, influencing the revenues of project developers and also their willingness to adopt a risk management system. It can be concluded from the research findings there are developers who perceive risk management as costly and it only receives a minimal degree of attention. Developer 2 stated - *"It's not an additional cost, it's a necessity. If you don't even implement simplistic risk management principles, you won't develop a successful project"* Financier 1 believed that risk management does add a considerable cost to management expense *"at the front end....but the advantages definitely outweigh the costs in the long term repayment of risk"*.

5.2.3 Principal Risks:

It can be concluded that developing a wind farm from an initial concept to operation is prolonged and an intricate process with associated risks of failure and non-recoupable costs in each stage of its development. From the literature it was highlighted that resource risks present the highest potential impact to successful project development. The findings from the interviews also indicated that resources risks present the largest risk to both developers and financiers, Developer 1 stated *"Everything else can be managed to a certain extent"* whereas Developer 2 stated *"We want projects that will payback"*. Therefore, the analysis of wind frequencies for the specific location is of critical importance for successful project development, ensuring wind measuring systems are installed early enough.

Grid Proximity and planning were the next principal risks outlined by developers. In terms of planning the literature highlights that this is the *'make or break'* phase of the development, the refusal pattern by the Irish planning authorities of wind farm developments equates to 50-60%, which is predominantly evident in the western counties. This similarly agreed with developer 2's rule of thumb indicating a 50% success rate.

On the basis of NIMBY's, the research findings agreed with study conducted by Lansdowne Market Research in that the Irish public are becoming more favourable towards wind farm developments, believing wind to be a good thing. Both developers eliminated the idea of NIMBY's having an instrumental affect on the development of renewable projects. Both developer's indicated that they have excellent consultation processes with communities stating they re-evaluate there development plans in the mitigation of such issues.

It can also be concluded that comparisons may be made to the development of off-shore wind farms and that of the major developments in the 1970's in the construction of oil fields in the North Sea, which acted as a catalyst for the development of formal risk management in construction. Therefore, it may be concluded that due to the resultant increase in off-shore wind developments, it may act as a catalyst for the development of a formal risk management process, where risk will be a critical factor. However, Carryer and

Deeming (2004) highlighted it is important that the offshore wind industry does not try and *'re-invent the wheel'* in that off-shore wind developers may look at some of the lessons learned in the oil & gas, water, telecommunication, and aggregate industries, which may be of benefit to the industry.

5.2.4 Risk Management:

Wiemann et al., (2010) underlined the essential elements to remember with regards risk management is to be aware of all kinds of risk, but also develop a plan to eliminate or minimise them in a cost effective approach. There are disagreements on the terminology, and occasional combination and separation of some stages in the risk management cycle. However, the most common activities practised are risk identification, risk analysis, risk response and risk monitoring and control.

Even though there were no recognised risk management techniques/systems in operation within the organisation, it was evident from the discussion that risk was a critical aspect and at the centre of each project development. Developer 1 having 20 years experience in the sector indicated that they utilise simplistic risk management tools and principals such as brainstorming, decision trees, SWOT (Strengths, Weaknesses, Opportunities, and Threats). In comparison within Developer 2's organisation risk management was also an internal process. Whilst Developer 2 indicated that they did not have a risk management department per se, it was a critical aspect of their project management structure. Developer 2 stated "*Our Risk management tool is simple... We ask the questions – What's the problem? What's the likelihood? What's the severity and how can it be mitigated?* In an interesting note Developer 2 indicated that they utilised a gateway process in the development of their projects which gave them an indication *"This gives us an indication at each stage of our development what the severity of risk is, and what level of risk management implementation is required".*

Therefore, it can be concluded that risk management is significantly emerging with developers with some similarities to that of contained in the literature. While it is simple in nature **SOME** developers are making progress to adopting techniques and practices which are contained in the risk management literature.

In a leading discussion, in determining the developers organisational maturity (commitment to risk management), it may be difficult to establish an exact conclusion from the research findings, due to some sensitivities which may have been portrayed in the interview. However, according to Hillson (2002), risk management maturity may be defined in four ascending grades (Ignoring, trying, growing, and maturing). Therefore, on this basis it would be concluded that the developer's interviewed would be in the early stages of maturing. This is primarily due to the developers, not having a risk management system per se, but viewed it as general project management. However, it must be highlighted that both developers deemed risk as a critical and at the focal point of every decision.

5.2.5 Industry Knowledge:

Mills (2001) established that traditionally risk management has been applied instinctively with risks remaining implicit and managed by judgement which is informed by experience. Consequently, it can be concluded from the research findings that all interviewees agreed that experience is essential not just in the management of risk but ensuring successful project development. However, it can be concluded from the research findings that there is inexperience existent within the sector. Developer 2 stated that *"There is a complete lack of knowledge in the renewable sector from people that have entered the market. They don't appreciate the need for expertise in the development of renewable projects."* Therefore, It may be concluded that this is a concerning issue within the industry to not only to ensure the development of successful projects, but in Ireland meeting its renewable energy targets.

For that reason developers within the industry, regardless of their maturity level learn from past projects bringing their experience in to the next project. Past projects could be considered real-life scenarios from which to gain experience that might stand the developers in the future so that probable risk that might be encountered in a new project can be identified beforehand and measures taken in order to avoid triggering those risk events. Therefore, it would be recommended that developers should adopt a continuous learning approach to project development ensuring the "*....Education of risk management....understanding the business" (Developer 2).*

5.3 CONCLUDING REMARKS

5.3.1 Strength of Research Question:

In conclusion all the interviewees agreed with the theory of the dissertation in that it was a novel idea especially in this particular era. In that they believed that the finance consortiums are lacking in confidence of investing in RE projects. However, a theme developed from all the interviewee's that this is primarily dependent on the type of organisations which are developing such projects. Developer 1 hoped *"that the banks would finance projects being developed by the larger companies in the market which have done and will continue to develop successful projects, who have the skill sets, capabilities and resources to present to the banks"*. Therefore, it may be evident to conclude that there are certain types of developers in existence within the renewable sector, which underestimate the magnitude of risk and view the development of projects as a *'money racket'*. Financier 1 stated *"Off course we are going to be more stringent in our project selection stage, especially in an unstable economic climate such as Ireland. Even at our end it requires layers of assessments which need to be done on project selection....if a developer has a significantly developed risk management system, we are going to be more willing to invest"*. Therefore, it can be concluded unquestionably that there is going to be reluctance from the finance consortiums to invest in RE projects. However, this may be dependent on the developer in existence within the sector.

5.3.2 Final Remarks:

This research dissertation provides some interesting insights into the importance of considering risk from the beginning of a renewable energy project. In the final objective of this study, it was intended to enhance awareness and understanding of the presence and nature of risk in a RE project environment. It is believed that this research not only created awareness on behalf of the researcher, but it is felt that the reader will gain significant knowledge and experience in terms of both risk and risk management. Therefore, encouraging the need to consider project risks more carefully and helping develop confidence in dealing with the risks associated with projects in an appropriate manner.

It can be concluded from both the primary and secondary data that investor confidence is critical for Ireland in meeting its renewable energy targets. Therefore, it is the belief of the researcher that the growth in financed renewable energy projects depends on the adequate design and implementation of risk management to mitigate inherent project risks. Therefore, in optimising the profitability/risk factor of each investment developers must carefully plan and analyse their project in avoiding the development inefficient renewable projects.

CHAPTER 6 – RECOMMENDATIONS

6.1 RECOMMENDATIONS

6.1.1 Introduction:

Based on negatives factors that were outlined throughout the dissertation in relation to risk management there are some recommendations and changes that would benefit the industry. Therefore, this chapter presents some recommendations for areas requiring further development and research. It also reveals the strengths of the research in relation to its originality and contribution to knowledge in this area.

6.2 FURTHER RESEARCH & DEVELOPMENT

A number of recommendations for future research and organisational development can be advised from analysing the findings of this study. They include:

6.2.1 Implementation at Inception:

In a general recommendation of risk management, the procedure should be systematically implemented at the inception stage of a project. Where the process of risk management is implemented at inception, it would set specific principles/goals for the entirety of the project. Management personnel will enter into a risk management mode of thinking and therefore all decisions made may be based on the best knowledge whether that decision poses a risk to the project or not. Risk management from inception will create an ethos of sound business decisions allowing the earliest possible identification of risks.

6.2.2 Education and Training:

As highlighted in the primary research conducted, it is the perception in the industry that there is a complete lack of experience in understanding project development. An attempt should be made to educate and train those responsible within organizations for dealing with risk to become more experienced with some of the existing processes of risk identification and analysis, therefore enabling such systematic processes to be conducted within organizations. Such education and training would enable the more effective management of risk. This, in turn, would help reduce the adverse affects occurring, producing low risk efficient renewable projects.

6.2.3 Development Regulation:

It was concluded in the research findings within the Irish renewable sector the barrier for entry is significantly low. Therefore, there are certain types of developers in existence within the sector which do not have the experience or knowledge to develop successful projects. The main concern is that there are no resulting consequences if the project fails. Therefore, there should be some means of a development regulation introduced into the renewable sector; the aim of this would be to control the type of developer undertaking projects, which could be dependent on their organizational maturity or project experience.

If it is felt that this particular resolution is unachievable, investors who actually provide the finance for these projects should implement stringent selection criteria, not only on the project selection, but also on the type of developer which is associated with the development.

6.2.4 Further Research (General):

The final recommendation is that the issues that were discussed in this study and the area of risk management should be a critical concept in the development of RE Projects. Therefore, it is essential that further research be conducted in the area of risk management particularly in a renewable context, but also for developers regardless of their organisational stature to acknowledge the inherent risks of these projects to ensure the successful development of RE ventures. It is the opinion of the researcher that the implementation of the recommendations outlined in this chapter, will help developers experience significant benefits in both project development but also an increase investor confidence within the industry.

6.3 STRENGTHS OF RESEARCH

6.3.1 Contribution to Knowledge:

This study contributed significantly to the knowledge of risk management as it is the first qualitative one of its kind to explore how developers perceive and undertake risk management in the development of renewable energy projects. Its originality lies in how it demonstrates to developers the concept of risk management, outlining the simplicity and benefits of implementing it in project development. Finally, this study contributes to the knowledge by enhancing the awareness and understanding of the presence and nature of risk in a RE Project environment.

6.4 CONCLUDING REMARKS

This chapter presents recommendations for further research and development derived from this study. It also discussed the originality of this study and its contribution to the knowledge of risk management within the subject area.

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APPENDICES

APPENDIX 1 – RISK ASSESSMENT CASE STUDY (CHINA)

This case study is a hypothetical wind farm development project in China, which is a representative case of an emerging RE project in a developing country. The case study examines the risks associated with the potential development, concentrating on contractual, performance, technology and other engineering risks. The case study uses a survey method to produce a ranking of these risks in the context of the wind project in China. The case study involves the installation of 67 turbines, with each turbine having a capacity of 1500 KW giving the project a total capacity of 100 MW. The project site is located in a North-eastern Chinese province with good wind conditions.

Risk Assessment:
The risks cover the four major phases of a project:

- Planning and development;
- Construction, testing and commissioning;
- Project operation; and
- Benefits realization with regards to certified emission reductions.

These distinct project phases present different risk profiles and concerns for lenders and financiers. The chart below describes 21 risks, with their details and project stages. Each risk is given a letter as a form of identity.

Table 5: Case Study Rank List

Risk Identifier	Risk Description	Details of Risk	Project Stage
A	Permitting/Planning Delays	Risks of delay due to the inability to obtain building permit/planning or other regulatory consents.	Project Development
B	Contract Bankability	Risks of being unable to secure bankable offtaker/fuel supply contracts.	Project Development
C	CER Bankability	Risk of Certified Emission Reduction (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.	Construction, Testing & 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)	Construction, Testing & Commissioning
F	Physical Hazard (caused by man or nature)	Risk of physical loss or damage to property caused man made and/or natural hazards/ catastrophes (e.g. fire, lighting, explosion, earthquake, flood, windstorm)	Construction, Testing & Commissioning
G	Offtaker Contract Failure	Risk that power offtakers withdraw from contract subsequent to financial closure	Construction, Testing & Commissioning
H	Catastrophic Design Failure	Risk of complete mechanical or control failure during testing and commission due to defective design.	Construction, Testing & 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, civil 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 electricity offtaker defaulting on 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 CER delivery shortfall or failure due to Kyoto regulatory risk (e.g. changes to the baseline methodology, monitoring procedures, additionality rules or other eligibility criteria).	Certified Emission Reduction
R	CER Political Risk	Risk of CER delivery shortfall or failure due to host country political action (e.g expropriation, nationalisation, confiscation and prohibitions in connection with the sale of CER's)	Certified Emission Reduction
S	CER Performance Risk	Risk of CER delivery shortfall or failure due to lower than expected plant performance.	Certified Emission Reduction
T	CER Insolvency Risk	Risk of 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 reduction post 2012	Certified Emission Reduction

Risk Assessment:

A risk survey gathering expert opinions was undertaken. The purpose of the survey was to capture the subjective perceptions of the above risks associated with the development and financing of the hypothetical wind installation in China, and to provide baseline data for further risk analysis and modelling. These risks were entered into simulation models, assessed for severity and frequency and ranked according to expected loss. There are four main risk categories identified:

- contractual risks;
- operational risks;
- physical hazards; and
- Risks related to CERs.

Contractual, performance and technology risks are perceived to be of the most concern in the context of financing RE projects. The most significant risk overall is contract bankability. It has the potential to effectively terminate the project. Other contractual-related risks are counterparty non-performance and default with respect to contractual obligations. Electricity offtaker default is considered to be symptomatic of doing business in emerging markets. Warranty non-performance is linked to the technology efficacy still in question. Engineering risk linked to defect in design, parts and workmanship during the construction phase and is the number one ranked technology risk. This is also symptomatic of many RE technologies such as wind with prototypical technology maturity. Risks involving clean development mechanisms (CDMs) appear less significant in terms of financial consequence compared to other risks. Still future certified emission reduction (CER) revenue streams depend on the delivery ability of the project. CER bankability risk is negatively affected by this.

Figure 13: Case Study Risk Map

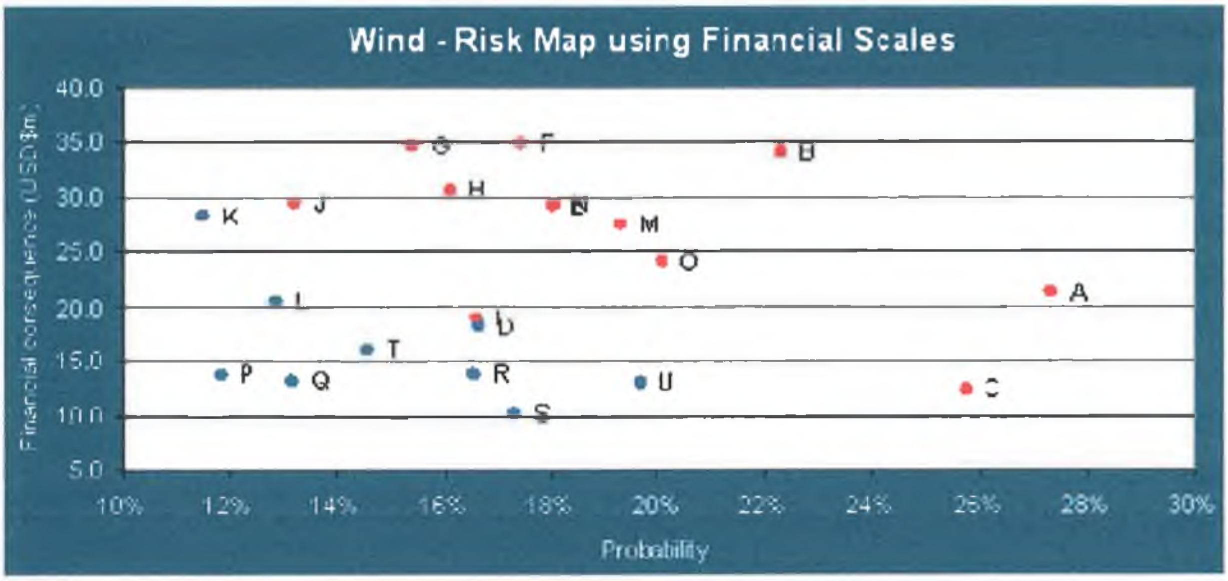

Table 6: Case Study Risk Ranking

Risk Ranking	Risk Letter	Head Line Risk	Details of Risk	Expected Loss
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 manmade and/or natural hazards/catastrophes (e.g fire, lightning, 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, lightning, 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 testing and commission due to defective design.	6,678,678
9	A	Permitting/Planning Delays	Risks 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 Emissions 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 fall below required thresholds to generate economically efficient power outputs/electricity	4,873,565
12	I	Process Interruption	Risk of complete plant shutdown (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	2,631, 244

			methodology, monitoring procedures, additionally rules or other eligibility criteria).	
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, nationalisation, confiscation and prohibitions in connection with the sale of CER's)	2,615,596
21	S	CER Performance Risk	Risk of Certified Emission Reduction delivery shortfall	1,512,113